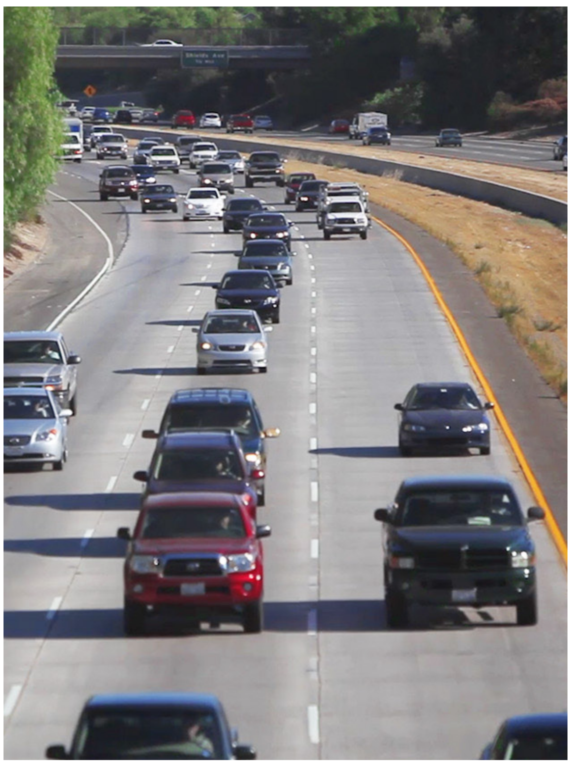
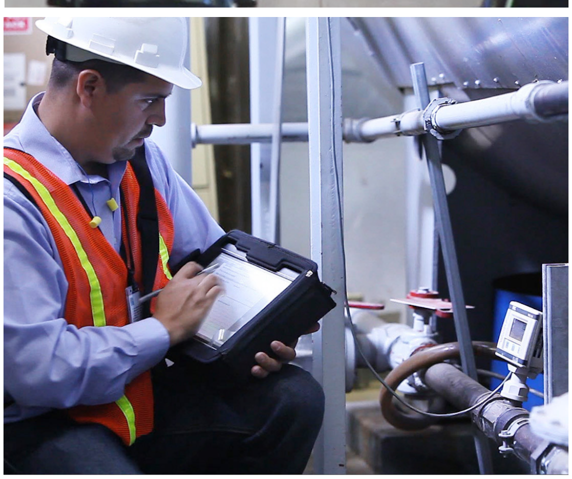
2012 PM2.5 Plan

Adopted - December 20, 2012





Strong regulations, effective incentives, and innovative technology advancement to meet the Valley's unmatched air quality challenges

San Joaquin Valley
AIR POLLUTION CONTROL DISTRICT

Executive Summary

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Executive Summary

The San Joaquin Valley (Valley) faces unique and unprecedented air quality challenges, and this plan is a continuation of the San Joaquin Valley Air Pollution Control District's mission to improve the Valley's air quality. Building on the *2007 Ozone Plan* and *2008 PM2.5 Plan*, this plan utilizes the latest science and best available information to lay out a strategy for demonstrating attainment of the newest federal standard for fine particulate matter (PM2.5) as expeditiously as possible. This *2012 PM2.5 Plan* was developed through an extensive public process, and will involve both Valley businesses and residents in making the efforts necessary to ultimately achieve clean air in the Valley.

Plan includes comprehensive strategy that builds on existing strategies and involves all Valley sectors

The District's *2012 PM2.5 Plan* is a multifaceted strategy that utilizes a combination of conventional and innovative control strategies to reduce emissions of PM2.5 and other pollutants that form PM2.5. The Valley's successes in adopting regulations and other strategies that have improved the Valley's air quality provide the foundation for this plan. In developing this plan, the District has left "no stone unturned" in evaluating all sources of emissions for potential strategies to reduce emissions (see Appendix D). In addition to reducing direct emissions of PM2.5, this plan focuses on reducing oxides of nitrogen (NOx) emissions, which is a predominant pollutant not only in the formation of PM2.5 in the Valley, but is also the focus of the District's ozone reduction strategies. This overlapping significance and emphasis on reducing NOx emissions helps to address both of the Valley's biggest air quality challenges, PM2.5 and ozone. Along with comprehensive efforts at the local level to reduce emissions, reducing mobile source emissions that are not under the direct authority of the District are critical to attaining the standard, and this plan includes state and federal measures that will provide significant new emissions reductions in the coming years. As outlined below, this plan's comprehensive control strategy includes regulatory actions, incentive programs, technology advancement, policy and legislative positions, public outreach, participation and communication, and additional strategies (see Chapter 10).

Overview of 2012 PM2.5 Plan Strategy

Local (District) Strategy:

- Wide-ranging regulations that reduce emissions from various Valley industries (stationary sources) and the general public. These regulations address stationary source emissions from boilers and steam generators, internal combustion engines, glass melting furnaces, turbines, and other sources. Additionally, the general public, employers, and small businesses are also involved in reducing emissions by complying with regulations that focus on residential wood burning, employer commuting, commercial cooking, and other sources.

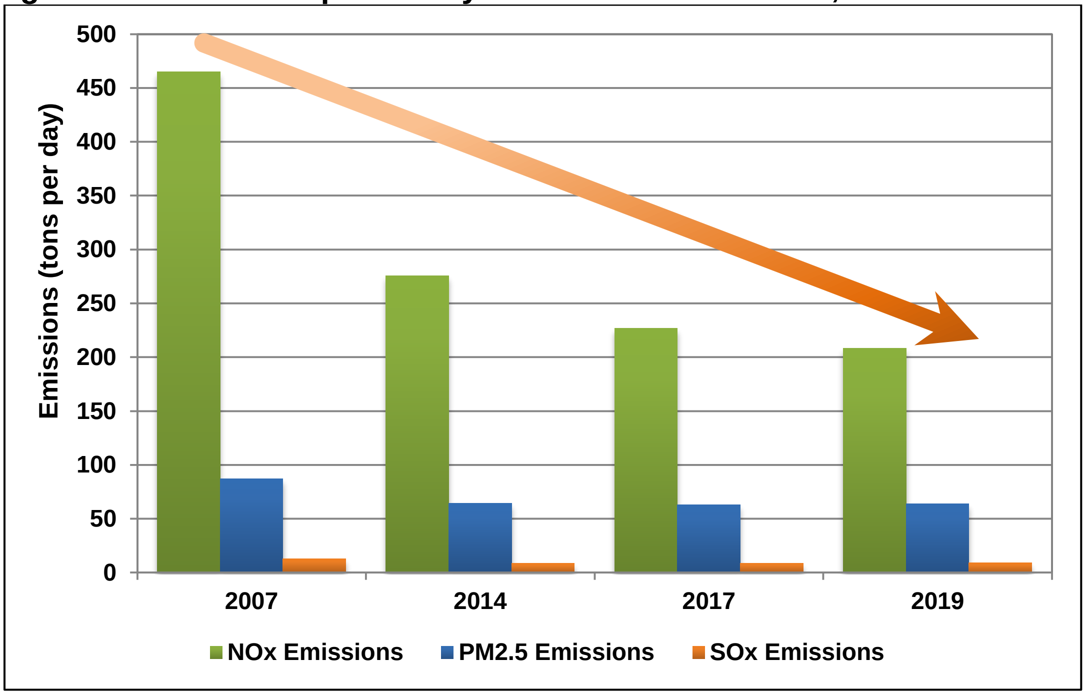
- Risk-based approach that prioritizes measures that expedite attainment of the standard and provide the greatest public health benefits.
- Incentive programs that target cost-effective mobile sources not under the direct jurisdiction of the District, including on and off-road vehicles and equipment.
- Technology advancement efforts that assist in the development of new zero and near zero-emissions technologies critical to addressing increasingly difficult air quality standards.
- Research/Further studies that will continue to develop policy-relevant air quality science and additional potential opportunities for clean air strategies.
- Policy and legislative efforts that assist in shaping new legislation and policies at the local, state, and federal levels that promote emission reduction efforts.
- Outreach efforts that assist in educating and empowering the public in getting involved in efforts to reduce emissions and improve the Valley's air quality.

State/Federal Strategy:

- Regulations that reduce emissions from the variety of mobile and other sources under state and federal jurisdiction, including on-road sources such as passenger vehicles and heavy duty trucks, and off-road sources such as construction equipment.
- Incentive funding and programs that assist the District in our effort to accelerate reductions from mobile sources.
- Technology advancement efforts including funding and collaborative support in the development of new zero and near zero-emissions technologies.

Through this comprehensive attainment strategy, the Valley will achieve attainment of the federal PM2.5 standard by 2019 (see Figure ES-1), reducing NOx emissions, the predominant pollutant leading to the formation of PM2.5, by 55% over this period. In addition to these much-needed NOx reductions, the District's strategy also reduces direct PM2.5 emissions that not only assist the Valley in attaining the standard as fast as possible, but also reduce the PM2.5 emissions that pose the greatest health impacts to Valley residents. These strategies, including new measures to further reduce emissions from residential wood burning and commercial charbroilers, reduce highly health-impactful PM2.5 emissions where and when they matter most in Valley neighborhoods, and provide health benefits beyond simply attaining the federal standard.

Figure ES-1 San Joaquin Valley Emissions Reductions, *2012 PM2.5 Plan*



Plan builds on successful strategies that have improved the Valley's air quality

The Valley's success in reducing its emissions through decades of clean-air efforts provides the foundation for this plan. This success provides assurance that similar strategies employed in the future will provide the desired results in helping to improve the Valley's air quality. This plan includes a comprehensive control strategy that builds on this past success, and identifies opportunities for reducing emissions from all Valley sectors, including the Valley's diverse range of businesses as well as the general public.

The District has a history of success in reducing particulate and ozone-forming emissions through a variety of ground-breaking rules and strategies. These innovative strategies, such as the first-of-its-kind Indirect Source Review regulation that addresses emissions from residential and commercial development, have proven to be highly effective, as evidenced by the steady rate of improvement in the Valley's air quality. The District's incentive program has become an increasingly important and effective strategy for reducing mobile source emissions that the District does not have direct regulatory authority over, with an expenditure of $481 million reducing over 94,000 tons of emissions since 1992. The District's landmark Conservation Management Practice rule proved critical in assisting the Valley to eliminate exceedances of the federal PM10 standard and reach attainment of the standard in 2005 (based on 2003-2005 data; see Figure ES-2). In addition to reducing emissions from the Valley's various industries and businesses, significant reductions in emissions have also been achieved by the general public, such as through the residential wood burning curtailment efforts that have been critical in helping to reduce PM2.5 concentrations. Based on the California Air Resources Board (ARB) 2006 almanac of emissions, from 1990 through 2005, the

Valley saw NOx emissions reduced by 41%, VOC emissions reduced by 38%, and SOx emissions reduced by 75% (see Figure ES-3).

Figure ES-2 Exceedances of PM10 Standard Eliminated

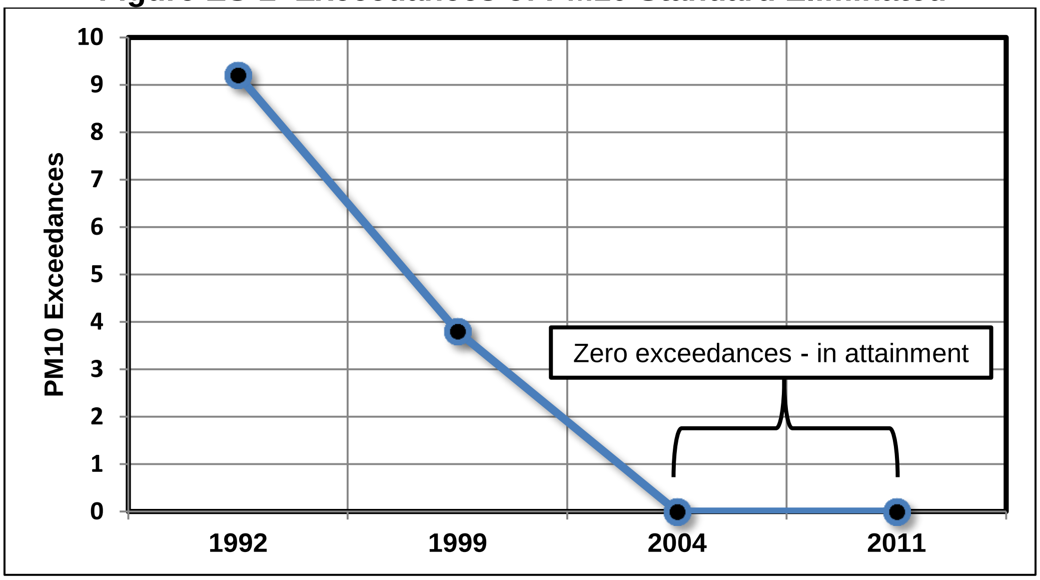
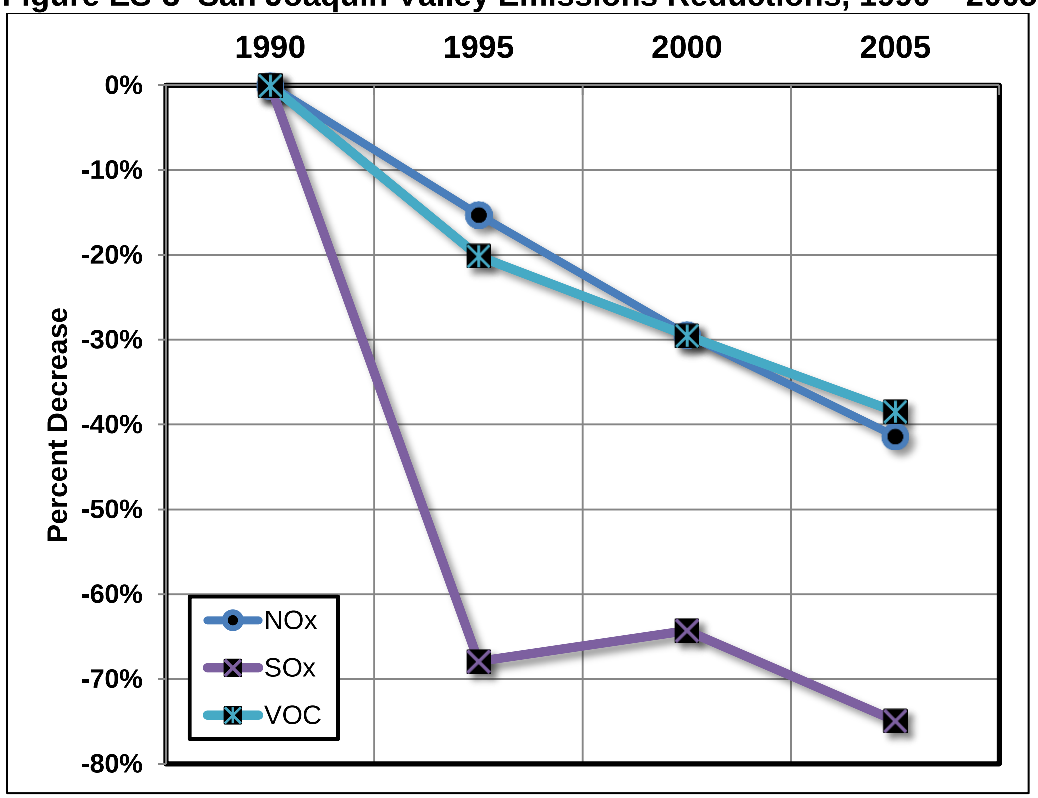


Figure ES-3 San Joaquin Valley Emissions Reductions, 1990 – 2005



These efforts to reduce emissions in the Valley have resulted in real and significant improvements in the Valley's air quality. The Valley's 24-hour PM2.5 "design values" used to measure progress relative to the federal standard have dropped by 40% since

2001, and are now below the 1997 federal 24-hour PM2.5 standard of 65 µg/m^3 (see Figure ES-4). With regard to ozone (commonly known as smog), exceedances of the 1997 and 2008 federal 8-hour ozone standards have dropped by 42% and 30% since 1992, respectively (see Figure ES-5). With respect to the Air Quality Index (AQI), in the winter season, during which the Valley sees its highest PM2.5 concentrations, the number of “good” AQI days has increased by 18%, while the number of “unhealthy” AQI days has decreased by 80% since 2000 (see Figure ES-6).

Figure ES-4 San Joaquin Valley PM2.5 Design Value Trends

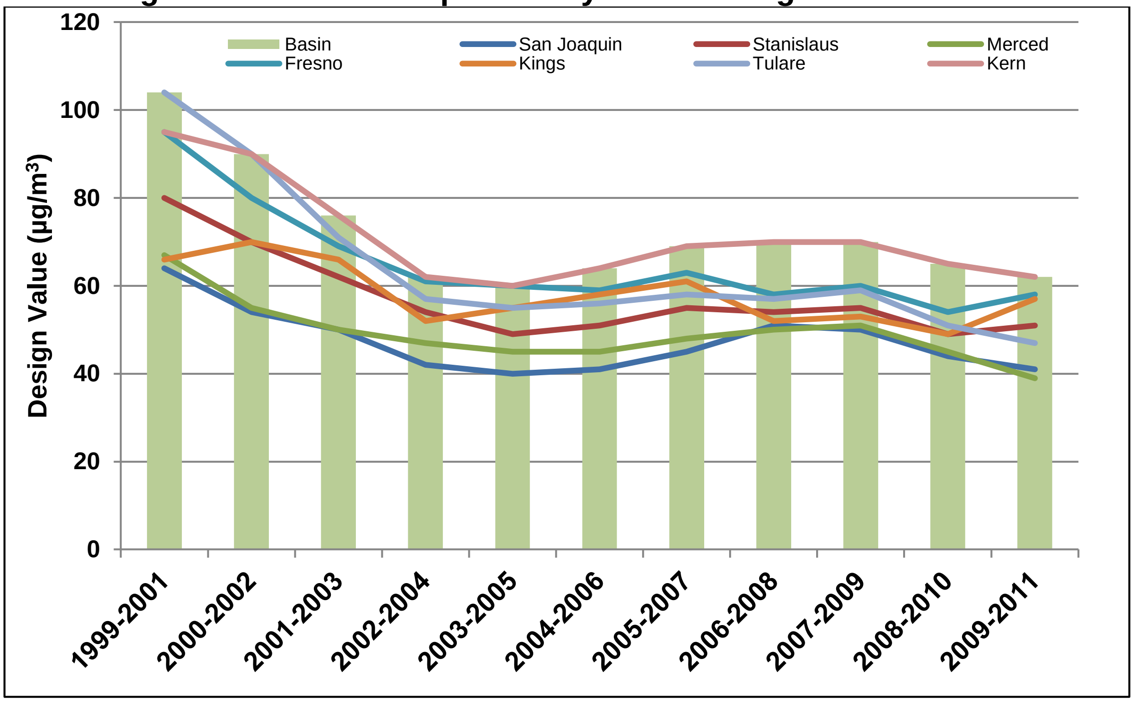


Figure ES-5 San Joaquin Valley Ozone Trends

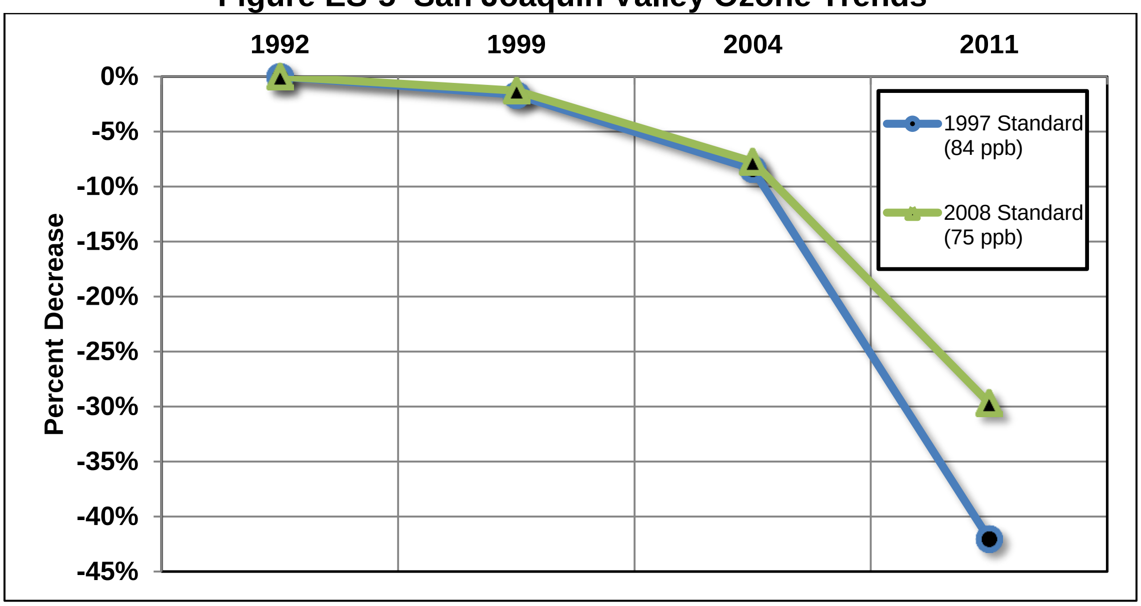
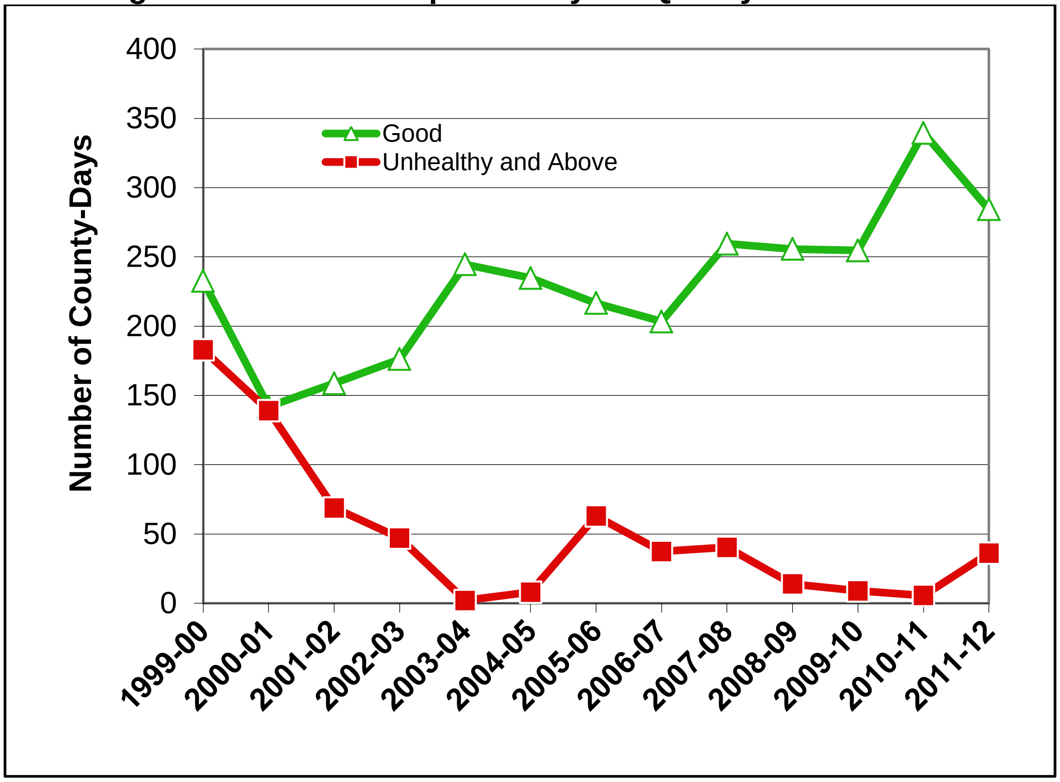


Figure ES-6 San Joaquin Valley Air Quality Index Trends



Plan prepared with extensive public input

The *2012 PM2.5 Plan* was prepared over the course of one year through an extensive public process that provided numerous opportunities for the general public and interested stakeholders to offer suggestions and comments for improving and strengthening the plan. The District has worked closely with these various stakeholders, including its partner agencies ARB and the Environmental Protection Agency (EPA), environmental and community advocacy groups, and business representatives to share information regarding the plan, and to receive comments and suggestions.

The District held numerous public workshops this past year that have outlined the air quality challenge faced by the Valley, and potential strategies for responding to the challenge. Workshops were held throughout 2012 in April, June, and October at the District's offices in Modesto, Fresno, and Bakersfield and by webcast, with many participants attending and providing feedback during these workshops. Discussions were held monthly during the District's public Governing Board hearings, where the public was invited to provide feedback. The plan was also frequently discussed with the District's Citizen's Advisory Committee and Environmental Justice Advisory Group.

In addition to meetings and workshops outlining the District's perspective and approach for developing this plan, the District collaborated with ARB to hold several public workshops that provided information about the scientific foundation of the plan, and provided additional opportunities for the public to ask questions and provide input. The District met with interested advocacy and industry representatives throughout the plan development process to address specific questions and comments, and solicit further suggestions for control strategies.

All of these workshops and meetings have provided opportunities for the public to provide verbal comments, and written comments have also been accepted throughout development of this plan. These comments have been integral to development of this plan, and have been incorporated as appropriate. All significant comments and responses are summarized and posted on the District's website.

Why has this plan been prepared?

The U.S. EPA set the first PM2.5 standard in 1997 and in 2005 designated the San Joaquin Valley (Valley) as nonattainment for the 1997 standard. The 1997 standard has two limits of attainment: an annual average of 15 $\mu g/m^3$ and a 24-hour average of 65 $\mu g/m^3$. The District adopted the *2008 PM2.5 Plan* in April 2008 to demonstrate how the Valley would come into attainment of the 1997 PM2.5 standard by no later than April 2015. EPA subsequently lowered the 24-hour standard to 35 $\mu g/m^3$ in 2006 and re-issued the nonattainment designation for the Valley in 2009. Through continued implementation of the *2008 PM2.5 Plan*, the Valley will be in attainment of the 1997 annual standard by 2015.

This *2012 PM2.5 Plan* demonstrates attainment of the newer 2006 24-hour PM2.5 standard by the federal attainment deadline of 2019, with the majority of the Valley actually experiencing attainment ahead of 2019. The District, in collaboration with ARB, based this attainment demonstration on comprehensive analysis, careful evaluation, and a sound scientific foundation. Using the District Governing Board's guiding principles adopted in February 2012, this plan emphasizes public health as the number one priority in meeting federal ambient air quality standards (NAAQS).

Plan is supported by strong scientific foundation and extensive modeling

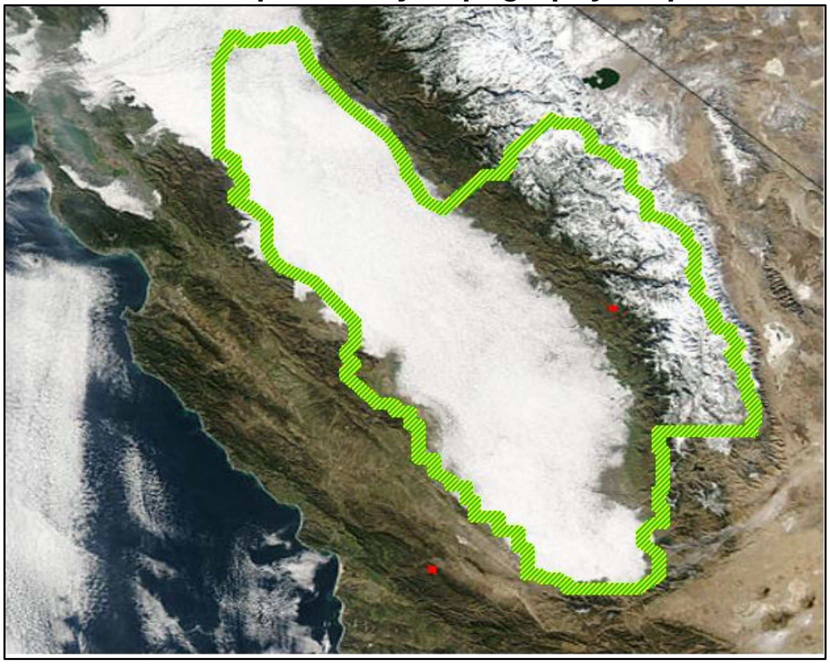
In developing this plan, the District and ARB took full advantage of the extensive scientific research and knowledge that has been developed to characterize the Valley's unique air quality chemistry and challenge. The District, through the San Joaquin Valleywide Air Pollution Study Agency, participated in and contributed to the expenditure of nearly $30 million to support the California Regional Particulate Air Quality Study (CRPAQS). This study, and the subsequent research built on its foundation, has shed light on the complexity of PM2.5 in the Valley. Additionally, recent health studies highlight the associated risks inherent in the complex components of PM2.5. Acknowledgement and understanding of this complexity is central to the *2012 PM2.5 Plan* and was used to form the scientific foundation of this plan, including the modeling.

Using the extensive body of knowledge regarding formation of PM2.5 in the Valley, ARB performed extensive modeling to predict future PM2.5 concentrations throughout the Valley. This modeling was performed consistent with EPA guidance, and involved thousands of hours of sophisticated computer modeling and review by a team of technical staff, including close coordination with the District. The modeling approach was reviewed and vetted through a technical advisory process that involved researchers and EPA, who provided valuable input that was integrated into the modeling. In addition to the modeling by ARB, the District has also performed extensive analysis that provides additional supporting evidence that the plan will effectively bring the Valley into attainment. Overall, the modeling and supporting technical analysis demonstrate that the emissions reductions achieved through the plan's control strategy bring the entire Valley into attainment of the 2006 federal PM2.5 standard by 2019, with most of the Valley reaching attainment earlier than 2019, and Bakersfield being the last portion of the Valley reaching attainment in 2019.

Why does the Valley face such a unique air quality challenge?

The Valley's natural environment supports one the most productive agricultural regions in the country: the Sierra Nevada provides the necessary water for growing an abundance of crops, and a temperate climate provides a long growing season. However, these same natural factors present significant challenges for air quality: the surrounding mountains trap pollution and block air flow, and the mild climate keeps pollutant-scouring winds at bay most of the year. Temperature inversions, while present to some degree throughout the year, can last for days during the winter, holding in nighttime accumulations of pollutants, including wood smoke. It is during the winter that these days of stagnant weather lead to the most Valley exceedances of PM2.5 concentrations.

Figure ES-7 San Joaquin Valley Topography Traps Air Pollution



The Valley's natural challenge in cleaning out accumulated pollutants requires that the District and Valley industry and residents take greater efforts to meet the challenging federal PM2.5 standard and reduce significant amounts of wintertime emissions. The episodic and seasonal nature of high PM2.5 concentrations may help to narrow the focus of emissions reductions, but also limits the number of months that strategies are most effective in reducing peak PM2.5 concentrations.

Through strong controls developed in previous attainment plans and successful incentive programs, the Valley has seen significant progress in reducing PM2.5 concentrations. The *2008 PM2.5 Plan* laid the groundwork for controlling PM2.5 emissions; as a result, wintertime PM2.5 24-hour annual concentrations have decreased by approximately 40% since 1999, with significant reductions seen after the implementation of wood-burning curtailments. Likewise, implementation of the *2007 Ozone Plan* reduced, and continues to reduce, PM2.5 precursors, NOx and VOC, not only to the benefit of reduced ozone, but reduced PM2.5 during the winter. Despite the progress, there is still work to be done, and the *2012 PM2.5 Plan* lays out the strategy for meeting the 2006 PM2.5 NAAQS with a strong emphasis on public health through scientific understanding.

Plan brings the Valley into attainment as expeditiously as possible

Attaining federal health-based standards is an important milestone for improving public health. Through the strategy outlined in this plan, the Valley as a whole will attain the federal 24-hour PM2.5 standard in 2019. Under federal regulation, while every region must be demonstrated to attain the standard in order for the entire Valley to be considered in attainment, the majority of Valley residents will actually see attainment much sooner than the projected date of 2019, with Bakersfield/Kern County being the last region within the Valley to ultimately reach attainment. In addition, as outlined in Appendix A, there are a variety of metrics for evaluating air quality progress. Even where areas have not yet attained the standard, there will be continuous air quality improvements.

Figure ES-8 illustratively shows the Valley's journey to attainment under this plan. As emissions are reduced through the plan's control strategy, 53% of the Valley's population will quickly experience PM2.5 concentrations below the federal standard by 2014, 85% of the population by 2016, 94% of the population by 2017. Figure ES-9 maps monitoring sites throughout the Valley, showing their progress to attainment through 2019, and, similarly articulating the significant progress to be made in bringing the majority of the Valley below the federal standard before 2019.

Figure ES-8 Percent of Valley Population Living in Attainment Areas through Implementation of 2012 PM2.5 Plan

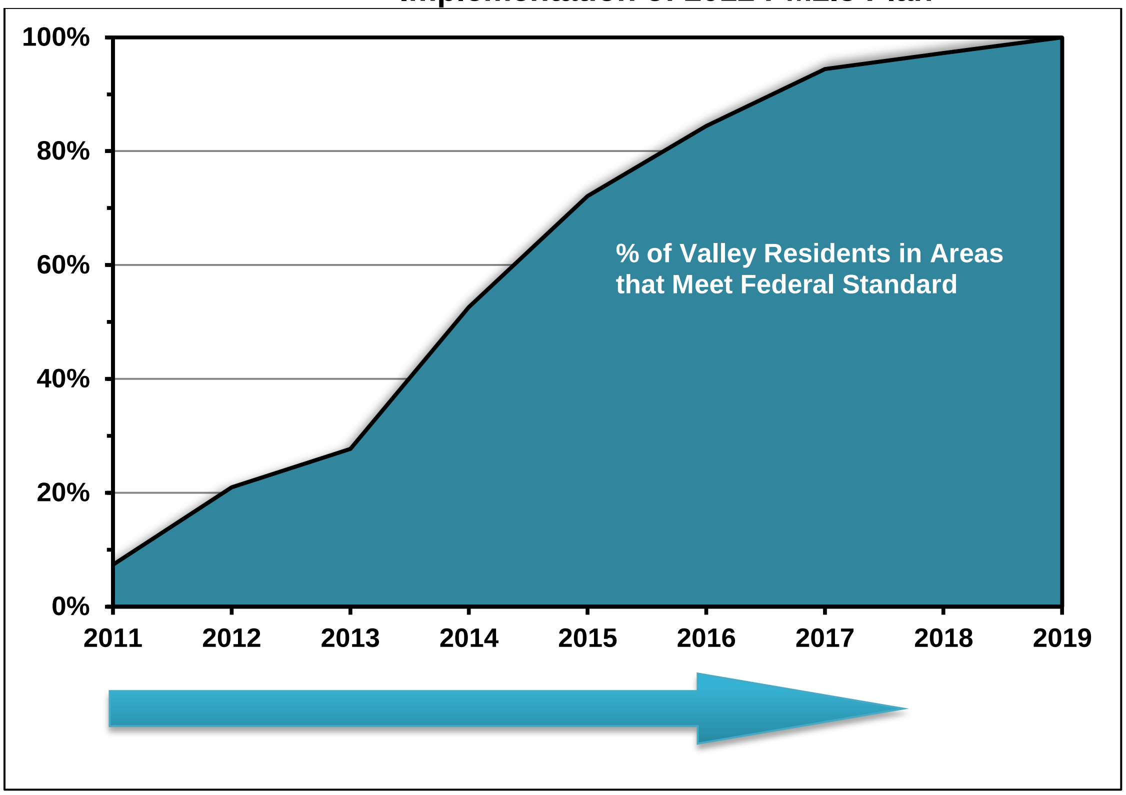
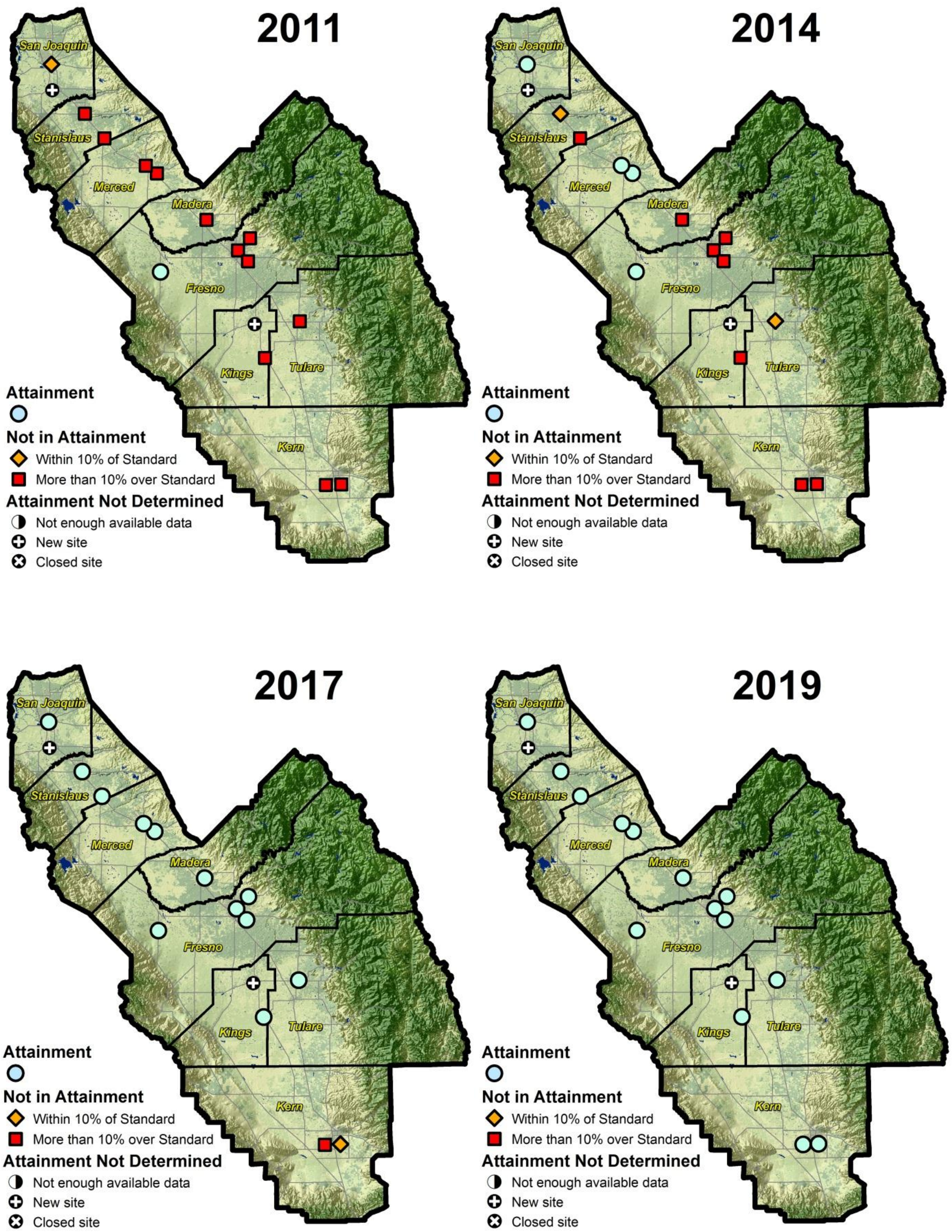


Figure ES-9 The Valley's Journey to Attainment



Plan achieves significant health benefits for Valley residents

In addition to demonstrating how the Valley will reach attainment of the federal PM2.5 standard as expeditiously as possible, the District has also estimated the fundamental metric associated with implementation of the *2012 PM2.5 Plan* – the health benefits resulting from implementation of this strategy. As presented below and described in more detail in Chapter 2 and Appendix E of the plan, the District utilized an EPA-developed model to estimate the annual reductions in morbidity (disease) and mortality (premature death) attributable to improved air quality due to the *2012 PM2.5 Plan* in the attainment year of 2019.

Through implementation of the comprehensive control strategy included in this plan and the resulting reductions in PM2.5 concentrations throughout the Valley, the District estimates the following health benefits:

Table ES-1 Health Benefits Achieved Through Implementation of *2012 PM2.5 Plan*

Health Impact	Health Benefit (reduction in health impact)
Premature Death	**671**
Acute Myocardial Infarction, Hospital Admissions	**93**
Asthma Age 0-19, Hospital Admissions	**131**
Cardiovascular, Hospital Admissions	**175**
Asthma Age 20-99, Hospital Admissions	**246**
Asthma Age 20-99, Emergency Room Visits	**407**
Asthma Age 0-19, Emergency Room Visits	**699**
Acute Bronchitis	**1,498**
Upper Respiratory Symptoms	**15,523**
Lower Respiratory Symptoms	**19,011**
Asthma Exacerbation	**114,376**
Work Loss Days	**125,138**

In addition to quantifying reductions in disease and premature death based on improvements in county-level PM 2.5 concentrations, tools can also be used to quantify the economic value associated with health benefits. While assigning economic values to health impacts is difficult given the tremendous social values associated with these impacts, an existing body of literature attempts to connect health impacts to hard costs such as lost wages, or, in the case of premature death, a social value of $7.99 million per incidence. Using this model, the District estimates that implementation of the plan will achieve an annual Valley-wide savings of $102 million in health costs in 2019. Additionally, and more significantly, a social benefit of $5.36 billion is estimated for the 671 avoided premature deaths.

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Appendices

Appendix G: PM2.5 Weight of Evidence Analysis

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Acronyms

ACRONYMS, ABBREVIATIONS, AND INITIALISMS

AADT: Annual Average Daily Trips
AB 118: Assembly Bill 118
AB 923: Assembly Bill 923
ACC: Advanced Clean Cars
ACT: Alternative Control Techniques
AEO: Annual Energy Outlook
AERO: Advanced Emissions Reductions Options
AIP: achieved in practice
AMI: acute myocardial infarction
AO: Agricultural Operations
APCO: Air Pollution Control Officer
AQI: Air Quality Index
AQIP: Air Quality Incentive Program
AQMD: Air Quality Management District
AQMP: Air Quality Management Plan
AQS: Air Quality System
ARB: California Air Resources Board
ARRA: American Reinvestment & Recovery Act
ATCM: Airborne Toxic Control Measure
ATV: all-terrain vehicles
BAAQMD: Bay Area Air Quality Management District
BACM: Best Available Control Measure
BACT: Best Available Control Technology
BAM: beta-attenuation method
BAM/FEM: Real-time Beta-attenuation method monitors designated as federal equivalent method
BAR: Bureau of Automotive Repair
BenMAP: The Environmental Benefits Mapping and Analysis Program
bhp: brake horsepower
BMP: best management practice
BVOC: biogenic volatile organic compound
CAA: Clean Air Act
CAF: confined animal facility
CAPCOA: California Air Pollution Control Officers Association
CARB: California Air Resources Board
CART: Classification and Regression Trees Method
CASAC: Clean Air Scientific Advisory Committee
CAV: Clean Air Vehicle
CCDAQ: Clark County Department of Air Quality
CCSE: California Center for Sustainable Energy

CE-CERT: University of California, Riverside College of Engineering - Center for Environmental Research and Technology
CEC: California Energy Commission
CEFS: California Emission Forecasting and Planning Inventory System
CEMS: Continual Emissions Monitoring System
CEQA: California Environmental Quality Act
CFO: Clean Fuels Outlet
CFR: Code of Federal Regulations
CGYM: Clean Green Yard Machine
CH&SC: California Health and Safety Code
ChIP: Charbroiler Incentive Program
CM: control measures
CMAQ: Community Multi-Scale Air Quality
CMB: chemical mass balance
CMP: Conservation Management Practice
CNG: compressed natural gas
CO: carbon monoxide
CO2: carbon dioxide
COG: Council of Governments
COI: cost of illness
CPF: Conditional probability function
CRF: concentration response function
CRPAQS: California Regional Particulate Air Quality Study
CSN: Chemical Speciation Network
CTG: Control Techniques Guidelines
CTM: Chemical transport models
CV: cardiovascular
CVRP: Clean Vehicle Rebate Project
DC&E: Design, Community, and Environment
DERA: Diesel Emission Reductions Act
DF: deposition fraction
DMV: Department of Motor Vehicles
DOF: Department of Finance
DOGGR: California Department of Conservation’s Division of Oil, Gas, and Geothermal Resources
DOORS: Diesel Off-road On-line Reporting System
District: San Joaquin Valley Air Pollution Control District
DPF: diesel particulate filter
DPR: Department of Pesticide Regulation
EC: elemental carbon
EE: exceptional event
EF: emission factor
EF&EE: Engine, Fuel, and Emissions Engineering, Inc.
EFMP: Enhanced Fleet Modernization Program
EIC: Emission Inventory Code
EMFAC: Emission Factors model

EPA: U.S. Environmental Protection Agency
EQIP: Environmental Quality Incentives Program
ER: emergency room
ERC: Emission Reduction Credits
ESP: electrostatic precipitator
eTRIP: Employer Trip Reduction Implementation Plan
FDOC: Final determination of compliance
FEM: federal equivalent method
FIP: federal implementation plan
FFMP: Farmland Mapping and Monitoring Program
FMP: Flare Minimization Plan
FR: Federal Register
FRM: Federal Reference Method
FTIP: Federal Transportation Improvement Plan
FY: fiscal year
GHG: greenhouse gas
GIS: geographic information systems
GMRP: Proposition 1B Goods Movement Emission Reduction Program
GSE: ground support equipment
GVWR: gross vehicle weight rating
HEP: head end power
HHDV: heavy heavy-duty vehicles
HVIP: Hybrid Truck and Bus Voucher Incentive Program
IC: internal combustion
ICAPCD: Imperial County Air Pollution Control District
IEPR: Integrated Energy Policy Report
ILD: idle limiting device
ILEV: Inherently Low Emission Vehicle
IMPROVE: Interagency Monitoring of Protected Visual Environments
IMS-95: Integrated Monitoring Study in 1995
IQR: interquartile range
ISR: Indirect Source Review
JPA: joint powers authority
kW: kilowatt
lb/MMBtu: pounds per million British thermal units of heat output
LD50: dose causing death for 50% of the exposed subjects
LDA: light-duty passenger
LDT: light-duty trucks
LEV: low-emission vehicles
LHDV: light heavy-duty vehicles
LMA: Land Management Agency
LNG: liquefied natural gas
LPG: liquefied petroleum gas
LSI: large spark-ignited
LTO: low temperature oxidation
MACT: Maximum Achievable Control Technology

MCY: motorcycles
MDL: minimum detection limit
MDV: medium-duty vehicles
MEGAN: Model of Emissions of Gases and Aerosols from Nature
MFB: mean fractional bias
MFE: mean fractional error
MH: motor homes
MHDV: medium heavy-duty vehicles
MHP: medium horsepower
MMBtu/hr: million British thermal units per hour
MMS: Mesoscale Meteorological Model
MODIS: Moderate Resolution Imaging Spectroradiometer
MOU: Memorandum of Understanding
MPO: Metropolitan Planning Organization
MSW: municipal solid waste
MW: megawatt
NAAQS: National Ambient Air Quality Standards
NCAR: National Center for Atmospheric Research
NESHAP: National Emission Standards for Hazardous Air Pollutants
ng/J: nanograms per Joule of heat output
NH3: ammonia
NMB: normalized mean bias
NOx: oxides of nitrogen
NOy: reactive nitrogen
NQ: not quantifiable
NRCS: Natural Resources Conservation Service
NSCR: non-selective catalytic reduction
NSPS: New Source Performance Standards
NSR: New Source Review
O3: ozone
OB: other buses
OBD: On board diagnostics
OC: organic carbon
OH: Hydroxyl radicals
PAH: polycyclic aromatic hydrocarbons
PAN: Peroxy Acetyl Nitrate
PASS: Polluting Automobile Scrap and Salvage
PEER: Permit-Exempt Equipment Registration
PEV: Plug-in Electric Vehicles
PM: particulate matter
PM0.1: ultrafine particles
PM2.0: particulate matter that is 2.0 microns or less in diameter
PM2.5: particulate matter that is 2.5 microns or less in diameter
PM10: particulate matter that is 10 microns or less in diameter
PMF2: Positive Matrix Factorization Model version 2
POA: Primary organic aerosols

Ppb: parts per billion
Ppm: parts per million
Ppmv: parts per million volume
PPN: Particulate protein nitrogen
PTFE: Poly Tetra Fluoro Ethylene
PUC: Public Utilities Commission
QA: quality assurance
QC: quality control
RAAN: Real-Time Air Quality Advisory Network
RACT: reasonably available control technology
RACM: reasonably available control measure
RARE: Regional Applied Research Effort
RBS: Risk-Based Strategy
REES: Regional Energy Efficiency Strategy
REHEX: Regional Human Exposure Model
REMI: Regional Economic Models, Inc.
RFP: reasonable further progress
RFP: request for proposal
RH: relative humidity
ROAR: Real-time Outdoor Activity Risk
ROG: reactive organic gases
ROP: Rate of Progress
ROS: reactive oxygen species
RRD: respirable road dust
RSD: remote sensing device
RTO: regenerative thermal oxidizer
RTP: regional transportation plan
RV: recreational vehicles
RWC: residential wood combustion
SAFETEA-LU: Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users
SASS: Spiral Aerosol Speciation Sampler
SB: school buses
SB: Senate Bill
SB375: Senate Bill 375
SBS: sodium bisulfate
SC: source category
SCAQMD: South Coast Air Quality Management District
SCR: selective catalytic reduction
SCS: C-35 Sustainable Community Strategy
SFM: State Fire Marshall
SIP: state implementation plan
SJV: San Joaquin Valley
SJVAB: San Joaquin Valley Air Basin
SLAM: State & Local Air monitoring System
SMAQMD: Sacramento Metropolitan Air Quality Management District

SMAT: Speciated Modeled Attainment Test
SMS: Smoke Management System
SO2: sulfur dioxide
SO3: sulfur trioxide
SOA: secondary organic aerosol
SORE: small off-road engines
SOx: oxides of sulfur
Study Agency: San Joaquin Valleywide Air Pollution Study Agency
SUV: sport utility vehicles
SWCV: Solid Waste Collection Vehicle
TAC: toxic air contaminant
TCM: transportation control measure
TDM: transportation demand management
TOR: thermal optical reflectance
TOT: thermal optical transmittance
Tpd: tons per day
Tpy: tons per year
TRU: transport refrigeration unit
TSD: technical support document
TSM: transportation system management
TSP: total suspended particulates
UB: urban buses
UCD-CIT: University of California/ California Institute of Technology
UCSF: University of California San Francisco
UFP: ultrafine particles
µg/m3: micrograms per cubic meter
UHI: urban heat island
ULNB: ultra-low NOX burner
USDA: United States Department of Agriculture
USDA-ARS: United States Department of Agriculture-Agricultural Research Service
USG: Unhealthy for Sensitive Groups
UTV: utility terrain vehicles
Valley: San Joaquin Valley
VCAPCD: Ventura County Air Pollution Control District
VDE: visible dust emissions
VDT: vehicle daily trips
VIP: Voucher Incentive Program
VMT: vehicle miles traveled
VOC: volatile organic compounds
VSL: value of a statistical life
WFU: Wildland Fire Use
WOE: Weight of Evidence
WTP: willingness to pay
XRF: X-ray fluorescence
ZEB: zero-emission bus
ZEV: zero-emission vehicle

Chapter 1

Introduction

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Chapter 1: Introduction

The U.S. Environmental Protection Agency (EPA) periodically reviews and establishes health-based air quality standards (often referred to as National Ambient Air Quality Standards, or NAAQS) for ozone, particulates, and other pollutants. Although the San Joaquin Valley's (Valley) air quality is steadily improving, the Valley experiences unique and significant difficulties in achieving these increasingly stringent standards. Over the past couple of decades, the San Joaquin Valley Air Pollution Control District (District) has implemented several generations of emissions control measures for those stationary and area sources under its jurisdiction. Similarly, the California Air Resources Board (ARB) has adopted regulations for mobile sources. Together, these efforts represent the nation's toughest air pollution emissions controls and have greatly contributed to reduced ozone and particulate matter concentrations in the Valley. Despite the significant progress under these regulations, greatly aided by the efforts of Valley businesses and residents, many air quality challenges remain, including attainment of EPA's most recent standard for particulate matter that is 2.5 microns or less in diameter (PM2.5).

This *2012 PM2.5 Plan* establishes the District's strategy for attaining the 2006 PM2.5 standard as expeditiously as possible, and synthesizes the District's strategies for improving air quality and public health in the Valley. To provide overall strategic direction in developing this *2012 PM2.5 Plan*, the District Governing Board adopted the following Guiding Principles at its February 2012 public hearing:

1. With public health as our number one priority, meet the national ambient air quality standards as expeditiously as practicable.
2. Use sound science as the plan's foundation. This includes efforts to assess public health impacts, predict future air quality, determine the extent of emissions reductions needed, and evaluate the availability, effectiveness, and feasibility of emission control measures.
3. Consider the Valley's unique challenges and develop cost-effective strategies that provide adequate operational flexibility and minimize costs to Valley businesses.
4. Consider all opportunities for timely, innovative, and cost-effective emission reductions. Consider traditional regulations, but look beyond traditional regulations to incorporate monetary incentives, policy initiatives, guidance documents, and outreach, including working with cities and counties to incorporate *2012 PM2.5 Plan* principles into their general plans.
5. Given that 80% of the Valley's NOx emissions originate from mobile sources, provide a balanced approach to reducing mobile and stationary source emissions.
6. Devise and implement reasonable strategies that involve the public in reducing emissions.

7. Prioritize strategies that contribute to the District's Risk-based Strategy by achieving the greatest public health benefits.
8. Prioritize strategies that contribute to attainment of multiple air quality standards.
9. Recognize that there is no "silver bullet" for attainment. In this plan and upcoming attainment plans, every sector—from the public through all levels of government, businesses, and industry—must continue to reduce emissions.
10. Compel state and federal agencies to provide adequate resources and regulatory assistance to reduce emissions from sources under their jurisdiction.
11. Address air pollutant transport issues with air districts neighboring the Valley.
12. Provide ample opportunity for public participation and feedback in the design and implementation of these plans. Utilize the planning process to also inform participants of the Valley's air quality challenges and successes as well as actions that can be taken to improve Valley air quality.
13. Build off of the successes of the District's Technology Advancement Program by identifying further opportunities to continue fostering technology advancement, thus paving the way for new emissions control devices to be increasingly used in the San Joaquin Valley.

1.1 THE VALLEY'S UNIQUE CHALLENGES

The Valley's geography and meteorology exacerbate the formation and retention of high levels of air pollution. Surrounding mountains and consistently stagnant weather patterns prevent the dispersal of pollutants that accumulate within the Valley. The Valley has significant naturally occurring biogenic emissions. The California landscape also allows for air pollutant transport within the Valley, as well as between the Valley and other air basins. These natural factors will continue to impact the Valley's progress toward attainment of air quality standards.

The Valley is also one of the fastest growing regions in the state (see Appendix B for more information). The Population Research Unit of the California Department of Finance (DOF) released interim revised population growth projections in May 2012.[1] Based on these revised DOF data, from 2010 to 2020, the Valley's population is expected to increase by 18% (Table 1-1). In contrast, the total population for the State of California is projected to increase by only 9% over the same time period. Increasing population generally means increases in air pollutant emissions as a result of increased consumer product use and more automobile and truck travel. Between 2010 and 2020, the Valley's total vehicle miles traveled (VMT) will increase about 21%,[2] consistent with

[1] California Department of Finance [DOF]: Interim Population Projects for California and its Counties 2010-2050. (May 2012). Retrieved from http://www.dof.ca.gov/research/demographic/reports/projections/interim/view.php
[2] California Air Resources Board: 2009 Almanac – Population and Vehicle Trends Tool. Retrieved July 2012 from http://www.arb.ca.gov/app/emsinv/trends/ems_trends.php

the Valley's population growth. Also, the Valley is home to the state's major arteries for goods and people movement, which adds to the increases in vehicular traffic.

Table 1-1 Estimated Valley Population by County, 2010-2020 [3]

County	Estimated 2010	Projected 2020
Fresno	932,926	1,083,889
Kern*	841,609	1,041,469
Kings	152,996	179,722
Madera	151,136	183,176
Merced	256,345	301,449
San Joaquin	686,651	795,631
Stanislaus	515,229	582,746
Tulare	443,567	536,429
Total	3,980,459	4,704,511

*Kern County is separated into two air districts: San Joaquin Valley and Eastern Kern. This data is the Valley-portion of Kern only.

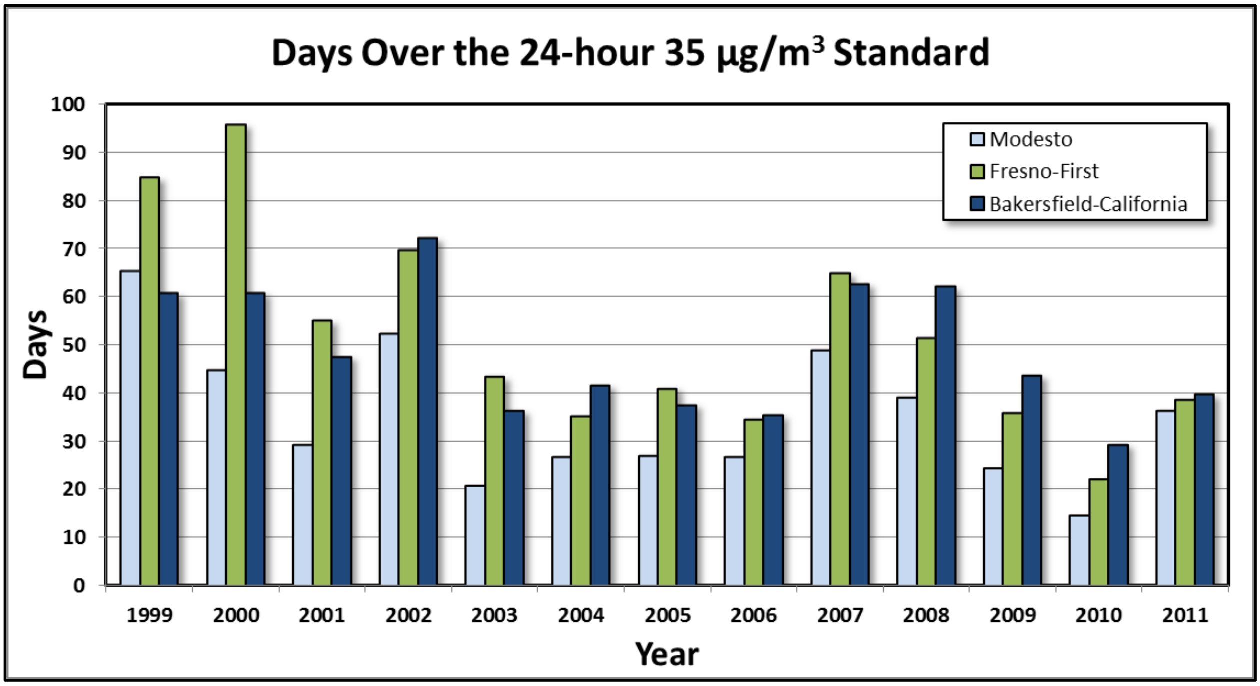
Although reducing mobile source emissions is critical to the Valley's attainment of air quality standards, the District does not have direct regulatory authority to reduce motor vehicle tailpipe emissions, which are regulated by the EPA and ARB. As described in Chapter 6 of this plan and in Appendix C, the District must collaborate with interagency partners and use innovative approaches to reduce mobile source emissions.

As Chapter 3 of this plan details, the formation and composition of PM2.5 can be complex, with some species impacting health more than others. Long-term trends show that PM2.5 concentrations throughout the Valley have declined since monitoring of this pollutant first began and are projected to continue on that trend. In addition to declining PM2.5 concentrations, most emissions inventories of PM2.5 precursors are also projected to decrease despite future population growth.

Figure 1-1 shows the trend in numbers of days that air monitoring sites recorded 24-hour PM2.5 averages over 35 $\mu g/m^3$ at the Modesto, Fresno-First, and Bakersfield-California air monitoring sites. An overall downward trend is apparent when comparing the early years of 1999 and 2000 to recent years. The current pattern shows generally that the northern Valley has the fewest days over the standard, that the southern Valley has the most days over the standard, and that the central Valley registers somewhere between the two.

[3] Ibid. footnote 1.

Figure 1-1 Trends in Exceedances of the 24-hour PM2.5 Standard



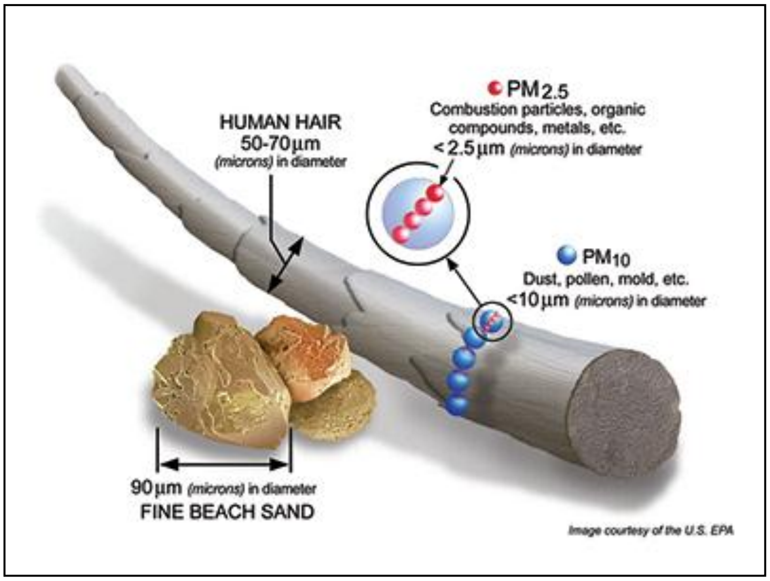
Despite the magnitude of the challenges described above, the Valley has a history of success in reducing emissions and improving air quality. The Valley must continue to reduce air pollutant emissions to improve air quality and to improve public health throughout the Valley.

1.2 PM2.5 AND ASSOCIATED HEALTH IMPACTS

Particulate matter (PM) is a mixture of solid particles and liquid droplets in the air. PM can be emitted directly into the atmosphere (primary PM), or can form as secondary particulates in the atmosphere through the photochemical reactions of precursors (when precursors are energized by sunlight). Thus, PM is made up of a number of components, including acids (such as nitrates and sulfates), organic chemicals, metals, and soil or dust particles. PM10 is PM that is 10 microns or less in diameter, and the PM2.5 subset includes smaller particles that are 2.5 microns or less in diameter (Figure 1-2).

Any particles 10 microns or less are considered respirable, meaning they can be inhaled into the body through the mouth or nose. PM10 can generally pass through the nose and throat and enter the lungs. PM2.5 can be inhaled more deeply into the gas exchange tissues of the lungs, where it can be absorbed into the bloodstream and carried to other parts of the body.

Figure 1-2 PM10, PM2.5, Human Hair, and Fine Beach Sand



The potential health impacts of particle pollution are linked to the size of the particles, with the smaller particles having larger impacts. Numerous studies link PM2.5 to a variety of health problems, including aggravated asthma, increased respiratory symptoms (irritation of the airways, coughing, difficulty breathing), decreased lung function in children, development of chronic bronchitis, irregular heartbeat, non-fatal heart attacks, increased respiratory and cardiovascular hospitalizations, lung cancer, and premature death. Children, older adults, and individuals with heart or lung diseases are the most likely to be affected by PM2.5. Many studies have quantified and documented the health benefits of attaining EPA's 2006 PM2.5 standard. For example, one 2008 study used the Regional Human Exposure Model (REHEX) to evaluate potential Valley health benefits.[4] As part of developing this *2012 PM2.5 Plan*, the District utilized an EPA-developed model named BenMAP to quantify the health that would be achieved by this plan, as discussed in more detail in Chapter 2 and Appendix E.

Air pollutant health impacts carry economic costs as well. For example, a study conducted in 2008 estimated that the economic benefits of meeting EPA's 2006 PM2.5 standard to be approximately $5.6 billion. Similarly, using the BenMAP model, the District estimated an economic and social benefit of $5.5 billion resulting from implementing this plan and attaining the PM2.5 standard (see Chapter 2 and Appendix E). The applied economic values were based on the cost of treating illness and the expressed value people place on avoiding illness and premature death. The 2008 study recognized that some known effects of pollutant exposure cannot yet be quantified in

[4] Hall, J.V., Brajer, V., Lurmann, F.W. (November 2008). *The Benefits of Meeting Federal Clean Air Act Standards in the South Coast and San Joaquin Valley Air Basins.* Institute for Economic and Environmental Studies, California State University, Fullerton. Retrieved from http://business.fullerton.edu/centers/iees/reports/Benefits_of_Meeting_Clean_Air_Standards_11-13-08.pdf

economic terms, so the actual economic benefits of attainment are likely higher than the study reports.

In addition to particle size, the chemical composition of PM2.5 is a primary factor in the type and severity of health impacts. There are several PM2.5 species, or chemical compounds, summarized in Table 1-2.

Table 1-2 PM2.5 Species

Species	Description
Organic carbon	Directly emitted, primarily from combustion sources (e.g. residential wood combustion). Also, smaller amounts attached to geologic material and road dusts. May also be emitted directly by natural sources (biogenic).
Elemental carbon	Also called soot or black carbon; incomplete combustion (e.g. diesel engines)
Geologic material	Road dust and soil dust that are entrained in the air from activity, such as soil disturbance or airflow from traffic
Trace metals	Identified as components from soil emissions or found in other particulates having been emitted in connection with combustion from engine wear, brake wear, and similar processes. Can also be emitted from fireworks.
Sea salt	Sodium chloride in sea spray where sea air is transported into the Valley
Secondary organic aerosol	Secondary particulates formed from photochemical reactions of organic carbon
Ammonium nitrate	Reaction of ammonia and nitric acid, where the nitric acid is formed from nitrogen oxide emissions, creating nitric acid in photochemical processes or nighttime reactions with ozone
Ammonium sulfate	Reaction of ammonia and sulfuric acid, where the sulfuric acid is formed primarily from sulfur oxide emissions in photochemical processes, with smaller amounts forming from direct emissions of sulfur.
Combined water	A water molecule attached to one of the above molecules

Understanding various PM2.5 species, including how each forms, how much each contributes to the Valley's total PM2.5 concentrations, and how each is linked to different public health impacts, is of the utmost importance for the development of an effective, health-protecting control strategy (see Chapter 2). For example, ammonium nitrate is estimated to comprise about 40% of the Valley's total PM2.5 concentrations, but it is generally regarded as having relatively low toxicity as compared to other types of PM2.5. In contrast, metals have higher health impacts, but are found in relatively low concentrations in the Valley. Bioaerosols, such as mold spores, bacteria, pollen, and endotoxins, carry significant health risks for sensitive individuals. Ultrafine particles, or those particles 0.1 microns or less in diameter (PM0.1), are small enough to effectively deliver harmful chemicals into the lungs, bloodstream, and the brain, but typically comprise a small portion of the Valley's total airborne PM mass.

In addition to affecting human health, air pollution also affects the health of the natural environment. PM2.5 can be transported from sources hundreds of miles away to contribute to visibility problems at remote locations, such as the Sierra Nevada and associated national parks. As PM settles out of the air, it can make lakes and streams acidic, change an ecosystem's nutrient balance, and affect ecosystem diversity. PM can affect vegetation by damaging foliage, disrupting the chemical processes within plants, reducing light adsorption, and disrupting photosynthesis. This can impact green spaces as well as crops. PM can also stain and damage stone and other materials. As the Valley progresses toward attainment of EPA's human-health-based PM2.5 standards, there will also be less harmful impacts to the surrounding natural environment.

1.3 NATIONAL AMBIENT AIR QUALITY STANDARDS

1.3.1 EPA's Standard-Setting Process

Clean Air Act (CAA) Sections 108 and 109 require EPA to set health-based standards for six criteria pollutants, including PM2.5. EPA periodically reviews existing standards to consider the most recent health studies. These reviews are to be conducted every five years, though in the past, some standard revisions did not meet the 5-year deadline. The review process starts as the Clean Air Scientific Advisory Committee (CASAC) analyzes available science and then, if supported by research, suggests to EPA a range of revised standards that would protect public health from the adverse effects of air pollution. The EPA Administrator appoints CASAC members, who are non-EPA experts in the fields of science, engineering, or the social sciences. The committee is to provide objective, independent advice to EPA on the technical basis for the standard. Thousands of peer-reviewed scientific studies are considered as EPA formulates its proposed standard, which is made available for scientific peer review and public comment. EPA then sets the standard.

In evaluating and setting new standards, federal law prohibits EPA from taking into account economic feasibility. However, economic feasibility issues *can* be considered as EPA promulgates the implementation rules that establish the deadlines for meeting the standards and in devising individual control measures aimed at attaining the standards.

Once a standard is set, EPA designates an area as *attainment* or *nonattainment* based on the most recent three years of air quality data available. For some pollutants, EPA classifies nonattainment areas as *marginal*, *moderate*, *serious*, *severe*, or *extreme*. The classification sets the attainment deadline and other planning requirements. The classification is to be based on certain air quality parameters, though areas can request reclassification with adequate documentation.

EPA also adopts implementation rules to guide states and local air districts as they prepare state implementation plans (SIPs) to bring areas into attainment with the standard. While EPA cannot consider costs or difficulty in setting the standards, costs and difficulty are inescapable for local air districts as they determine the best way to bring areas into attainment. That being said, local air districts must meet planning and attainment requirements to avoid federal sanctions and to improve public health.

There are a number of serious penalties and risks associated with any failure to submit approvable attainment strategies for meeting federal standards. Upon development of an attainment strategy, an area submits the plan to EPA for approval. If EPA finds that an area fails to submit an approvable plan on time or fails to implement plan commitments after the plan has been approved, then the following sanctions may be applied:

- Two-to-one offset requirement for major sources, leading to a de facto ban on new and expanding business
- Loss of federal highway funds, which would cost the Valley an estimated $250 million per year
- A federal implementation plan (FIP), which would result in a loss of local control

Once EPA approves a SIP, that plan becomes federally enforceable. The plan can then be enforced by the public or EPA through lawsuits. In addition, failure to reach attainment by the deadline would result in the assessment of Section 185 penalty fees.

1.3.2 Federal PM2.5 Standards and Implementation

EPA established the first PM2.5 standard in 1997 and in 2005 designated the Valley as nonattainment for the 1997 standard. The 1997 standard has two limits of attainment: an annual average of 15 micrograms per cubic meter (µg/m³) and a 24-hour average of 65 µg/m³. The District adopted the *2008 PM2.5 Plan* in April 2008 to document its regulatory commitments, to demonstrate the anticipated effectiveness of its PM2.5 strategy to bring the Valley into attainment of the 1997 PM2.5 standard no later than April 2015 (based on 2012-2014 data), and to meet other federal requirements. EPA approved the *2008 PM2.5 Plan* in 2011.

EPA revised the 24-hour average PM2.5 standard to 35 µg/m³ in October 2006.[5] EPA designated the Valley as nonattainment of the 2006 PM2.5 standard in 2009, effective December 14, 2009.[6] The effective date of designation triggered an attainment plan due date of December 14, 2012.

Areas must attain the 2006 standard within five years of the effective date of EPA designations, though up to a five year extension is possible. This sets the Valley's initial attainment date at December 14, 2014, with an extension up to December 14, 2019, if needed. This *2012 PM2.5 Plan* will demonstrate that the Valley will attain the 2006 standard as expeditiously as practicable, with all feasible measures and strategies being considered to accomplish this goal.

Designation under the national PM2.5 standard (unlike the ozone standard) does not use a nonattainment area classification system (i.e., moderate, serious, severe, and extreme). Therefore, attainment planning requirements are the same for all PM2.5

[5] National Ambient Air Quality Standards for Particulate Matter; Final Rule. 71 Fed. Reg. 200, pp. 61144–61233. (2006, October 17). (codified at 40 CFR Part 50) Retrieved from http://www.gpo.gov/fdsys/pkg/FR-2006-10-17/html/06-8477.htm

[6] Air Quality Designations for the 2006 24-Hour Fine Particle (PM2.5) National Ambient Air Quality Standards; Final Rule. 74 Fed. Reg. 218, pp. 58688–58781. (2009, November 13). (codified at 40 CFR Part 81). Retrieved from www.epa.gov/pmdesignations/2006standards/documents/2009-10-08/FR-11-13-2009.pdf

nonattainment areas. EPA finalized the PM2.5 Implementation Rule[7] in April 2007 to provide rules and guidance on the CAA requirements for attainment plans required under the 1997 PM2.5 standard. On March 2, 2012, EPA issued its “Implementation Guidance for the 2006 24-Hour Fine Particle (PM2.5) NAAQS.”[8] This memo confirmed the continued appropriateness of the 2007 implementation rule framework for PM2.5 attainment planning and provided additional guidance where needed. Table 1-3 summarizes PM2.5 attainment planning requirements and where those requirements will be met in this plan.

During the compilation and subsequent implementation of this plan for the 2006 PM2.5 standard, EPA’s standard-setting process continues. On June 14, 2012, EPA published a proposed new annual PM2.5 standard of 12 or 13 µg/m³, with the new standard projected to be finalized by December 2012. This new standard will require new planning and strategy development, beyond what will be implemented with the *2012 PM2.5 Plan*—such is the nature of complying with overlapping federal standards within the rigors of local planning and regulatory processes. This overlap of planning requirements is shown in Table 1-4.

Despite the overlap, efforts to reduce PM2.5 and PM2.5 precursors under one PM2.5 standard will help the Valley to start progressing toward more stringent PM2.5 standards on the horizon. This is already occurring with the 1997 and 2006 PM2.5 standards—the emissions reductions strategy being implemented under the plan for the 1997 PM2.5 standard will continue to achieve additional emissions reductions as fully implemented over the next couple of years, and these reductions will contribute to improvements in 24-hour average PM2.5 concentrations, bringing the Valley closer to the 2006 standard. Building on the *2007 Ozone Plan* and *2008 PM2.5 Plan*, the District is coordinating emissions reductions strategies whenever possible to address multiple standards, to maximize efficiency for staff as well as stakeholders, and to maximize health benefits.

[7] Clean Air Fine Particle Implementation Rule [PM2.5 Implementation Rule]. 72 Fed. Reg. 79, pp. 20586–20667. (2007, April 25). Retrieved from http://www.gpo.gov/fdsys/pkg/FR-2007-04-25/pdf/E7-6347.pdf#page=1

[8] U.S. Environmental Protection Agency (2012, March 2). Memorandum from the Office of Air Quality Planning and Standards: Implementation Guidance for the 2006 24-Hour Fine Particle (PM2.5) National Ambient Air Quality Standards (NAAQS). Retrieved from http://www.epa.gov/ttn/naaqs/pm/pdfs/20120302_implement_guidance_24-hr_pm2.5_naaqs.pdf

Table 1-3 Federal Requirements for PM2.5 Nonattainment Areas

General Requirements	Federal CAA	PM2.5 Implementation Rule	Description	2012 PM2.5 Plan
Attainment demonstration due date	172(b)	72 *FR* 20599	PM2.5 SIPs are due to EPA by December 14, 2012, three years from the designation date.	NA
Attainment date	172(b)(2)	72 *FR* 20601	Nonattainment areas should reach attainment as expeditiously as practicable, but no later than 5 years from the designation date. EPA may extend the attainment date up to 10 years from the designation date, considering severity of nonattainment and availability and feasibility of control measures.	Chapter 9
RACT/RACM	172(c)(1)	72 *FR* 20609-20633	SIP provisions should provide for the implementation of reasonably available control measures (RACM), including, at a minimum, reasonably available control technologies (RACT).	Chapter 5 and 9
RFP	172(c)(2)	72 *FR* 20633-20642	SIP provisions must provide for reasonable further progress.	Chapter 9
Contingency provisions	172(c)(1)	72 *FR* 20642-20645	The SIP must provide for the implementation of specific measures that would take effect without further action by the State and that would be undertaken if the area fails to make RFP or attainment on time.	Chapter 9
Emissions inventory	172(c)(3)	72 *FR* 20647-20651	The SIP must include a comprehensive, accurate, current inventory of actual emissions from all sources of the relevant pollutants in the area.	Appendix B
NSR	172(c)(4-5)	72 *FR*	The SIP must identify and quantify the emissions of pollutants that will be allowed (in accordance with section 173(a)(1)(B)), from the construction and operation of major new or modified stationary sources in the area. The SIP must require permits for new or modified stationary sources.	Appendix H
Other measures	172(c)(6)	72 *FR* 20599	The SIP must include enforceable emission limitations, other control measures and techniques, and compliance schedules to provide for attainment by the applicable deadline.	Chapters 5 through 8

Table 1-4 Federal Air Quality Standards and Valley Status for PM2.5

	PM2.5 Standards and Timelines		
	1997 PM2.5	**2006 PM2.5**	**2012 PM2.5**
LEVEL OF THE STANDARD	24-hr: 65 µg/m³ annual: 15 µg/m³	24-hr: 35 µg/m³ annual: 15 µg/m³	To be determined
1997	EPA sets standard		
1998–2004			
2005	EPA finalizes attainment designations		
2006		EPA sets standard	
2007	EPA implementation rule		
2008	Attainment plan due (SJV's *2008 PM2.5 Plan*)		
2009		EPA finalizes attainment designations	
2010			
2011	EPA approves SJV plan		
⇨ **2012**		**Attainment plan due (SJV's *2012 PM2.5 Plan*)**	Proposes annual standard of 12 or 13µg/m³: June 2012 Final standard to be issued: December 2012
2014		Initial attainment deadline	EPA attainment designations: December 2014. Attainment plan likely due in early 2018, and attainment deadline to be determined
2015	Final attainment deadline		
2016 & beyond		Final attainment deadline: 2019	

1.3.3 State Standards

California also sets ambient air quality standards for several pollutants, including PM2.5. The California ambient air quality standards are considerably more stringent than the federal standards and are more protective of human health. California's annual average PM2.5 standard is currently 12 µg/m³. There is no California standard for 24-hour average PM2.5 concentrations.

California has no specific attainment date for state air quality standards, nor does it require attainment plans. In fact, California Health and Safety Code (CH&SC) Section 39602 says, "Notwithstanding any other provision of this division, the state implementation plan shall only include those provisions necessary to meet the requirements of the [federal] Clean Air Act." Federal standards thus provide the framework for SIPs, such as this PM2.5 plan. However, progress toward federal standards also brings areas closer to the lower, California standards.

1.4 PUBLIC PROCESS OF PLAN DEVELOPMENT

To ensure that the public has the opportunity for meaningful involvement in reviewing and commenting on the plan, the District has been using the following timeline for the public process (Table 1-5).

Table 1-5 *2012 PM2.5 Plan* Development and Public Workshop Timeline

Ongoing	Outreach on plan process and findings: presentations/discussions with stakeholders at various meetings
April 27th and 30th 2012	Public workshops and commenting period
June 2012	Public workshops and public commenting
October 9, 2012	Public workshops and public commenting
November 2012	Proposed draft of the plan
December 20, 2012	District Governing Board hearing to adopt the plan
January 2013	ARB hearing to adopt the SJV plan and the state strategy

The District has held a number of meetings and workshops throughout development of this plan to seek public input. These meetings have been well-attended by members of the public, and a number of questions have been raised and discussed. The District has discussed the *2012 PM2.5 Plan* at numerous meetings of District Governing Board, Citizens Advisory Committee (CAC), Environmental Justice Advisory Group (EJAG), and other meetings (including an April meeting with the Central Valley Air Quality Coalition).

The comments and questions received during workshops and associated written comment periods have been integral to development of this plan. All significant comments and responses are summarized in Appendix I of this plan. The following summarizes the recent public workshops:

April 27, 2012
***2012 PM2.5 Plan* Technical Symposium**
The District and ARB staff co-hosted a technical symposium on the scientific basis of air quality modeling being conducted for the *2012 PM2.5 Plan*. Attendees included District staff, ARB staff, EPA staff, and members of the public. The meeting, which was hosted in Fresno, could be attended via VTC in the District's Modesto and Bakersfield offices, or attended via webcast. Presenters representing District staff, ARB staff, and UC Davis researchers addressed the scientific basis of modeling for the plan, the nature of PM2.5 species and formation in the Valley, a review of modeling results from CRPAQS (the California Regional Particulate Air Quality Study), modeling for state

implementation plan purposes, and the technical approach for *2012 PM2.5 Plan* modeling. These presentations and the discussions that followed provided a valuable opportunity to improve understanding of how PM2.5 is formed and retained in the Valley, as well as how these processes are analyzed in the plan.

April 30, 2012
***2012 PM2.5 Plan* Workshop**
The District hosted a public workshop on the general direction and first draft components of the *2012 PM2.5 Plan*. Attendees included District staff, ARB staff, and members of the public. District staff presented an overview of federal planning requirements, the District's guiding principles for the plan, draft emissions inventory trends, ambient PM2.5 trends, and the District's approach for analyzing control measure opportunities.

June 27, 2012
***2012 PM2.5 Plan* Workshop**
The District hosted a public workshop on further development of draft *2012 PM2.5 Plan* components. Attendees included District staff, ARB staff, and members of the public. District staff presented an overview of the background for the plan, air quality trends, development of the risk-based strategy as it is to be incorporated into the PM2.5 plan, preliminary control measure findings, and the role of incentives and technology advancement in the Valley's attainment challenges. ARB staff presented an overview of photochemical modeling, emissions inventory improvements, and the Valley's preliminary attainment outlook.

October 9, 2012
Two-session *2012 PM2.5 Plan* Workshop
The District and ARB hosted a two-session workshop on the *2012 PM2.5 Plan* and its technical components. Attendees included District staff, ARB staff, EPA staff, and members of the public. ARB hosted the morning session to present and respond to questions on plan modeling, modeling results, and other analysis. The District hosted the afternoon session to present and respond to questions on the plan control strategy, demonstration of federal plan requirements, and the public health benefits that would be achieved by the PM2.5 Plan. Public comments were heard during the workshop and invited on the draft plan.

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Chapter 2

Risk-Based Strategy

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Chapter 2: Risk-Based Strategy

2.1 WHAT IS THE RISK-BASED STRATEGY?

The U.S. Environmental Protection Agency's (EPA) National Ambient Air Quality Standards (NAAQS) are the primary driving force for new emissions controls that result in air quality improvements and health benefits to Valley residents. In the conventional planning process for attaining these standards, success in protecting public health is defined by whether the standards are met at all air monitors. In effect, the reduction in PM2.5 mass, which shows progress toward attainment of the standard, serves as the surrogate for population exposure and risk.

NAAQS are indeed health-based, and attaining these standards will result in clear and significant health benefits. However, NAAQS, as currently established, are essentially *mass-based* standards. In the case of PM2.5, the current standards do not account for particle size distribution, chemical species composition, surface area, and other factors of health risk. There is inherent complexity in documenting the health risks associated with exposure to particles (which have a wide range of characteristics) as compared to pollutants like ozone (which has more consistency between molecules).

In contrast, recent health-science research has substantially deepened our knowledge of air pollutant health risk beyond the current Clean Air Act (CAA) framework and EPA standards. There is a growing recognition within the scientific community that the NAAQS alone can be incomplete measures of public exposure to air pollution. Thus, while the CAA's NAAQS and state implementation plan (SIP) process is motivated by public health, the process alone does not fully address public health impacts of ambient air pollution. To fully address potential public health benefits, an attainment strategy can use a more comprehensive, multidimensional population exposure assessment approach that goes beyond ambient mass measurements.[1]

EPA policy directly acknowledges the importance of a Risk-based Strategy to maximize public health benefits within a region's efforts to attain the National Ambient Air Quality Standards (NAAQS). EPA's March, 2012, PM2.5 implementation guidance memo states, "…it is likely that SIPs for the 2006 24-hour PM2.5 NAAQS may need to include *greater emphasis on reducing emissions from local sources* [emphasis added] as compared to plans to attain the 1997 PM2.5 NAAQS."[2] EPA's memo further encourages that states consider evidence from published literature indicating that reductions of direct PM2.5 have a greater health benefit per ton than reductions of other criteria

[1] Lippman, M. (2012, April 16). Presentation: Results from National Particle Component Toxicity (NPACT) Program and NYU: Toxicology Findings, Integration, and implications. Presented at the Annual Meeting of the Health Effects Institute (HEI) in Chicago, IL, April 15–17, 2012. Presentation retrieved from http://www.healtheffects.org/Slides/AnnConf2012/Lippmann-MonPM.pdf

[2] U.S. Environmental Protection Agency (2012, March 2). Memorandum from the Office of Air Quality Planning and Standards: Implementation Guidance for the 2006 24-Hour Fine Particle (PM2.5) National Ambient Air Quality Standards (NAAQS). Retrieved from http://www.epa.gov/ttn/naaqs/pm/pdfs/20120302_implement_guidance_24-hr_pm2.5_naaqs.pdf

pollutants, such as SO2 and NOx,[3] and that providing methods local air quality plans can use to maximize health benefits and minimize risk inequality.[4]

In September 2010, the District Governing Board adopted a research-driven Risk-based Strategy (RBS) designed to maximize public health improvements resulting from the District's attainment strategies and related initiatives. The overall goal of the RBS is to minimize cumulative population exposure to air pollution and corresponding health risk in the region. This risk reduction goal is being pursued through the integration of emerging scientific knowledge into the District's control strategies, incentive programs, public communication, and enforcement actions.

The District is integrating the RBS into the development of the *2012 PM2.5 Plan.* The purpose of this chapter is to document the scientific foundation for the RBS and how it is being applied to the District's PM2.5 SIP. This chapter includes the following elements:

- The key aspects of particulate pollution that shape human exposure and risk from PM2.5, along with a discussion of how the RBS is reflected in existing District programs;
- Further details about key health risk elements of PM2.5 particles and exposure; and
- An outline of how these risk elements are used to characterize the associated risk when evaluating sources of PM2.5 and related control or incentive options in subsequent chapters.

2.2 BACKGROUND FOR THE RISK-BASED STRATEGY

As a response to mounting epidemiological evidence that PM2.5 was more harmful than PM10, EPA established a PM2.5 NAAQS in 1997 to accompany the previously established PM10 NAAQS. PM10 occurs at larger mass concentrations than PM2.5, so the shift to PM2.5 somewhat conflicted with the time-tested toxicological precept of "the dose (mass) makes the poison." Particulate inhalation studies found that the smaller PM2.5 particles penetrate more deeply into the lungs, where particles more effectively avoid immune system defenses. Toxicological analyses of PM2.5 identified chemical species that acted differentially to promote respiratory and cardiovascular inflammation. While it was unclear at that time which PM2.5 chemicals were the most harmful, the scientific consensus was that the health risks stemmed from the chemicals rather than the particles themselves.

In the 15 years since the first PM2.5 NAAQS was established, scientists have conducted many studies that have identified which chemical species of PM2.5 are most

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[3] Fann, N., Fulcher, C.M., & Hubbell, B.J. (2009). The Influence of Location, Source, and Emission Type in Estimates of the Human Health Benefits of Reducing a Ton of Air Pollution. *Air Quality, Atmosphere & Health, 2(3)*, 169–176. doi: 10.1007/s11869-009-0044-0

[4] Fann, N., Roman, H.A., Fulcher, C.M., Gentile, M.A., Hubbell, B.J., Wesson, K., & Levy, J.I. (2011). Maximizing Health Benefits and Minimizing Inequality: Incorporating Local-Scale Data in the Design and Evaluation of Air Quality Policies. *Risk Analysis, 31(6)*, 908–922. doi: 10.1111/j.1539-6924.2011.01629.x

harmful and have pinpointed their sources.[5] Health researchers have also documented the negative cardiovascular and immune system effects of ultrafine particles, or particles that are 0.1 microns or smaller (PM 0.1), based on these particles' ability to penetrate the alveolar region of the lungs and deliver chemicals into the bloodstream. This smaller-is-more-dangerous phenomenon parallels the previous discovery regarding the higher toxicity of PM2.5 particles compared to larger and heavier PM10 particles. In each case, the dose-makes-the-poison assumption governing the NAAQS for carbon monoxide, lead, ozone, and the other criteria pollutants does not apply to particulates.

Addressing the complexity of health risks posed by particulate pollution has been a motivating factor in the development and application of the RBS. Rather than ignore this growing body of scientific knowledge in the development of this SIP, the District's RBS seeks to embrace it to the extent possible within the current CAA to maximize public health benefits. In practice, this knowledge provides the District with the necessary scientific foundation for justifying and prioritizing the pollution control measures that are necessary for demonstrating attainment in this plan. The outcome is a stronger, more health-protective plan that reflects the current trajectory of scientific knowledge toward a more complete understanding of population risk from PM2.5 particles.

The NAAQS-SIP process and the RBS are complimentary strategies, not an either-or scenario. The RBS should not be interpreted as a zero-sum tradeoff that emphasizes controls on certain forms and sources of high-risk PM2.5 while ignoring others. The current mass-based indicator (micrograms per cubic meter of air) will continue to serve as the final yardstick for PM2.5 attainment and as a surrogate for achieving significant health benefits. As required under the CAA, the District is committed to attaining the 2006 PM2.5 standard as expeditiously as possible, and the District will not ignore sources of PM2.5 under its jurisdiction that could contribute to the Valley's attainment of the PM2.5 NAAQS.

A number of the District's programs have been influenced by the underlying principles and goals of the Risk-based Strategy and provide a model of the success and added potential benefits possible under this strategy.

- **District Rule 4901 (Wood Burning Fireplaces and Wood Burning Heaters) and the District's corresponding Check-Before-You-Burn program** have both been reducing harmful species of PM2.5 where and when those reductions are most needed—in impacted urbanized areas when the local weather is forecast to hamper PM dispersion. By decreasing emissions from residential wood burning, Rule 4901 decreases directly emitted PM2.5, as well as carbon monoxide, formaldehyde, sulfur dioxide, irritant gases, and known and suspected carcinogens, such as polycyclic aromatic hydrocarbons (PAH). In 2008, the Central Valley Health Policy Institute found that District wood burning curtailments on days with high PM concentrations reduced annual PM exposure

[5] U.S. Environmental Protection Agency [EPA]. (2009). Integrated Science Assessment for Particulate Matter: Final Report. Washington, D.C.: EPA/600/R-08/139F. Available at http://cfpub.epa.gov/ncea/isa/recordisplay.cfm?deid=216546

by about 13% in Bakersfield and Fresno, resulting in an estimated 59 to 121 avoided cases of annual premature mortality.[6]

Even though the *2008 PM2.5 Plan* was developed per EPA requirements for the 1997 PM2.5 standard (with a 24-hour standard of 65 µg/m³), the 2008 plan included a commitment to amend Rule 4901 in 2009 (with implementation in 2010) to align the wood-burning curtailment threshold with the newer 2006 PM2.5 standard (with a 24-hour standard of 35 µg/m³). Then, based on research reiterating the effectiveness of Rule 4901 in protecting public health, as well as public support for a stronger rule, the District amended and implemented Rule 4901 in 2008—one year ahead of the scheduled rule development and two years ahead of scheduled implementation. The amended rule also set the curtailment level lower than initially planned (to 30 µg/m³) to provide an extra margin of safety and to address air quality forecast uncertainties.

The significant increase in the number of curtailment days resulting from the lower threshold has resulted in a parallel reduction in nighttime neighborhood exposure to PM 0.1, including exposure that has been shown to occur as a result of indoor infiltration. This aspect of Rule 4901, i.e. reducing the frequency of elevated exposure to PM0.1 that induces immune system sensitization and cardiovascular inflammation, has been carried forward into the Risk-based Strategy. The District's prioritization of Rule 4901 is one of the best examples of a District policy aimed at maximizing public health benefits based on a rigorous assessment of population exposure and risk.

- **District grant programs** reach beyond the current CAA NAAQS-SIP process to reduce emissions in advance of or beyond regulations. For example, through the District's popular Clean-Green-Yard-Machine grant program, the District has replaced over 2,000 high-polluting gas-powered lawn mowers with clean electric mowers, thus decreasing the urban, localized health risks associated with the use of gas-powered equipment. As described in Appendix C of this plan, the District is now expanding its lawn care emissions reductions programs to the commercial sector. In conjunction, District-funded field measurements of PM 0.1 by UCSF-Fresno found very high concentrations in and around lawn care activities, indicating a very high intake fraction for lawn care workers and concomitant cardiovascular risk.

- **The District's information and educational programs, such as the Real-Time Air Quality Advisory Network (RAAN),** also contribute to the Risk-based Strategy. RAAN uses real-time data from air monitoring stations throughout the Valley to provide hour-by-hour air quality updates to schools and other subscribers. Subscribers can use this information to make informed decisions and plan outdoor activities for times with the best air quality, reducing potential

[6] Lighthall, D., Nunes, D., & Tyner, T.R. (2009). Environmental Health Evaluation of Rule 4901: Domestic Wood Burning. Fresno, CA: Central Valley Health Policy Institute for the San Joaquin Valley Air Pollution Control District. Retrieved from http://www.fresnostate.edu/chhs/cvhpi/documents/wood-burning-report.pdf

air quality health risks. Reflecting the latest science on PM2.5 exposure risk for sensitive individuals, ambient concentrations of PM2.5 that are used to trigger RAAN health risk warnings are more health protective than those used in the EPA's Air Quality Index.

- **The District tracks and sponsors health research.** The District has sponsored several Valley-based health research projects in recent years. In 2010–2011, the District sponsored a first-of-its-kind epidemiological investigation of health effects of air pollution in Modesto, Fresno, and Bakersfield.[7] The study found that high PM and ozone concentrations clearly correlate to increased hospital and ER admission rates, especially for those 19 and younger. During 2011 and 2012, the District is sponsoring a follow-up epidemiological study to examine which of the chemicals found in Valley PM2.5 are most highly correlated with elevated ER and hospital admission rates. The District is also sponsoring a pilot study of PM 0.1 in Fresno, partnering with UCSF-Fresno, to investigate the quantity and spatial distribution of PM 0.1 plumes from motor vehicles, lawn care equipment, wood burning, and restaurants. The District will continue to seek out and fund research opportunities that further the understanding of PM2.5 and ozone impacts on public health.

2.3 HOW IS THE RISK-BASED STRATEGY BEING INCORPORATED INTO THIS PLAN?

Though there are several existing District programs that readily fit into this strategy, this *2012 PM2.5 Plan* is the District's first formal effort to synthesize research, population-exposure analysis, and comprehensive emissions reductions efforts into a cohesive Risk-based Strategy. This is also the District's first opportunity to demonstrate how the RBS fits within and effectively supplements EPA's current CAA framework.

The District is integrating the RBS into various aspects of the *2012 PM2.5 Plan*. The District expects to incorporate the RBS into this plan with the following:

- **Information regarding health effects of PM2.5:** Chapters 1 and 2 include detailed discussions regarding the different types of PM2.5 and their associated health effects.

- **Ambient data analysis:** In addition to evaluating PM2.5 mass trends per CAA and EPA guidelines, Chapter 3 and Appendix A discuss PM2.5 species-based trends. This species analysis, when considered with health research, will highlight which PM2.5 and PM2.5 precursor sources might be prioritized under the RBS. The District is also evaluating the timing of higher PM2.5

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[7] Capitman, J.A., & Tyner, T.R. (2011). *The Impacts of Short-Term Changes in Air Quality on Emergency Room and Hospital Use in California's San Joaquin Valley*. Fresno, CA: Central Valley Health Policy Institute for the San Joaquin Valley Air Pollution Control District. Retrieved from http://www.fresnostate.edu/chhs/cvhpi/publications/index.html

concentrations to see if there are certain times of the day or times of the year when PM2.5 reductions might have more public health benefits.

- **Health Research:** The RBS is driven by strong science and research, and the District will continue to evaluate existing research and assist in promoting new research relevant to the Valley.

- **Analysis of health benefits under the attainment strategy:** Building on regional SIP modeling provided by ARB, the District used EPA's BenMAP benefit estimation model to estimate the health benefits in the Valley resulting from the District's attainment strategy. (See section 2.5 and Appendix E for additional details)

- **Source-by-source assessment:** The District is conducting a thorough analysis of all potential opportunities to reduce emissions of directly emitted PM2.5 and significant PM2.5 precursors in the Valley. The qualitative exposure assessment described below will be used to assist in evaluating the potential health benefit of reducing emissions from these various sources. This more comprehensive assessment will help establish the strongest scientific justification for new source control strategies and incentive program investments.

- **Control measure/strategy prioritization:** Based on the above source-by-source assessment, and other evaluation being conducted as part of developing this plan, priority will be given to regulatory control measures, incentive programs, technology advancement efforts, policy initiatives, and other strategies that maximize public health.

2.4 FIVE-FACTOR EXPOSURE ASSESSMENT METHODOLOGY

To qualitatively evaluate the potential risk reduction benefits from various sources, this plan will employ a scientifically based exposure characterization methodology that draws on the latest scientific understanding about health risk from PM2.5 exposure.

The District will use a five-factor exposure assessment methodology under the RBS:

1. **Relevance to attainment**
2. **Toxicity of chemical species**
3. **Particle size and deposition**
4. **Proximity to PM 0.1**
5. **Population intake fraction**

The qualitative exposure assessment employed in this SIP is different than a formal risk assessment. Risk assessment requires the quantification of key elements relating to emission levels, particle or chemical toxicity, dose-response relationships, and total population exposure. The primary drawback for formal risk assessment models in a SIP context is pervasive empirical uncertainty regarding the values of the different elements listed above. Even if the chemical composition, geographic pattern and volume, and spatial distribution of emissions from a given source are known, it is very difficult to isolate and quantify the regional health impacts of emissions from that source because many other sources are also contributing to PM2.5 exposure. In addition, PM2.5 aerosols undergo photochemical aging over time and space, often resulting in new secondary organic and inorganic species generated by variable regional source loads and meteorological conditions. Despite these limitations, it is possible to use a simple but robust exposure characterization tool for making important qualitative and categorical distinctions regarding the relative contribution and associated of a given source to population exposure.

2.4.1 Relevance to Attainment

An important element of the RBS is the relevance of the emissions reductions to the Valley's attainment of EPA's health-based standards. This portion of the analysis will consider emissions type (such as PM2.5, NOx, or SOx), seasonality of the emissions (since PM2.5 exceedance days occur during the winter months), and the percent contribution of that source's emissions relative to the Valley's total emissions inventory. For example, NOx is the limiting factor for ammonium nitrate and therefore reductions of NOx emissions in the Valley will provide a greater impact to achieving attainment than reductions of ammonia emissions.

2.4.2 Toxicity of Chemical Species

PM2.5 particles vary in their toxicity depending on their chemical composition. PM2.5 particles are characterized by a widely diverse combination of chemicals depending on unique regional combinations of meteorology, topography, and pollution sources. In addition to experimental and clinical research that has identified these toxicity differences, epidemiological studies have found regional differences in health impacts despite comparable regional PM2.5 mass exposure.[8] Beyond the intrinsic toxicity of individual chemicals, the unique combinations of chemicals generated by some sources can actually magnify health risk above and beyond what their mass concentrations would suggest.[9]

Many emissions sources evaluated in this plan are sources of direct (primary) PM2.5 emissions characterized by a unique combination of chemical species. Other sources emit chemical species such as ammonia and nitrogen oxides (NOx), precursors that contribute to the formation of secondary PM2.5 species. The PM2.5 chemical species categories adopted in the exposure characterization model include elemental carbon (carbon black), organic carbon compounds (OC), metals (elements), ammonium nitrate,

[8] Bell, M.L. (2012). *Assessment of the Health Impacts of Particulate Matter Characteristics*. Research Report 161. Boston: MA. Health Effects Institute. Retrieved from http://pubs.healtheffects.org/getfile.php?u=685

[9] Kelly, F.J. (2006). Oxidative Stress: Its Role in Air Pollution and Adverse Health Effects. *Occupational Environmental Medicine, 60,* 612–616. Retrieved from http://oem.bmj.com/content/60/8/612.full doi: doi:10.1136/oem.60.8.612

ammonium sulfate, and geological (see Appendix A, Section A.4.9). PM2.5 is regularly speciated at several Valley monitoring sites (see Chapter 3, Figure 3-7; and Appendix A). The following discussion provides an overview of PM2.5 species and their associated health impacts.

Organic carbon (OC): OC species found in PM2.5 aerosol are generated as primary organic aerosol (POA), predominantly through the combustion of hydrocarbons. Key POA sources include cooking, industrial processes, mobile source exhaust, prescribed burning, tire wear, and wood burning.[10] Secondary organic aerosols (SOA) are formed from the oxidation of motor vehicle hydrocarbons, prescribed burning, wood burning, solvent use, and industrial processes.

OC is recognized as one of the most biologically reactive of PM2.5 chemical species categories, with ample evidence of high toxicity found in experimental, clinical, and epidemiological studies. OC, often in combination with metals such as iron, has been shown to generate reactive oxygen species (ROS) that drive several different mechanisms of pulmonary inflammation, including disruption of normal immune system functioning.[11] In addition, OC and metals have been shown to indirectly stimulate ROS production by macrophages, which are cells responsible for defending the lungs from pathogens and aerosols.

One of the primary OC species categories is polycyclic aromatic hydrocarbons (PAH). PAH species fall into two categories: a high molecular weight fraction and a low molecular weight fraction. The former is found in diesel exhaust and engine oil and is a significant risk factor for lung cancer.[12] Low molecular weight PAH is found in other hydrocarbon combustion particles and serves as a precursor to the formation of an important OC species category known as quinones. Formed from atmospheric processing of PAH or within the body (in vivo), quinones have been shown to be one of the most important drivers of pulmonary oxidative stress, resulting in a host of negative spillover effects on immune system functioning.[13] Quinone formation via chemical aging of PAH occurs during multi-day winter stagnation events in the Valley. A District-funded clinical study of asthmatic patients in Fresno found that quinone levels in urine

[10] U.S. Environmental Protection Agency [EPA]. (2004, October). *Air Quality Criteria for Particulate Matter: Final Report*. Washington, D.C.: EPA 600/P-99/002aF-bF. Available at http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=87903

[11] Ayres, J.G., Borm, P., Cassee, F.R., Castranova, V., Donaldson, K., Ghio, A. … Froines, J. (2008) Evaluating the Toxicity of Airborne Particulate Matter and Nanoparticles by Measuring Oxidative Stress Potential—A Workshop Report and Consensus Statement. *Inhalation Toxicology 20,* 75–99. Retrieved from http://faculty.unlv.edu/buckb/scanned%20pfd/Ayres%20et%20al%202008.pdf

[12] Landvik, N.E., Gorria, M., Arlt, V.M., Asare, N., Solhaug, A., Lagadic-Gossmann, D., & Holme, J.A. (2007). Effects of Nitrated-Polycyclic Aromatic Hydrocarbons and Diesel Exhaust Particle Extracts on Cell Signalling Related to Apoptosis:Possible Implications for their mutagenic and Carcinogenic Effects. Toxicology, 231, 159–174. doi:10.1016/J.tox.2006.12.009

[13] Bolton, J., Trush, M.A., Penning, T.M., Dryhurst, G., & Monks, T.J. (2000). Role of Quinones in Toxicology. *Chemical Research in Toxicology, 13(3)*, 135–160. doi: 10.1021/tx99

correlated with sustained (multi-day) high ambient concentrations of PM2.5 and was accompanied by decreased lung function.[14]

Elemental carbon (EC): Elemental carbon is found in combustion-based aerosols produced by mobile exhaust (mainly diesel), wood burning, and cooking (especially charbroiling). Compared to OC species, there is limited evidence of comparable impacts on ROS production, pulmonary inflammation, and immune system disruption. For example, EC appears not to be a significant agent for the induction of inflammation in macrophage cells, indicating a significantly lower toxicity level relative to OC species.[15] A recent study of PM 0.1-based exposure of EC in mice found modest cardiovascular effects. Pulmonary inflammation was noted but only at high doses beyond normal ambient concentrations.[16] A recent study in Mexico City found an association between exposure levels of EC and lung function decrements among asthmatic and non-asthmatic children.[17]

Characterization of health effects of elemental carbon from human exposure studies is complicated by the high correlation between EC, OC, and metals emitted by diesel exhaust. Exposure to EC is a PM2.5 risk factor, although there is more evidence to date that other chemical species, e.g. metals and OC, found in these particles are the primary drivers of negative health effects.

Metals: A combination of clinical, experimental, and epidemiological studies have implicated several of the metals found in PM2.5 with negative respiratory or cardiovascular outcomes, sometimes in conjunction with the action of OC species. One of the most important is iron because of its ability to catalyze the production of hydrogen peroxide, leading to highly reactive hydroxyl radicals (OH). In turn, these highly reactive chemicals stimulate the production and action of cytokines by macrophages. Cytokines are cell-signaling molecules that are critical to normal functioning of the immune system. A recent experimental study examined the impact of iron in silica particles in triggering respiratory toxicity.[18] Compared to silica particles with no iron, silica particles with iron were found to have a significantly greater effect on oxidative stress via hydrogen peroxide production with subsequent stimulus of cytokines by macrophages.

[14] Ikeda, A., Vu, K.K.-T., Lim, D., Tyner, T.R., Krishnan, V.V., & Hasson, A.L. (2012). An Investigation of the Use of Urinary Quinones as Environmental Biomarkers for Exposure to Ambient Particle-Borne Pollutants. *Science of the Total Environment* (submitted).

[15] Vogel, C.F., Sciullo, E., Wong, P., Kuzmicky, P., Kado, N. & Matsumura, F. (2005). Induction of Proinflammatory Cytokines and C-Reactive Protein in Human Macrophage Cell Line U937 Exposed to Air Pollution Particulates. *Environmental Health Perspectives 113(11)*, 1536–1541.

[16] Vesterdal, L.K., Folkmann, J.K., Jacobsen, N.R., Sheykhzade, M., Wallin, H., Loft, S., & Møller, P. (2010). Pulmonary Exposure to Carbon Black Nanoparticles and Vascular Effects. *Particle and Fibre Toxicology 7:33*. Retrieved from http://www.particleandfibretoxicology.com/content/7/1/33 doi: 10.1186/1743-8977-7-33

[17] Barraza-Villarreal, A., Escamilla-Nuñez M.C., Hernández-Cadena L., Texcalac-Sangrador. J.L., Sienra-Monge, J.J., Del Río-Navarro, B., Cortez-Lugo, M., Sly, P.D., & Romieu, I. (2011). Elemental Carbon Exposure and Lung Function in Schoolchildren from Mexico City. *European Respiratory Journal, 38,* 548–552.

[18] Premasekharan, G., Nguyen, K., Contreras, J., Ramon, V., Leppert, V.J. & Forman, H.J. (2011). Iron-Mediated Lipid Peroxidation and Lipid Raft Disruption in Low-Dose Silica-Induced Macrophage Cytokine Production. *Free Radical Biology and Medicine, 51(6)*, 1184–1194. doi: 10.1016/j.freeradbiomed.2011.06.018

Extensive research relates exposure in metals (particularly nickel and vanadium) in PM2.5 to cardiovascular effects. A national epidemiological study recently found that communities with higher fractions of nickel, vanadium, and EC in their PM2.5 also had higher risk of cardiovascular and respiratory hospitalization.[19] Specifically, cardiovascular hospitalizations were 26% higher in counties with a nickel fraction in the 75th percentile versus counties with nickel in the 25% percentile. In an investigation of the relatively higher association between PM2.5 daily concentrations and daily rates of cardiovascular mortality in New York City, the exceptionally high level of nickel and vanadium resulting from residual oil fly ash used for heating and as fuel for ships were identified as a principle cardiovascular risk factor.[20] In a related study, rats exposed to PM2.5 with high fractions of chromium, iron, and nickel fractions responded with significantly reduced heart rate variability and increased heart rates, each being an indicator of cardiovascular disruption and risk.[21]

In conclusion, metals found in PM2.5 produced from combustion of coal, residual oil, diesel fuel, and motor oil are recognized as chemical drivers of cardiovascular and respiratory morbidity and mortality. This has led some researchers to conclude that regional differences in U.S. cardiovascular mortality that cannot be explained by differences in average daily PM2.5 concentrations are likely to be caused by regional differences in coal combustion and resultant exposure to metals and OC.[22]

Ammonium nitrate: Ammonium nitrate (nitrate) is classified as a secondary inorganic species (not directly emitted) primary source of PM2.5, and it does not contain carbon. Nitrate is formed by atmospheric reactions between two precursors: ammonia and nitric acid. Prior to this reaction, nitric acid generally originates from the chemical processing of nitrogen oxides (NOx), largely from fuel combustion under meteorological conditions found during Valley winters, particularly during multiday stagnation events. As seen in Figure 2-1, nitrate is significant because it can contribute up to 50% or more to PM2.5 mass during peak days during winter seasons. The percentage contribution of nitrate to PM2.5 mass is substantially reduced in summer, with the 2000–2006 Valley average for June ranging from 13 to 18%, with mass levels at or below 2 µg/m^3.[23]

[19] Bell, M.L., Ebisu, K., Peng, R.D., Samet, J.M. & Dominici, F. (2009). Hospital Admissions and Chemical Composition of Fine Particle Air Pollution. *American Journal of Respiratory Critical Care, 179*, 1115–1120. Retrieved from http://ajrccm.atsjournals.org/content/179/12/1115.full.pdf+html

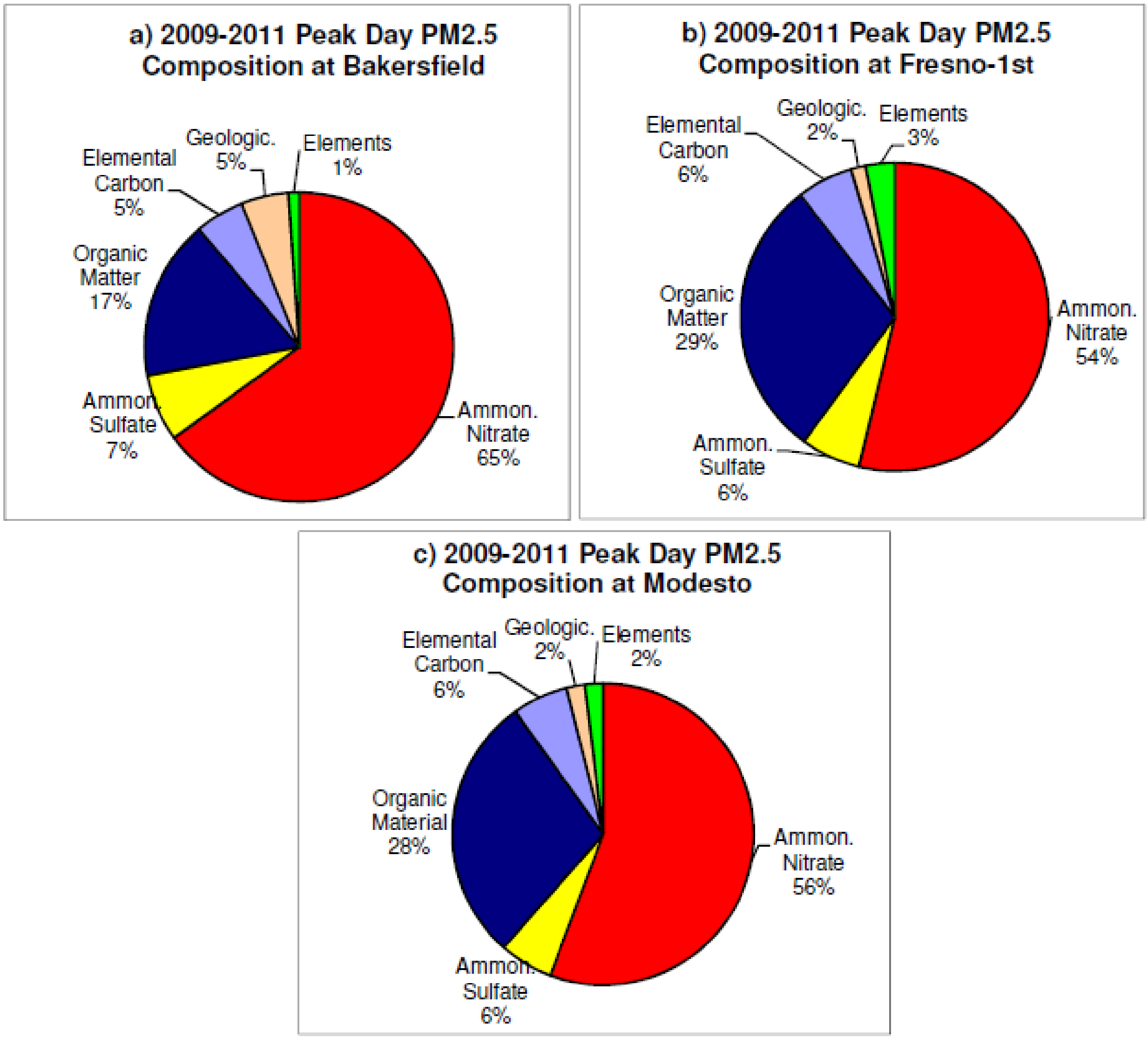
[20] Lippmann, M., Ito, K., Hwang, J-S., Maciejczyk, P., & Chen, L-C. (2006). Cardiovascular Effects of Nickel in Ambient Air. *Environmental Health Perspectives*, *114(11)*, 1662–1669. Retrieved from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1665439/

[21] Chen, L.C., & Lippmann, M. (2009). Effects of Metals within Ambient Air Particulate Matter (PM) on Human Health. *Inhalation Toxicology, 21(1),* 1–31. Retrieved from http://faculty.unlv.edu/buckb/scanned%20pfd/Chen%20and%20Lippmann%202009.pdf

[22] Lippman, M. (2012, April 16). Presentation: Results from National Particle Component Toxicity (NPACT) Program and NYU: Toxicology Findings, Integration, and implications. Presented at the Annual Meeting of the Health Effects Institute (HEI) in Chicago, IL, April 15–17, 2012. Presentation retrieved from http://www.healtheffects.org/Slides/AnnConf2012/Lippmann-MonPM.pdf

[23] California Air Resources Board [CARB]. (2011). CARB speciation data: District Staff Analysis of the 2000-2006 Sampler Data for the Four Speciation Samplers in the San Joaquin Valley. Available at http://www.epa.gov/ttn/airs/airsaqs/detaildata/downloadaqsdata.htm

Figure 2-1 PM2.5 Chemical Composition on Peak Days



A recent cold-season ammonia emissions inventory for the Valley estimated that motor vehicles and livestock production each contribute approximately 40% to total seasonal ammonia.[24] Green waste composting and nitrogen fertilizer emissions from soil are also major sources. As temperatures increase, the proportional contribution of livestock to the regional inventory increases, peaking at nearly 75% of the total in the hot season.

The relative toxicity of ammonium nitrate is an important issue given its substantial mass contribution to regional PM2.5. The oral toxicity of nitrate is very low, with an LD50 (dose causing death for 50% of the exposed subjects) reported to be two thirds that of table salt. This raises the question as to whether other factors intrinsic to inhalation could lead to health effects at considerably lower exposure concentrations.

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[24] Battye, W., Anaja, V.P., & Roelle, P.A. (2003). Evaluation and Improvement of Ammonia Emissions Inventories. *Atmospheric Environment, 37*, 3873–3883.

As seen in the case of OC species, the most compelling evidence of species toxicity is built on a foundation of experimental, clinical, and epidemiological research. In particular, epidemiological studies draw their inferences from statistical associations between exposure variables and health outcomes only. Uncovering the actual mechanisms of harm, therefore, requires further isolation of mechanisms through experimental and clinical research.

In the case of ammonium nitrate, evidence of toxicity is largely limited to epidemiological research alone. For example, a recent epidemiological study of traffic air toxics and pre-term birth in Los Angeles found statistical associations between nitrate mass, PAH, and several other air pollutants and the increased likelihood of pre-term birth.[25] The authors point to other experimental studies that identified very high oxidative stress potential resulting from PAHs, metals, and other OC species collected from Los Angeles traffic sources as being the likely mechanism for pre-term birth. They conclude by emphasizing the need to further study the links between pre-term birth and PAH exposure.

One experimental study was found that explicitly looked for toxic mechanisms driven by ammonium nitrate.[26] The study exposed rats to high concentrations of nitrate (70 to 420 $\mu g/m^3$) in combination with EC. After exposure, animals were sacrificed and a necropsy was performed, followed by a range of tests for pathological impacts between the control (non-exposed) and exposed groups. The authors did not find abnormalities that could be tied to the experimental exposure to nitrate alone or in combination with EC. This absence of experimental evidence for mechanisms of pathology for inhaled ammonium nitrate is consistent with its low oral toxicity.

Ammonium sulfate: Ammonium sulfate (sulfate) is also classified as a secondary inorganic species. It is formed when sulfuric acid, itself a product of oxidation of sulfur, reacts with ammonia. As seen in Figure 2-1, mass concentrations of sulfate are significantly lower than for nitrate in the Valley, averaging from 6% to 7% of PM2.5 mass during winter peaks. Fossil fuel combustion is the primary source of sulfate in the Valley, but globally, coal combustion is the primary source. Unlike nitrate, mass concentrations of sulfate are not appreciably different in cold and hot seasons.

Research findings regarding the toxicity of sulfate are comparable to that of nitrate. Oral toxicity is low and it is approved as a food additive by the US Food and Drug Administration and the European Union. One study[27] examined the response of 20 non-smoking subjects to four-hour exposure sessions in chambers containing 500 $\mu g/m^3$ of sulfate aerosol, a concentration over two orders of magnitude above ambient

[25] Wilhelm, M., Ghosh, J.K., Su, J., Cockburn, M., Jerrett, M. & Ritz, B. (2011). Traffic-Related Air Toxics and Preterm Birth: A Population-Based Case-Control Study in Los Angeles County, California. *Environmental Health 10: 89*. Available at http://www.ehjournal.net/content/10/1/89/ doi: 10.1186/1476-069X-10-89

[26] Cassee, F., Arts, J.H., Fokkens, P.H., Spoor, S.M., Boere, A.J., van Bree, L., & Dormans, J.A. (2002). Pulmonary Effects of Ultrafine and Fine Ammonium Salts Aerosols in Healthy and Monocrotaline-Treated Rats Following Short-Term Exposure. *Inhalation Toxicology, 14(12)*, 1215–1229. doi: 10.1080/08958370290084872

[27] Kulle, T.J., Sauder, L.R., Shanty, F., Kerr, H.D., Ferrell, B.P., Miller, W.R., & Milman, J.H. (1984). Sulfur Dioxide and Ammonium Sulfate Effects on Pulmonary Function and Bronchial Reactivity in Human Subjects. *American Industrial Hygiene Association Journal, 45(3)*, 156–161. ISSN:1542-8125

levels in the Valley. Pulmonary function tests were performed to assess the response of these exposures. No significant changes in pulmonary function or bronchial reactivity were observed immediately after the individual exposures or 24 hours after exposure. In an experimental study that also exposed rats to 500 µg/m^3 of sulfate for four to eight months, modest pulmonary impacts were noted.[28] After four months, cellular immunologic responsiveness was not impaired, but physiologic changes were detected, including enlargement of bronchial epithelial (surface) cells and in alveolar size.

For each of these studies, the modest health impacts observed at very high exposure levels are consistent with the low intrinsic toxicity of sulfate. This is consistent with results of a review of the epidemiological and toxicological research on sulfate.[29] Researchers found that PM sulfate was a weaker indicator of health risk than PM2.5 mass. Because sulfate is correlated with PM2.5 mass, this result is inconsistent with sulfate having a strong health influence. The study concluded that the epidemiologic and toxicologic evidence provide little or no support for a causal association of sulfate and health risk at ambient concentrations.

Geological: Winter season and annual average PM2.5 found in the Valley contains a very small fraction of species that are termed *crustal*, i.e. having their origins in the earth's crust. This coarse fraction—PM 2.5-10—contains a much higher fraction, as do particles beyond the PM10 size category. Suspended dust consists mainly of oxides of aluminum, silicon, calcium, titanium, iron, and other metal oxides. The precise combination of these components depends on the geology, industrial, and agricultural processes of the area. Geological material typically consists of 5% to 15% PM particles.

Other researchers examined the respiratory inflammation potential of PM2.5 soil dust taken from nine different sites in the western U.S. taken from windblown dust and vehicle-generated particles from unpaved roads.[30] None of the sites were located in the Valley. Cultured human epithelial cells were exposed and then were assessed for their release of cytokines known to be triggered by oxidative stress. PM2.5 from five of the sites was found to be benign, three of the sites demonstrated measurable cytokine response, and PM2.5 from one site was found to be highly reactive. Endotoxin, a potentially reactive bio-aerosol that is often found in PM, was not found to be a contributing factor to the variations in inflammatory potential.

Although not technically a geologic species, respirable road dust (RRD) has been recognized and analyzed as a separate form of PM2.5 that has relevance to exposure

[28] Smith, L.G., Busch, R.H., Buschbom, R.L., Cannon, W.C., Loscutoff, S.M., & Morris, J.E. (1989). Effects of Sulfur Dioxide or Ammonium Sulfate Exposure, Alone or Combined, for 4 or 8 Months on Normal and Elastase-Impaired Rats. *Environmental Research 49(1)*, 60-78. doi: 10.1016/S0013-9351(89)80022-2

[29] Reiss, R., Anderson, E.L., Cross, C.E., Hidy, G., Hoel, D., McClellan, R., Moolgavkar, S. (2007). Evidence of Health Impacts of Sulfate-and Nitrate-Containing Particles in Ambient Air. *Inhalation Toxicology, 19(5),* 419-449. doi:10.1080/08958370601174941

[30] Veranth, J., Rielly, C.A., Veranth, M.M., Moss, T.A., Langelier, C.R., Lanza, D.L., & Yost, G.S. (2004). Inflammatory Cytokines and Cell Death in BEAS-2B Lung Cells Treated with Soil Dust, Lipopolysaccharide, and Surface-Modified Particles. *Toxicological Science 82(1)*, 88–96. Retrieved from http://toxsci.oxfordjournals.org/content/82/1/88.full.pdf+html doi: 10.1093/toxsci/kfh24

characterization of sources in this plan. In this context, RRD is defined as PM less than 2.5 microns in diameter that is deposited along paved roadways as a result of roadway breakdown, tire wear, brake wear, deposition of exhaust-related particles, and other anthropogenic sources. Speciation analysis[31] of RRD in southern California identified over 100 organic compounds including n-alkanes, n-alkanoic acids, n-alkenoic acids, n-alkanals, n-alkanols, benzoic acids, benzaldehydes, polyalkylene glycol ethers, PAH, oxy-PAH, steranes, hopanes, natural resins, and other compound classes. This relatively toxic mix of OC species is coincident with a range of metals associated with motor vehicle exhaust and component wear. RRD particles are re-suspended by passing traffic, leaf blowers, and other sources for possible inhalation by individuals in or near the roadway.

To conclude, the geologic fraction of PM2.5 found in the Valley makes a relatively small contribution to overall PM2.5 mass and, by itself, has relatively low toxicity. RRD, while not of geologic origins, has been reviewed here because of its relevance to subsequent exposure characterization of sources in subsequent chapters.

2.4.3 Particle Size and Deposition

Particle size has a significant bearing on bodily deposition, net exposure, and corresponding health risk, even within the PM2.5 size fraction. Key metrics for deposition assessment include the percentage of inhaled particles that remain deposited and not exhaled (known as the deposition fraction) and the location where particles are deposited within the body).[32] Within the PM2.5 size range, particles less than 0.1 microns (PM 0.1) and greater than 10 microns are least likely to be exhaled, and thus have higher deposition fractions.[33]

The relationship between particle size, zone of deposition, and deposition fraction are depicted in Figure 2-2 and is summarized as follows:

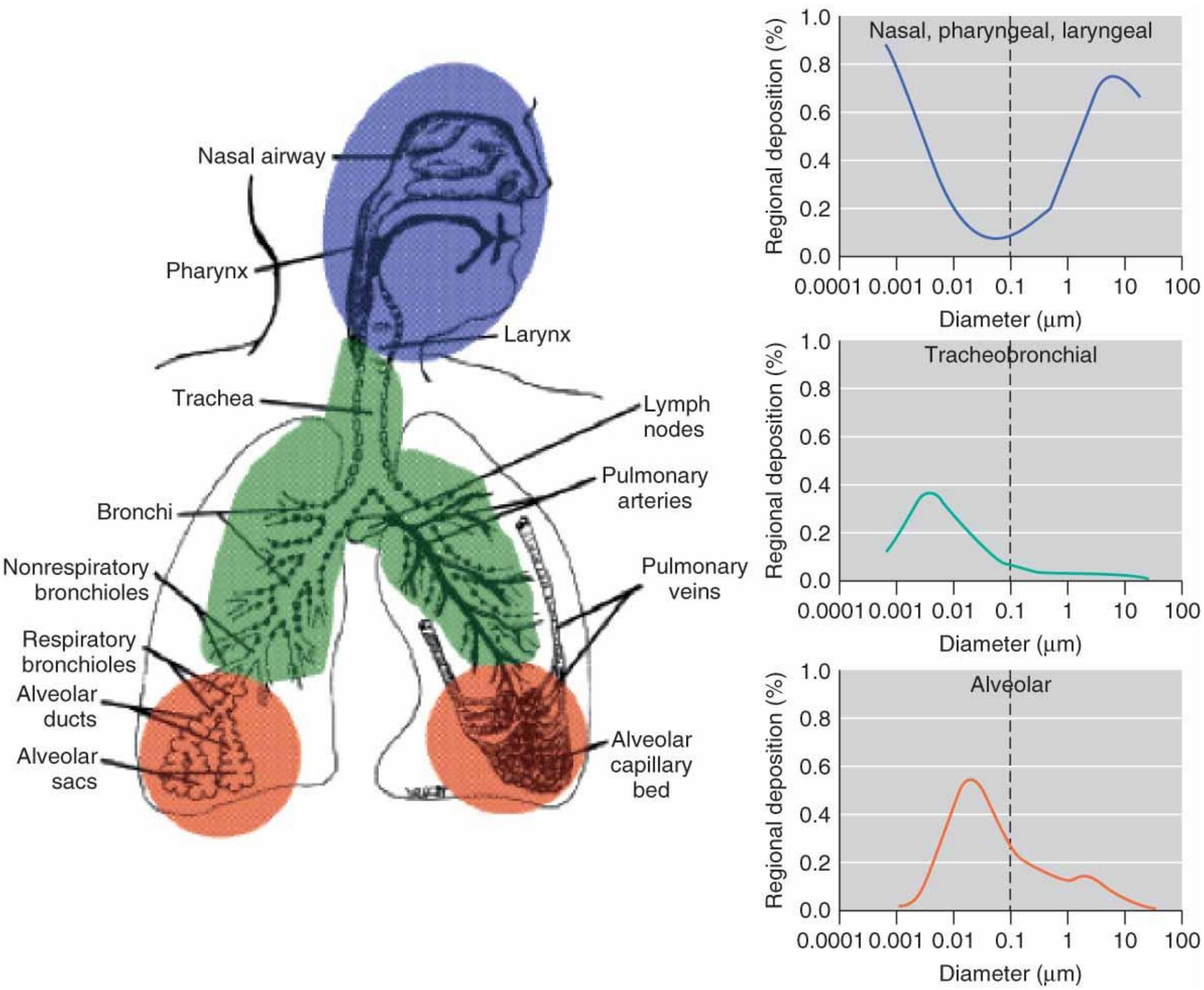
A. Nasal, pharyngeal, laryngeal: As shown in Figure 2-2 at the upper right, the uppermost segment of the respiratory tract is the primary zone of deposition for the smallest and largest particles. Approximately 80% of extremely small particles of one nanometer (0.001 micron) diameter or less are retained here with a comparable deposition fraction in the 10 micron diameter.

B. Tracheobronchial: The deposition fraction in this zone peaks at nearly 40% for particles with diameters between 1 and 10 nanometers. Almost 100% of the particles above the PM 0.1 size cut are either deposited in the other two deposition zones or exhaled.

[31] Rogge, W. F., Hildemann, L. M., Mazurek, M. A., Cass, G. R. and Simoneit, B. R. T. (1993). Sources of Fine Organic Aerosol—3. Road Dust, Tire Debris, and Organometallic Brake Lining Dust—Roads As Sources and Sinks. *Environmental Science & Technology 27(9),* 1892-1904.
[32] International Commission on Radiological Protection [ICRP]. (1995). Human Respiratory Tract Model for Radiological Protection. ICRP Publication 66.. *Annals of the ICRP 24,* 1–3.
[33] U.S. Environmental Protection Agency [EPA]. (2004, October). *Air Quality Criteria for Particulate Matter: Final Report*. Washington, D.C.: EPA 600/P-99/002aF-bF. Available at http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=87903

C. Alveolar: Deposition in the gas exchange zone of the lungs peaks in the 10 nanometer size with a gradual dissipation of deposition beyond the PM 0.1 size.

Figure 2-2 Relationships Between Particle Size Distribution and Respiratory Deposition Zones



Deposition of very small particles in the alveolar region of the lungs results in the delivery of their chemicals into the bloodstream where they promote cardiovascular disruption and immune system sensitization.[34] These chemicals can trigger heart attacks and premature death among individuals with pre-existing heart conditions.[35] Extremely small particles can also be absorbed into the brain via the nasal tract,

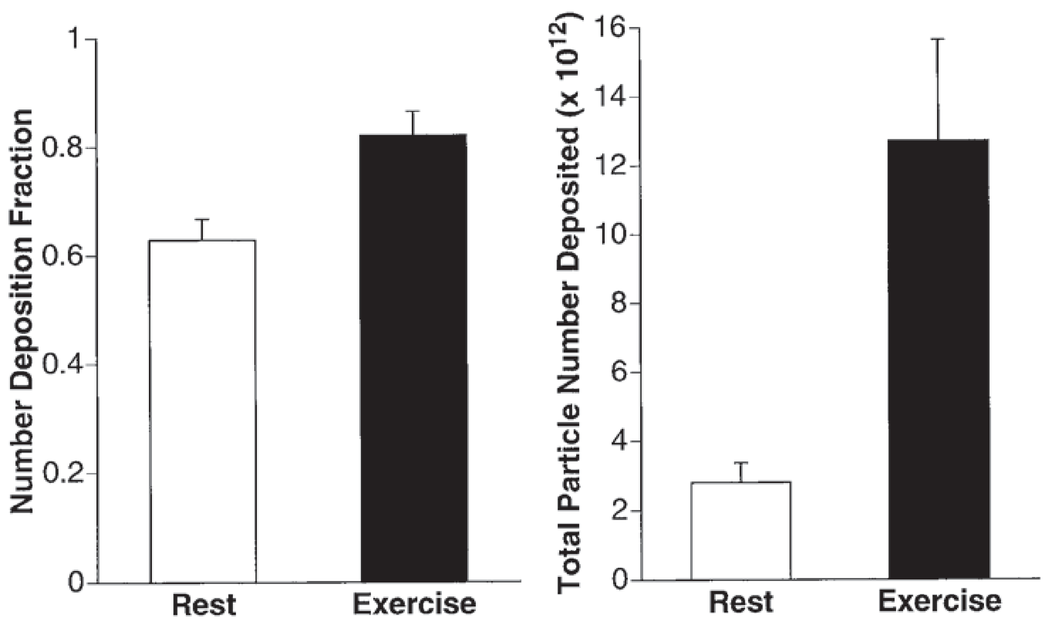
[34] Delfino, R.J., Sioutas, C., & Malik, S. (2005). Potential Role of Ultrafine Particles in Associations between Airborne Particle Mass and Cardiovascular Health. *Environmental Health Perspectives 113(8),* 934–946. Retrieved from http://ehp03.niehs.nih.gov/article/fetchArticle.action?articleURI=info%3Adoi%2F10.1289%2Fehp.7938

[35] Nel A. (2005). Air Pollution-Related Illness: Effects of Particles. *Science, 308(5723),* 804–806. doi: 10.1126/science.1108752

bypassing the protection provided by the blood-brain barrier.[36] The effects of particles deposited primarily in the tracheobronchial region center on respiratory function.[37]

As depicted in Figure 2-3, particle deposition and associated health risk is magnified by exercise in several ways. First, the amount of inhaled air per minute rises substantially when breathing faster and more deeply. Second, breathing harder means that particles, especially PM 0.1, are more likely to penetrate the alveolar region of the lungs where absorption into the bloodstream occurs. A 2003 study[38] found that during moderate exercise 80% of inhaled PM 0.1 was deposited in the lungs, compared with 60% lung retention while at rest (see left panel in Figure 2-3). However, because the volume of air exchanged per minute increases substantially during exercise, overall PM 0.1 deposition increased by 450% (right panel). Discussed further below, this phenomenon underscores the health risk posed to individuals who work or exercise in areas where sources of hydrocarbon combustion result in very high PM 0.1 particle concentrations.

Figure 2-3 Particle Number Deposition Fraction (DF) and Total Particle Deposition of PM 0.1 at Rest and Exercise



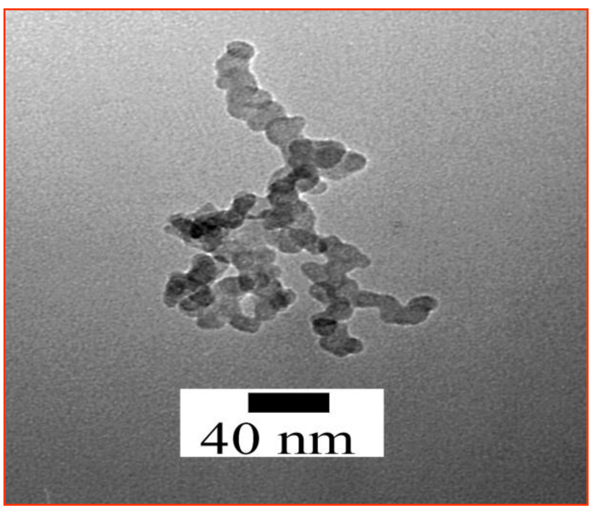
[36] Oberdorster, G., Sharp, Z., Atudorei, V., Elder, A., Gelein, R., Kreyling, W., & Cox, C. (2004). Translocation of Inhaled Ultrafine Particles to the Brain. *Inhalation Toxicology, 16(6-7)*, 437–445.
[37] U.S. Environmental Protection Agency [EPA]. (2009). *Integrated Science Assessment for Particulate Matter: Final Report*. Washington, D.C.: EPA/600/R-08/139F. Available at http://cfpub.epa.gov/ncea/isa/recordisplay.cfm?deid=216546
[38] Daigle, C., Chalupa, D.C., Gibb, F.R., Morrow, P.E., Oberdörster, G., Utell, M.J., & Frampton, M.W. (2003). Ultrafine Particle Deposition in Humans during Rest and Exercise. *Inhalation Toxicology, 15(6)*, 539–552. doi: 10.1080/08958370304468

2.4.4 Exposure to Ultrafine Particles (PM 0.1)

Elevated exposure to freshly emitted PM 0.1 is a critical health risk factor that often does not correspond to ambient PM2.5 concentrations at local monitors. PM 0.1 are formed through nucleation and gas-to-particle reactions and grow (or shrink) through a number of mechanisms including condensation, coagulation, and volatilization.[39] High concentrations of primary (directly emitted) PM 0.1 are typically found near fresh sources of hydrocarbon combustion, including coal plants, charbroiled meat, diesel and gasoline vehicles, wood combustion, and lawn care equipment. These combustion particles start out very small, grow larger over time and space, and evolve chemically at the same time. Secondary PM 0.1 typically is formed via particle nucleation from gas or liquids and are characterized by larger geographic scales and more uniform population exposure.

Despite being extremely small, PM 0.1 has an extremely high surface area, as seen in Figure 2-4. Compared to an equal mass of particles of two microns (PM 2.0) in diameter, ultrafine particles that are 1,000 times smaller (20 nanometers or PM 0.02) nonetheless have 125 times the surface area.[40] In addition, PM 0.1 produced by hydrocarbon combustion typically contain a rich mixture of chemicals with potential health effects, including nickel, iron, vanadium, PAH, and others.[41] Chemical potency, very high surface area, and alveolar deposition are signal characteristics of PM 0.1 from hydrocarbon combustion that result in significant health risks from chronic exposure.

Figure 2-4 Electron Micrograph of an Ultrafine Particle[42]



[39] Solomon, P. (2012). An Overview of Ultrafine Particles in Ambient Air. *EM: Journal of the Air & Waste Management Association, May,* 18–26.
[40] Donaldson, K., Stone, V., Clouter, A., Renwick, L., & MacNee W. (2001). Ultrafine Particles. *Occupational Environmental Medicine 58*, 211–216.Retrieved from http://oem.bmj.com/content/58/3/211.short doi: 10.1136/oem.58.3.21
[41] Morawska, L., Ristovski, Z., & Jayaratne, E.R. (2008). Ambient Nano and Ultrafine Particles from Motor Vehicle Emissions: Characteristics, Ambient Processing and Implications on Human Exposure. *Atmospheric Environment, 42(35)*, 8113–8138. doi: 10.1016/j.atmosenv.2008.07.050
[42] Nel A. (2005). Air Pollution-Related Illness: Effects of Particles. *Science, 308(5723),* 804–806. doi: 10.1126/science.1108752

Sub-populations who live or work near sources of primary PM 0.1 from hydrocarbon combustion are particularly at risk. Health scientists have generated an overwhelming body of epidemiological (statistical) evidence that individuals near freeways (less than 300 meters) are being harmed via chronic inhalation of PM 0.1 from vehicles.[43] Similarly, a recent study of residential wood burning in Cambria, California found very high neighborhood concentrations of PM 0.1 from wood smoke even though concentrations of PM2.5 at the nearby ambient monitor met the federal health standard.[44] The health risk from fresh sources of PM 0.1 has important environmental justice implications to the extent that elevated exposure to near-source PM 0.1 is concentrated in communities that already face sources of risk related to race or socioeconomic status.[45] Chronic exposure to near-source PM 0.1 commonly occurs in locations where local monitors are in attainment for PM2.5 standards and during seasons when ambient PM2.5 concentrations are below the annual daily standard of 15 $\mu m/m^3$.

2.4.5 Population Proximity and Intake Fraction

Estimating total exposure and net health risk from a given source of PM2.5 requires that population proximity and population density be considered in addition to the source's contribution to the regional PM2.5 emissions inventory and its toxicity. In addition to factors governing net deposition of inhaled particles reviewed above, net population exposure from the source in question is also shaped by the number of exposed individuals who inhale the emissions and the duration of exposure in conjunction with aerosol concentration levels (see Figure 2-5). Known as the intake fraction, this measure of population exposure is defined empirically as the pollutant mass inhaled divided by the mass emitted.[46] Intake fraction is useful in connecting emissions to health risk because the mass inhaled is a better indicator of health risk than the mass emitted or airborne concentration. Two different pollutant sources with very comparable emission rates of the same pollutant can nonetheless have significantly different intake fractions depending on the surrounding population density. For example, sources of PM2.5 located in rural areas may have an intake fraction that is 10 to 100 times smaller than a comparable source located within a densely populated city.

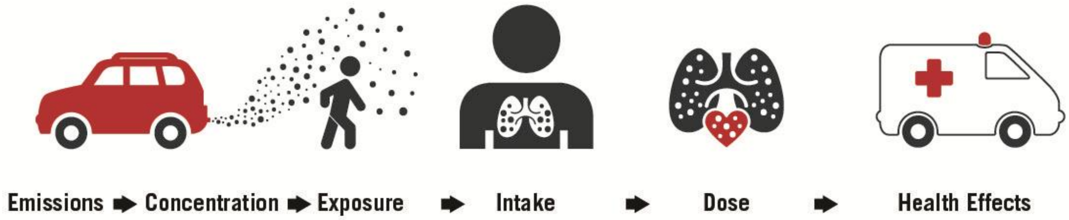
[43] Gauderman, W., Vora, H., McConnell, R., Berhane, K., Gilliland, F., Thomas, … Peters, J. (2007). Effect of Exposure to Traffic on Lung Development from 10 to 18 Years of Age: A Cohort Study. *The Lancet 369(9561*), 571–577. Retrieved from http://www.thelancet.com/journals/lancet/article/PIIS0140-6736(07)60037-3/fulltext#article_upsell

[44] Thatcher, T. & Kirchstetter, T. (2011). *Assessing Near-Field Exposures from Distributed Residential Wood Smoke Combustion Sources*. Report prepared for the California Air Resources Board. Retrieved from http://www.arb.ca.gov/research/rsc/10-28-11/item2dfr07-308.pdf

[45] London, J., Huang, G., & Zagofsky, T. (2011). *Land of Risk, Land of Opportunity: Cumulative Environmental Vulnerabilities in California's San Joaquin Valley*. Davis, CA: University of California, Davis, Center for Regional Change. Retrieved from http://regionalchange.ucdavis.edu/publications/Report_Land_of_Risk_Land_of_Opportunity.pdf

[46] Marshall, J.D., & Nazaroff, W.W. (2004, October). *Using Intake Fraction to Guide ARB Policy Choices: The Case of Particulate Matter*. Unpublished California Air Resources Board Report.

Figure 2-5 Simplified Intake Fraction Model



The relevance of the intake fraction concept can be seen in a recent study of neighborhood variability in wood smoke concentrations in Cambria, California.[47] As described above, the winter study found very high concentrations of PM 0.1 on a neighborhood scale that were often not reflected in PM2.5 concentrations measured by local air quality monitors. In effect, a single wood-burning household had the effect of enveloping the adjacent and downwind homes with a PM 0.1 plume. Furthermore, the study also found that wood smoke PM 0.1 was infiltrating adjacent homes that were not burning, with an average indoor concentration found to be 74% as high as immediately outside the homes. Taking into consideration the length of PM 0.1 inhalation during sleeping hours, the relatively high concentration of PM 0.1 found in the plume, and the number affected of individuals in an urban neighborhood, the intake fraction resulting from the source of the wood smoke would be very high. Assuming that this nightly exposure occurred over the course of a season, the cumulative health risk to the neighborhood would be considerable and would almost certainly exceed the risk indicated by daily concentrations of PM2.5 measured by ambient monitors.

[47] Thatcher, T. & Kirchstetter, T. (2011). *Assessing Near-Field Exposures from Distributed Residential Wood Smoke Combustion Sources*. Report prepared for the California Air Resources Board. Retrieved from http://www.arb.ca.gov/research/rsc/10-28-11/item2dfr07-308.pdf

2.5 HEALTH BENEFITS ACHIEVED THROUGH *2012 PM2.5 PLAN*

Understanding the results of any strategy is critical to assessing the overall value and success of that strategy. As part of integrating the Risk-Based Strategy into this plan, the District has estimated the fundamental metric associated with implementation of the *2012 PM2.5 Plan* – the health benefits resulting from implementation of this strategy. As presented below and described in more detail in Appendix E, an EPA-developed model called BenMAP has been employed in order to estimate the annual reductions in morbidity (disease) and mortality (premature death) attributable to improved air quality due to the *2012 PM2.5 Plan* in the attainment year of 2019.

BenMAP is a sophisticated computer software model developed by the U.S. EPA that is well-suited for estimating the health benefits from the *2012 PM2.5 Plan*. Over the course of the past decade, ongoing progress in the fields of epidemiology and geographic information systems (GIS) have resulted in the development of computer models that are capable of estimating the health benefits of improved air quality with reasonable accuracy when properly applied. These models estimate the number of avoided cases of certain diseases and other health impairment categories, known as health endpoints, which result from a specified reduction in exposure to criteria air pollutants, in this case, reduced exposure to PM2.5 concentrations.

Through implementation of the comprehensive control strategy included in this plan and the resulting reductions in PM2.5 concentrations throughout the Valley, the District estimates the following health benefits using this model:

Table 2-1: Health Benefits Achieved Through Implementation of the Plan

Health Impact	Health Benefit (reduction in health impact)
Premature Death	**671**
Acute Myocardial Infarction, Hospital Admissions	**93**
Asthma Age 0-19, Hospital Admissions	**131**
Cardiovascular, Hospital Admissions	**175**
Asthma Age 20-99, Hospital Admissions	**246**
Asthma Age 20-99, Emergency Room Visits	**407**
Asthma Age 0-19, Emergency Room Visits	**699**
Acute Bronchitis	**1,498**
Upper Respiratory Symptoms	**15,523**
Lower Respiratory Symptoms	**19,011**
Asthma Exacerbation	**114,376**
Work Loss Days	**125,138**

In addition to quantifying reductions in disease and death based on improvements in county-level PM2.5 concentrations, BenMAP can also be used as a tool to quantify the economic benefits associated with quantified health benefits. While assigning economic values to health impacts is difficult given the tremendous social values associated with these impacts, BenMAP attempts to assign values using an existing body of literature that connects impacts to hard costs such as lost wages, or, in the case of premature death, a social value of $7.99 million per incidence. Using this model, the District estimates that implementation of the plan will achieve an annual Valley-wide savings of $102 million in health costs in 2019 , as outlined in the following table. Additionally, and more significantly, a social benefit of $5.36 billion is estimated for the 671 avoided premature deaths.

Table 2-2: Economic Costs Associated with Quantified Health Benefits

Health Impact	Health Benefit (reduction in health impact)
Hospital Admissions, Respiratory	$386,955
Asthma, Emergency Room Visits	$429,496
Acute Bronchitis	$717,759
Acute Myocardial Infarction	$3,081,686
Upper Respiratory Symptoms	$3,677,083
Lower Respiratory Symptoms	$4,502,994
Asthma, Hospital Admissions	$6,279,033
Cardiovascular, Hospital Admissions	$6,767,955
Asthma Exacerbation	$10,660,442
Work Loss Days	$19,539,004
Acute Respiratory Symptoms	$46,109,557
Total	**$102,151,964**

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Chapter 3

Air Quality in the San Joaquin Valley: Challenges and Trends

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Chapter 3: Air Quality in the San Joaquin Valley: Challenges & Trends

While presented with unique geographical and meteorological challenges, the San Joaquin Valley (Valley) has made significant progress in reducing total PM2.5 emissions and PM2.5 precursor emissions and in improving air quality for Valley residents. Through progressively more stringent regulations and improved control technologies, the overall amount of directly emitted PM2.5 emissions has decreased by 17.9% over the last five years and will continue to decrease through 2019. Similarly, the overall amount of NOx (a significant precursor to PM2.5 in the Valley) emissions has decreased by 35% over the last five years and will also continue to decrease through 2019.

PM2.5 concentrations have also decreased over this time period, although achieving these reductions has been quite challenging given frequent meteorological conditions conducive to PM2.5 formation that are characteristic of the Valley, and which are outside human (and regulatory) control. Annual fluctuations in weather patterns affect the Valley's carrying capacity (the ability to disperse pollutants), which is reflected in long- and short-term ambient air quality trends. Despite the impacts of these uncontrollable meteorological conditions, the Valley is progressing toward attainment of the 2006 PM2.5 National Ambient Air Quality Standard (NAAQS).

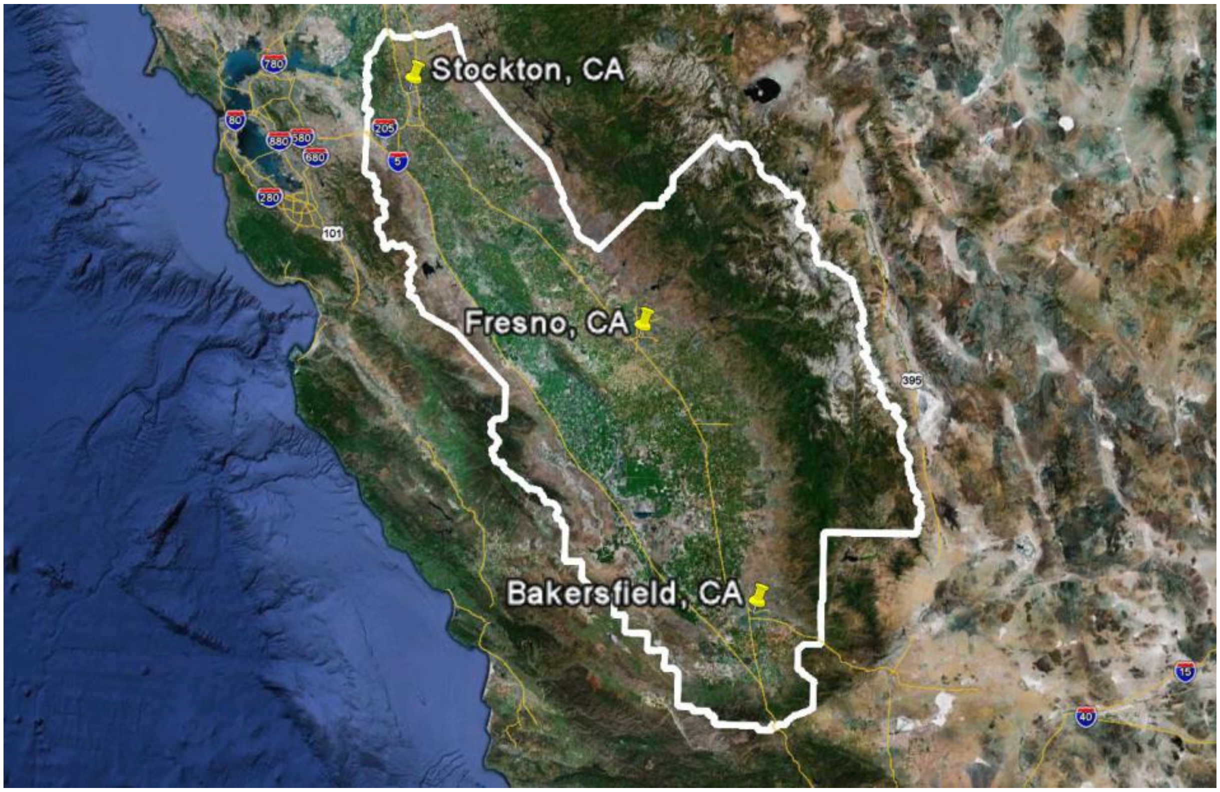
3.1 CHALLENGES OF THE NATURAL ENVIRONMENT

The Valley's natural environment supports one of the most productive agricultural regions in the country: the Sierra Nevada provides the necessary water for growing the abundance of crops, and a temperate climate provides a long growing season. However, these same natural factors present significant challenges for air quality: the surrounding mountains trap pollution and block air flow, and the mild climate keeps pollutant-scouring winds at bay most of the year. Despite the challenges, the District and the Valley are making progress in attaining the national air quality standards and improving public health for Valley citizens.

3.1.1 Unique Climate and Geography

The challenge of PM 2.5 NAAQS attainment in the Valley is grounded in the unique topographical and meteorological conditions found in the region. The Valley, as seen in Figure 3-1, is an inter-mountain valley encompassing nearly 25,000 square miles. Surrounded by mountain ranges to the west, east, and south, the air flow through the Valley can be blocked, leading to severely constrained dispersion. During the winter, high-pressure systems can cause the atmosphere to become stagnant for longer periods of time, where wind flow is calm and air movement is minimal. These stagnant weather systems can also cause severe nighttime temperature inversions, which exacerbate the build-up of PM2.5 and related precursors both beneath and above the evening inversion layer.

Figure 3-1 San Joaquin Valley Air Basin



Normally, temperature decreases with increasing altitude, but during temperature inversions the normal temperature gradient is reversed, with temperatures *increasing* with altitude, causing warmer air to be above cooler air. Figure 3-2 shows that this reversal of the “normal” pattern impedes the upward flow of air, causes poor dispersion, and traps pollutants near the surface. Temperature inversions are common in the Valley throughout the year. Since the inversion is often lower than the height of the surrounding mountain ranges, the Valley effectively becomes a bowl capped with a lid that traps emissions near the surface. When horizontal dispersion (transport flow) and vertical dispersion (rising air) are minimized, PM2.5 concentrations can build quickly, especially in the winter. These naturally occurring meteorological conditions have the net effect of spatially concentrating direct PM2.5 concentrations near their sources; promoting the formation and regional buildup of secondary species, particularly ammonium nitrate; and chemically aged organic carbon species, resulting in an increase in their relative toxicity. Given these challenges, the Valley needs even more effective emissions reductions to attain the PM2.5 NAAQS.

Figure 3-2 Atmosphere with and without a Temperature Inversion

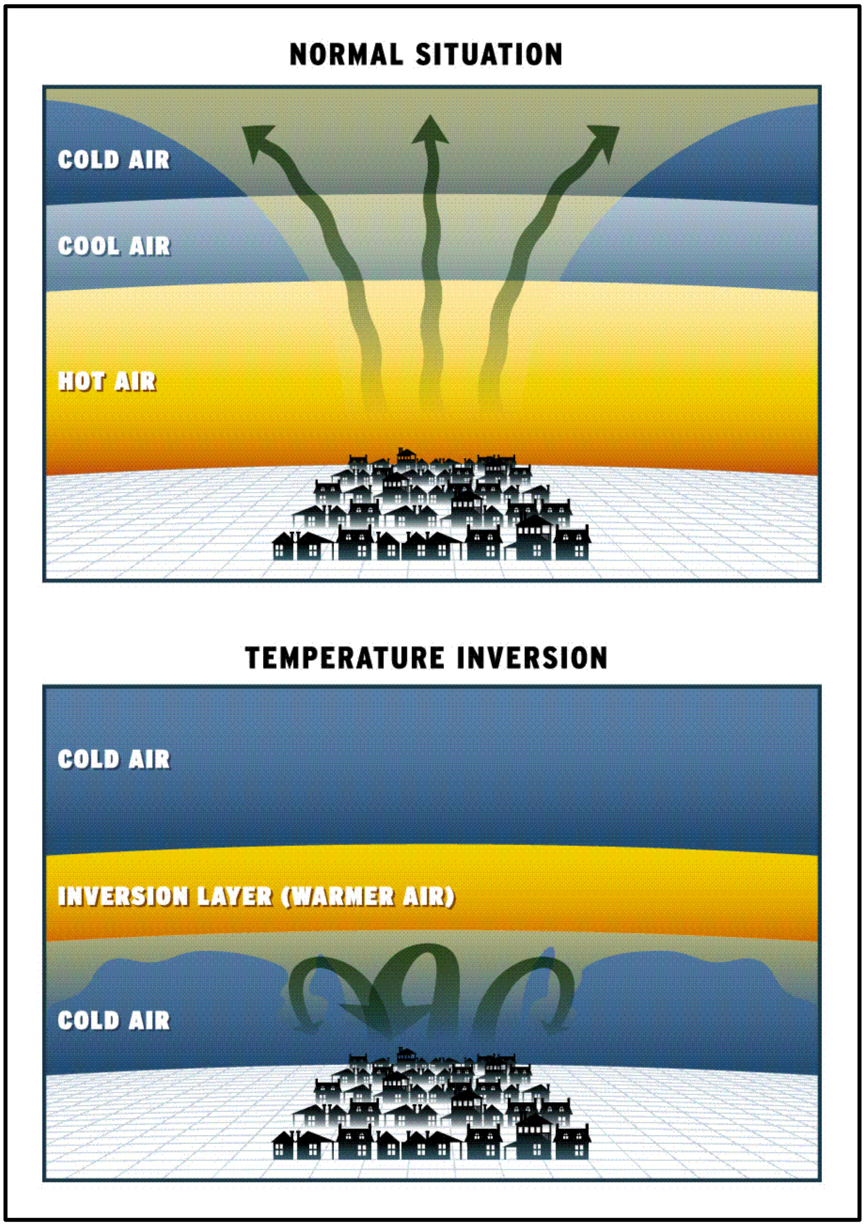
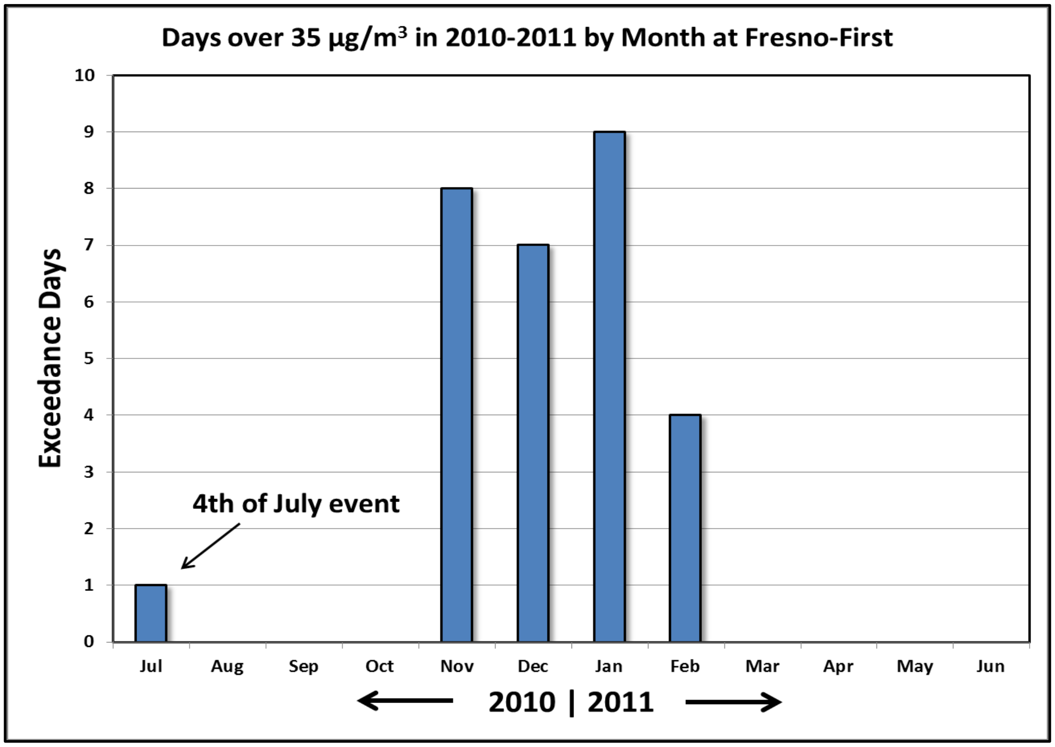


Image source: http://ffden-2.phys.uaf.edu/212_spring2007.web.dir/Amber_Smith/Effects_of_Inversions.htm

Because of frequent stagnant conditions during Valley winters, PM2.5 concentrations tend to be the highest from November to February. As an example, Figure 3-3 shows the number of days per month during the 2010–2011 time period when the Fresno-First air monitoring site exceeded the 2006 PM2.5 NAAQS threshold of 35 µg/m^3.

Figure 3-3 Days Over 35 μg/m^3 by Month at Fresno-First from 2010–2011



3.1.2 Valley Carrying Capacity

Carrying capacity, in the context of air quality, refers to the density of emissions that an air basin can “absorb” or “carry” and still meet ambient air quality standards for a given pollutant. The key factors that shape variations in a regional carrying capacity include meteorology, climate, and the topography. Some air basins may have a high total pollutant emission rate (emissions per person or area), but if those emissions are easily dispersed or removed from the basin, that basin is much more likely to meet ambient standards despite high emission rate. On the other hand, an air basin may have a lower emission rate (or the same rate, over the same time period), but because of unfavorable environmental factors (low air flow, stagnant air, inversions) those pollutant concentrations typically accumulate (possibly above the standard) and remain in the air basin until weather patterns change. The latter scenario describes the San Joaquin Valley, and the first scenario is analogous to the Los Angeles (L.A.) air basin, especially for NOx emissions and the formation of ozone.

As an example, total NOx emissions for the L.A. basin were 754 tons per day (tpd) in 2008. During that year, the L.A. basin recorded 80 days above the 1997 national 8-hour ozone standard. For the same year, the total NOx emissions for the Valley air basin were 409 tpd (over a larger area), yet the Valley recorded 82 days above the standard. NOx dispersal is primarily dependent on summertime weather patterns. The L.A. basin experiences regular coastal winds through much of the summer that not only disburse pollutants from the air basin, but also moderates temperatures. Conversely, the Valley, surrounded by mountain ranges, routinely experiences stagnant weather patterns (less wind) and extended periods of high temperatures, both of which build and concentrate ozone to levels above the standard. In this real example, it is obvious that the Valley has a much lower carrying capacity than the L.A. basin for NOx, a precursor to ozone formation.

While not as drastic as the NOx-ozone example above (in terms of emission rate), the Valley's carrying capacity for PM2.5, when compared to the L.A. basin, is greatly affected by prevailing weather during the winter months and the region's topography (surrounding mountains). For 2008, the annual average direct PM2.5 emission rate for the L.A. basin was 80 tpd; during that year, that basin recorded 19 days above the national PM2.5 24-hour standard. For the same year, the Valley's annual average direct PM2.5 emission rate was 82 tpd; however, the Valley recorded 66 days above the 24-hour standard. During this same time period, the NOx and SOx emissions, which are also precursors to PM2.5, were significantly lower in the Valley compared to the L.A. Basin (NOx—409 tpd and 754 tpd, respectively, as stated above; and SOx—13 tpd and 54 tpd, respectively). As noted in Section 3.1.1, temperature inversions are common during the winter months in the Valley. During these sometimes lengthy stagnant air episodes, PM2.5 emissions from daily activities rapidly build up to levels above the standard. It is during these events (or anticipation of these events) that the District's Check-Before-You-Burn program and Real-time Air Advisory Network (RAAN) system intervene to inform (or require) the public to limit activity that generates PM2.5 emissions.

The District uses quantitative carrying capacity analysis in its modeling of attainment demonstrations. Such analyses can determine which combinations of PM2.5 and PM2.5 precursor emissions reductions can contribute to future attainment given anticipated population and activity growth, potential regulations or control measures, and the unchanging natural physical constraints. Chapter 4 presents the carrying capacity analyses conducted for this plan.

3.2 PM2.5 EMISSIONS INVENTORY TRENDS

The emissions inventory is the foundation for the attainment planning process. The District and the California Air Resources Board (ARB) maintain an accounting of PM2.5 and precursor emissions for the Valley based on known sources within the Valley and those sources outside the Valley that influence Valley air quality (inter-region transport). The District requires detailed accounting of emissions from regulated sources throughout the Valley. ARB makes detailed estimations of emissions from mobile, area, and geologic sources using known emissions factors for each source or activity and accounting for relevant economic and population data. Together, these feed into the emissions inventory that represents an estimate of how much direct pollution is going into the Valley air basin as a result of the cumulative pollutant-generating activities and sources.

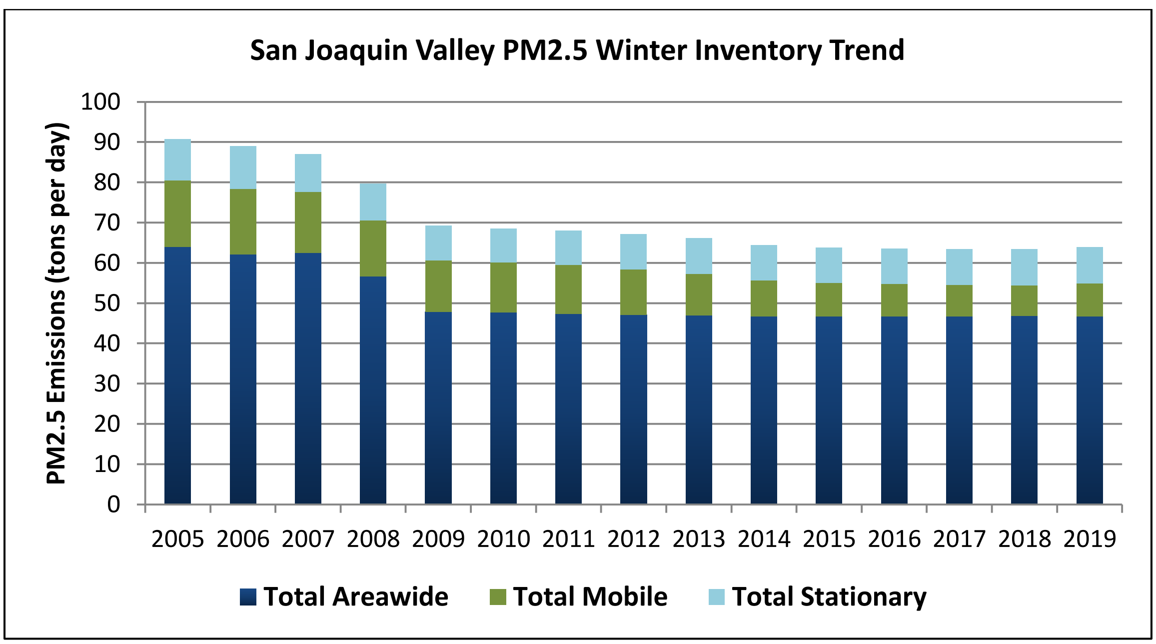
The District uses the emissions inventory to develop control strategies, to determine the effectiveness of permitting and control programs, to provide input into air quality modeling, to fulfill reasonable further progress requirements, and to screen regulated sources for compliance investigations.

The following general list represents the major inventory categories for which emissions are recorded and tracked. Appendix B to this plan contains the detailed accounting of the emissions inventory with projected emissions based on anticipated growth of each source and the anticipated control (regulatory or non-regulatory) of each source, if applicable.

- **Mobile sources** – motorized vehicles
  - On-road sources include automobiles, motorcycles, buses, and trucks
  - Other or off-road sources include farm and construction equipment, lawn and garden equipment, forklifts, locomotives, boats, aircraft, and recreational vehicles
- **Stationary sources** – fixed sources of air pollution
  - Power plants, refineries, and manufacturing facilities
  - Aggregated point sources, i.e. facilities (such as gas stations and dry cleaners) that are not typically inventoried individually, but are estimated as a group and reported as a single source category
- **Area sources** – human activity that takes place over a wide geographic area
  - Includes consumer products, fireplaces, controlled burning, tilling, and unpaved road dust
- **Natural sources** – naturally occurring emissions
  - Geologic sources, such as petroleum seeps
  - Biogenic sources, such as emissions from plants
  - Wildfire sources

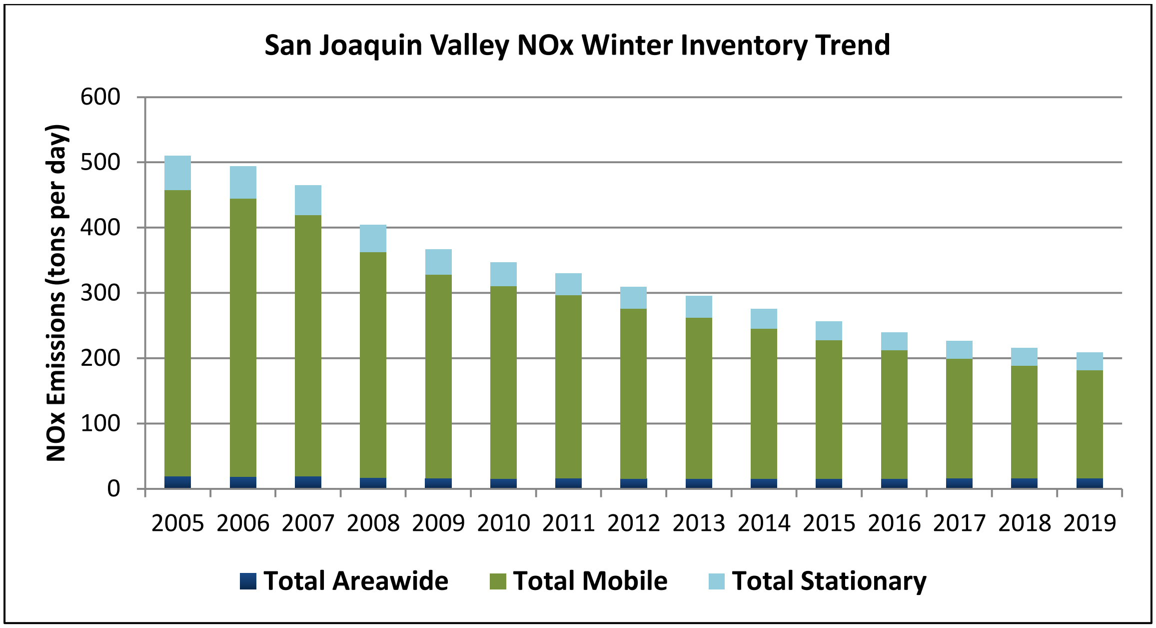
Figure 3-4 shows the PM2.5 emissions inventory trend for the mobile, stationary, and area source categories.

Figure 3-4 San Joaquin Valley PM2.5 Winter Emissions Inventory Trend



Because NOx is a significant PM2.5 precursor, the District relies heavily on NOx emissions to also reduce PM2.5 emissions. Figure 3-5 summarizes the NOx emissions inventory trends for the mobile, stationary, and area source categories. District and ARB control strategies for NOx play a significant role in reducing both ozone and PM2.5 emissions.

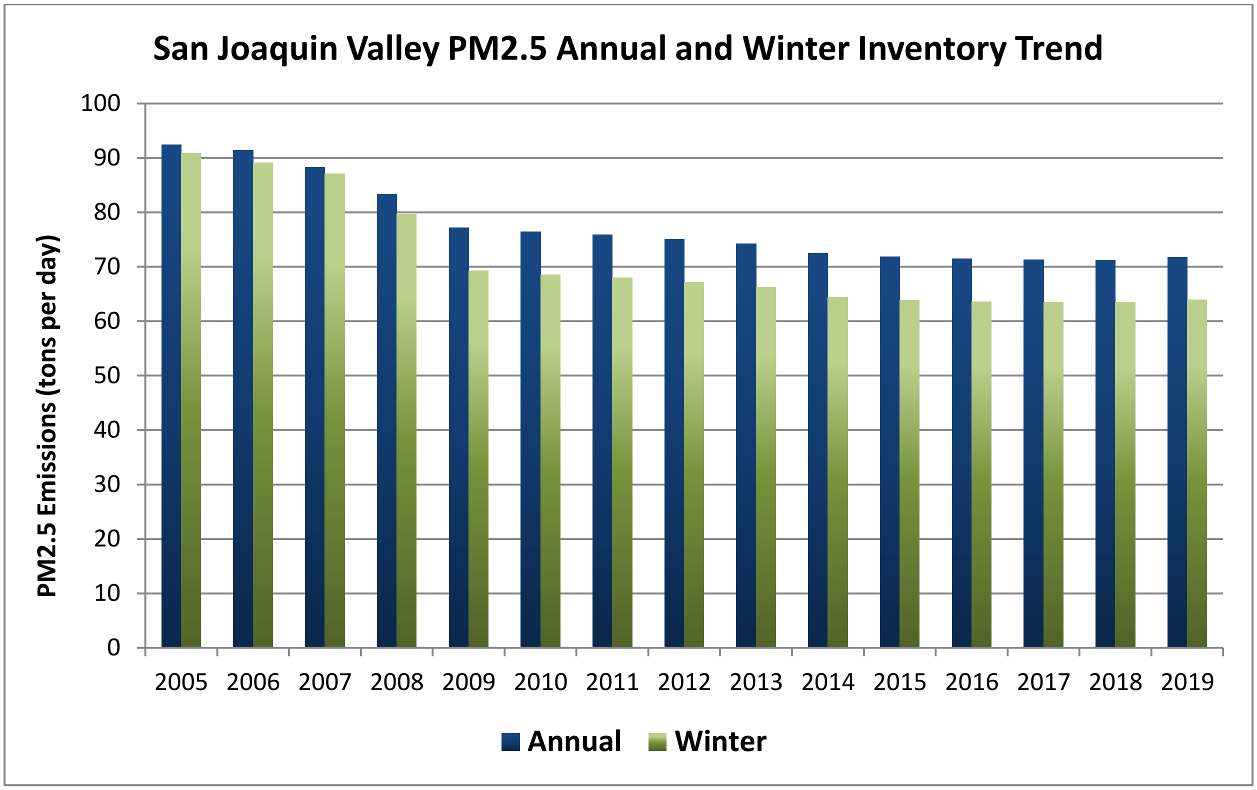
Figure 3-5 San Joaquin Valley Winter NOx Emissions Inventory Trend



Through an exhaustive evaluation of this inventory, which includes directly emitted PM2.5 and relevant PM2.5 precursors (NOx, SOx), the District has developed a control strategy that will be effective in reducing overall concentrations of PM2.5. Chapter 5 of this plan details the regulatory control measures based on this evaluation.

Emissions inventory trends show the progress made through progressive regulatory and non-regulatory activities, e.g. as rules are amended with tighter emission limits, or as reduction technologies improve, overall emissions decrease. Figure 3-6 shows how the overall tons of PM2.5 emissions per day have decreased in the past and are anticipated to continue decreasing in the future based on anticipated growth and controls. Figure 3-6 also shows the comparative emission inventory reduction of winter PM2.5. Winter PM2.5 emissions have decreased significantly, in large part due to the effectiveness of Rule 4901 (Wood Burning Fireplaces and Wood Burning Heaters). Continued emissions reductions are based on current control strategies that will continue to take effect into the future. In light of the Valley's projected increase in population, the projected emissions reductions highlight the success of the control measures adopted and enforced by the District, ARB, and other regulatory agencies.

Figure 3-6 San Joaquin Valley PM2.5 Annual and Winter Inventory Trends



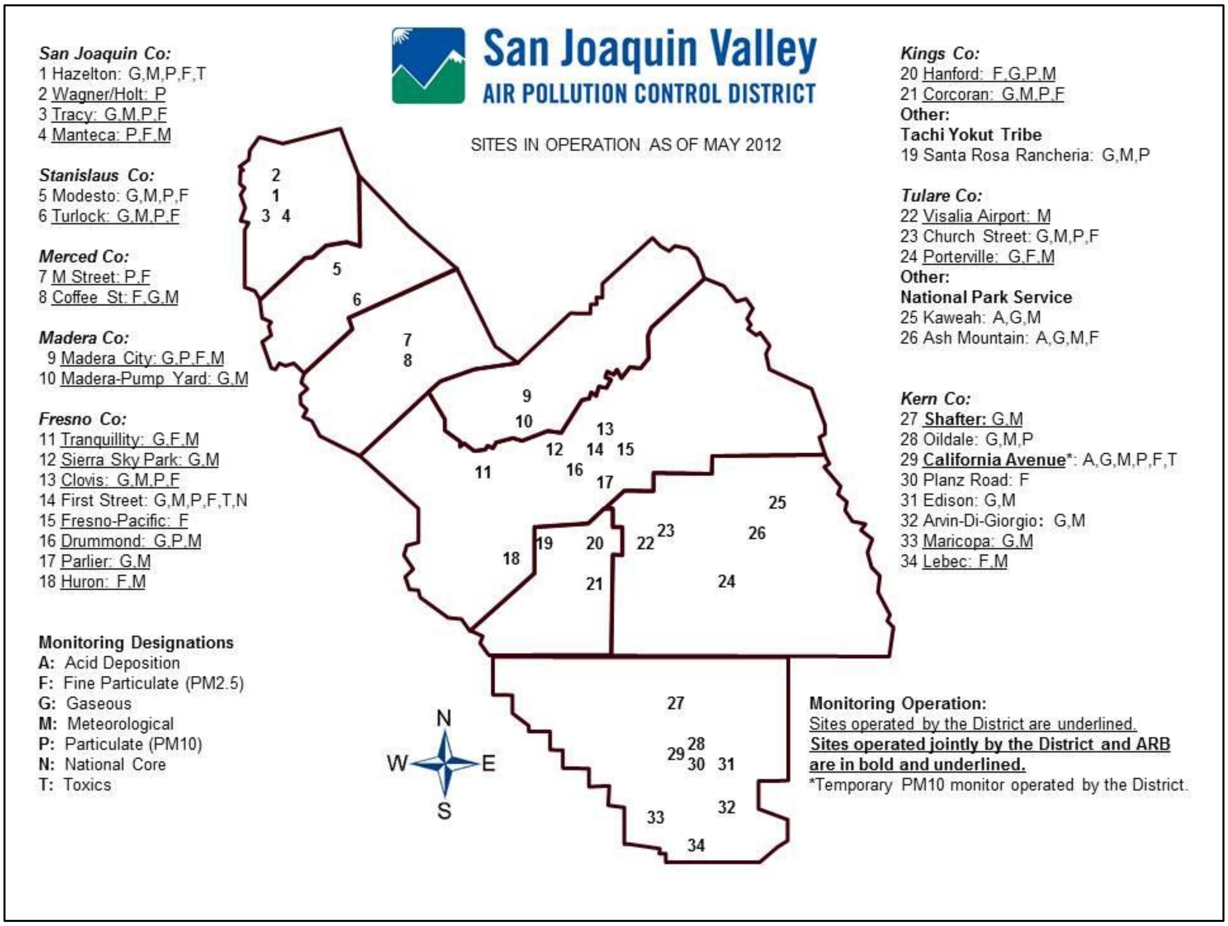
3.3 PM2.5 AIR QUALITY TRENDS

As a public health agency charged with monitoring Valley air quality and ensuring progress toward meeting national air quality standards, the District has established an extensive air monitoring network that provides ongoing data for evaluating such progress. Information from this extensive monitoring network, which began measuring PM2.5 concentrations in 1999, allows the District to track air quality trends that show progress toward attainment and inform the planning process for reaching attainment.

3.3.1 Air Monitoring Network

Numerous pollutants and meteorological parameters are measured throughout the Valley on a daily basis using an extensive air monitoring network managed by the District, ARB, and other agencies. This network measures pollutant concentrations necessary to show progress toward compliance with the NAAQS. The network also provides real-time air quality measurements used for daily air quality forecasts, residential wood-burning declarations, Air Alerts, and RAAN. Air quality monitoring networks are designed to monitor areas with high population densities, areas with high pollutant concentrations, areas impacted by major pollutant sources, and areas representative of background concentrations. Together, the District and the ARB operate 34 air monitoring stations throughout the Valley; 21 of these sites measure PM2.5, either through the use of filter-based monitors that measure each 24-hour period or hourly monitors that use light energy to provide near-continuous concentration levels. Figure 3-7 shows the Valley's network of air monitoring sites.

Figure 3-7 Air Monitoring Sites within the San Joaquin Valley Air District



PM2.5 is measured and expressed as the mass of particles contained in a cubic meter of air (micrograms per cubic meter, or $\mu g/m^3$). The data collected from the District's network of PM2.5 monitors is used to calculate design values for the 24-hour and annual PM2.5 standards, as outlined in U.S. Environmental Protection Agency (EPA) guidance and regulations.[1,2]

3.3.2 Air Quality Progress

Air quality progress can be assessed in several ways. The calculation of *design values* is the official method used to determine whether an area is in attainment of a standard; however, other indicators can reveal more about the progress being made toward attaining that standard. Comparing the days per year when each monitor exceeded the

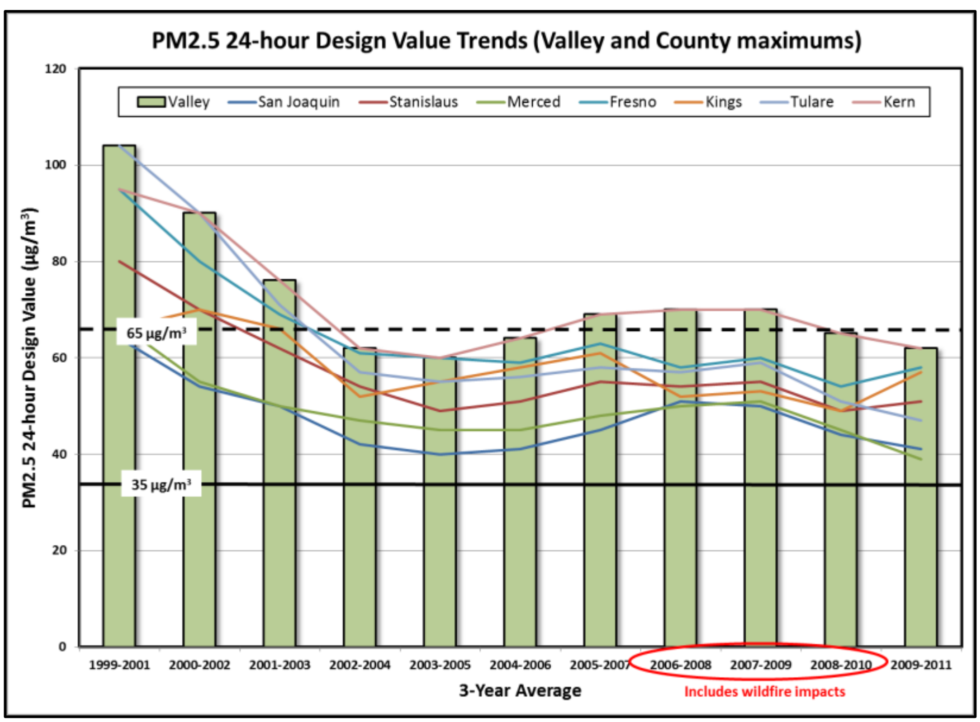
[1] Environmental Protection Agency [EPA]: Office of Air Quality Planning and Standards. (1999, April). *Guideline on Data Handling Conventions for the PM NAAQS* (EPA-454/R-99-008). Retrieved from http://www.epa.gov/ttn/oarpg/t1/memoranda/pmfinal.pdf

[2] Interpretation of the National Ambient Air Quality Standards for PM2.5, 40 C.F.R. Pt. 50 Appendix N (2012).

PM2.5 24-hour NAAQS threshold from year to year shows the progress in reducing the number of days with the highest concentrations, while quarterly averages can help to show progress with respect to seasonal peaks in concentration levels. Some of the conclusions from these analyses are included below, followed by a more detailed discussion in Appendix A, which also provides analysis results for a number of other air monitoring sites in the Valley.

Under the 2006 PM2.5 NAAQS, a region must meet both the 24-hour average standard of 35 µg/m^3 and the annual average standard of 15 µg/m^3 to meet attainment. Rather than using yearly maximum concentrations for the PM2.5 standards, EPA requires the use of design values for the attainment metric. Design values represent a three-year average and help to smooth out outlier years with exceptional meteorology or exceptional events. Details on how PM2.5 design values are calculated are provided in Appendix A of this plan. As seen in Figure 3-8, the Valley and county maximum 24-hour average PM2.5 design value trends show that although there is some year-to-year variation significant progress has been made in reducing long-term PM2.5 concentrations. Valley design value maximums have decreased by 40% over the 1999–2011 time period. This trend is also represented in the county maximum design values over the same time period. Note that some of the county design values calculated for the 2009–2011 data point have increased, partly due to the abnormal stagnation and poor air quality in late 2011.

Figure 3-8 Historical PM2.5 24-Hour Design Value Trends*



* Madera has not been included in this analysis since PM2.5 monitoring in Madera began in 2011.

Since monitoring began, the Bakersfield-Planz air monitoring site in Kern County has consistently been among the highest PM2.5 design values in the Valley. Figures 3-9 and 3-10 show the trend of the 24-hour and annual average design values at Bakersfield-Planz through 2011, as demonstrated with the 2009–2011 design value (3-year average).

Figure 3-9 Trend of 24-Hour Average PM2.5 Design Values at Bakersfield-Planz

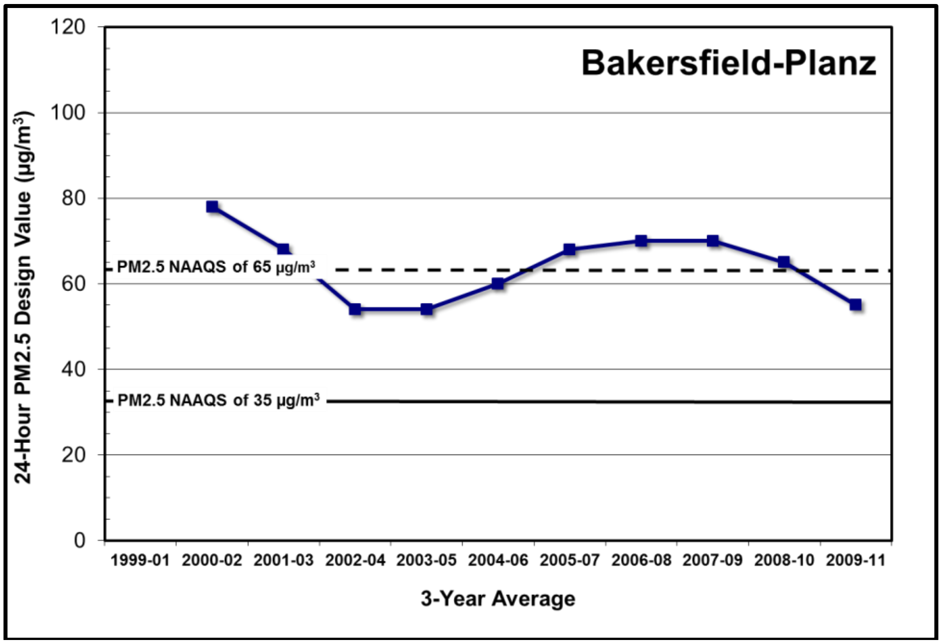
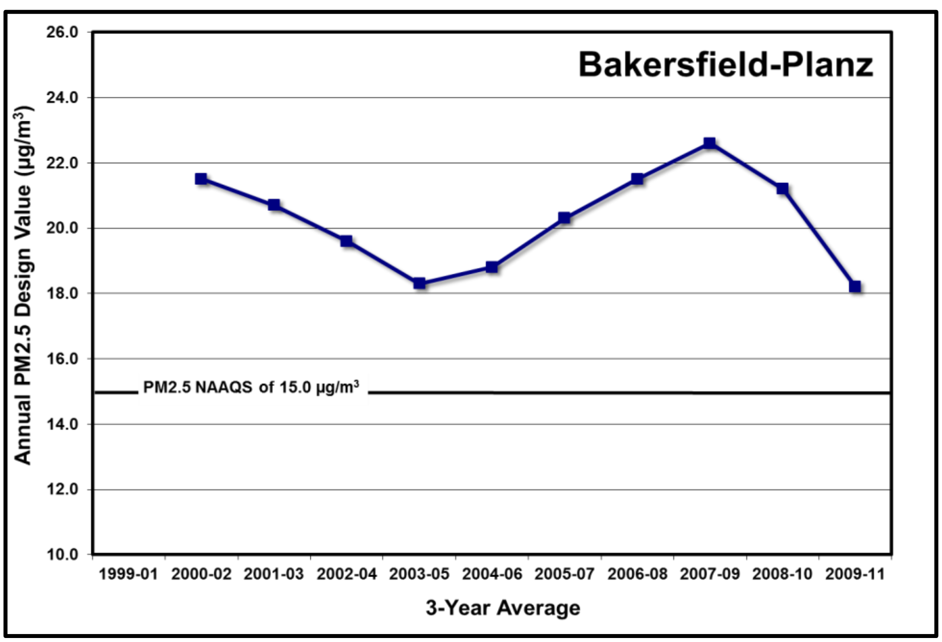


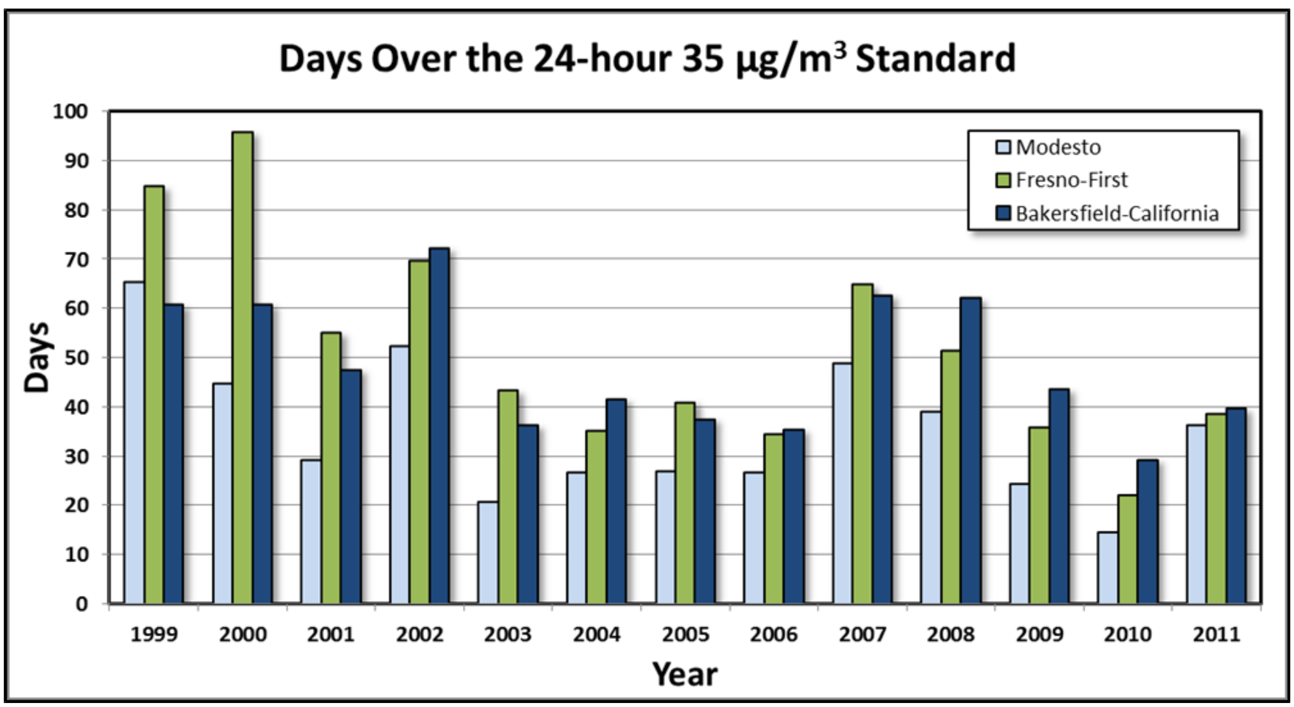
Figure 3-10 Trend of Annual Average PM2.5 Design Values at Bakersfield-Planz



Overall decreasing PM2.5 concentrations at the Bakersfield-Planz air monitoring site are shown in the design value trend for that site. Figure 3-9 shows that the site now has a 24-hour design value below the 1997 24-hour PM2.5 standard of 65 µg/m^3. Figure 3-10 shows that the annual average design value for the 2009–2011 time period was at an all-time low for the site at 18.2 µg/m^3. This downward trend will need to continue at all sites within the Valley as the Valley strives for attainment of the 2006 PM2.5 NAAQS.

The District also assesses long-term trends of PM2.5 concentration by looking at the number of days per year that a monitoring site measures concentrations over the PM2.5 2006 24-hour NAAQS limit of 35 µg/m^3. Figure 3-11 shows the general downward trend of this metric from 1999 to 2011 for air monitoring sites at Modesto (Stanislaus County), Fresno-First (Fresno County), and Bakersfield-California (Kern County). Overall, these sites have measured a 46% decrease in the number of days exceeding a concentration of 35 µg/m^3. The increase in the number of days over the standard in 2011 reflects unfavorable meteorology during the winter of that year. However, similar meteorology was experienced during the 1999–2000 and 2000–2001 winter seasons, yet there were a much greater number of days exceeding 35 µg/m^3 during these years, supporting the fact that emissions have been reduced since 1999.

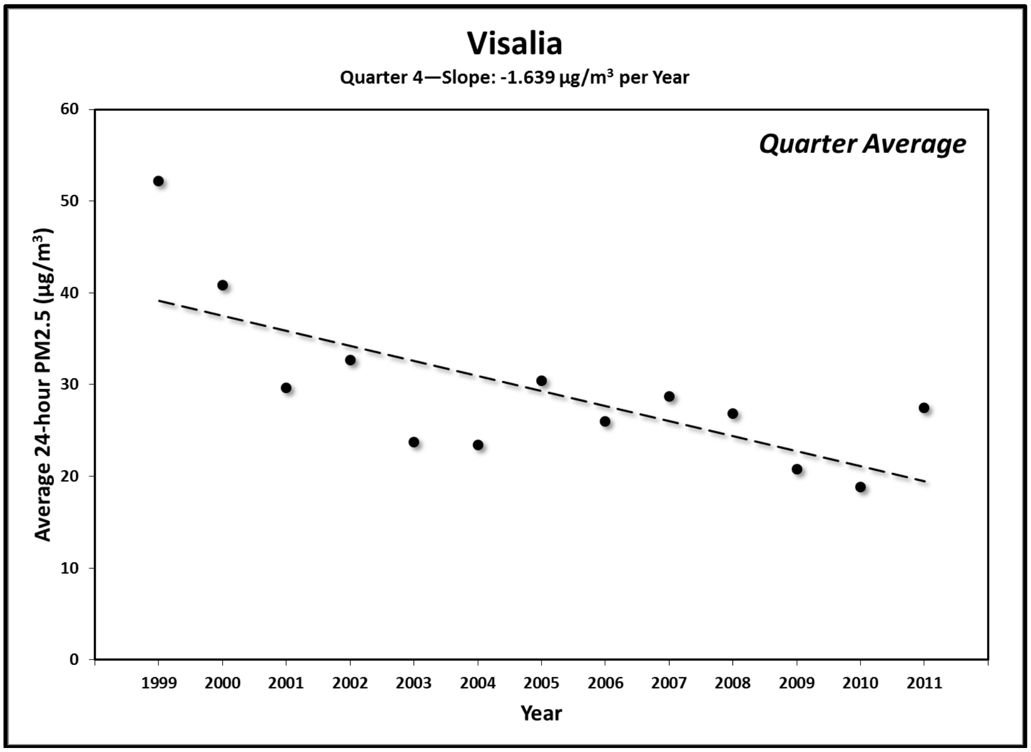
Figure 3-11 Annual Trends in Days over 35 µg/m3



Since the Valley's highest PM2.5 concentrations occur during the fall and winter months, the first (January through March) and fourth (October through December) quarters tend to have the highest average concentrations. Observing the trend in these quarterly averages can shed light on how the peak of the PM2.5 season is changing over time.

Data from the Visalia monitoring site, as shown in Figure 3-12, is representative of fourth-quarter averages among the PM2.5 sites in the Valley. This data also shows a downward trend of 1.64 µg/m³ per year. The District anticipates continuation of this trend as the Valley gets closer to attaining the annual average PM2.5 standard of 15 µg/m³. Appendix A contains detailed results of this analysis.

Figure 3-12 Trend of Fourth-Quarter Average at Visalia



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Chapter 4

Scientific Foundation and PM2.5 Modeling Results

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Chapter 4: Scientific Foundation and PM2.5 Modeling Results

The nature of PM2.5 formation in the San Joaquin Valley is highly complex, and attainment of the 2006 National Ambient Air Quality Standard (NAAQS) PM2.5 standard is not a one-size-fits-all effort. Even though ultimate attainment of the 2006 NAAQS is determined by PM2.5 concentrations on the days with the highest concentrations—the worst air quality days—significant differences in regional natural environments and the relative contribution of precursor emissions requires regionally specific modeling and regionally specific control strategies. Also, differences within PM2.5 itself, directly-emitted PM2.5 versus secondary PM2.5 forming in the atmosphere through series of chemical reactions, adds to the complexity inherent in modeling and planning efforts. Within this complexity, the District's modeling efforts must be able to project PM2.5 concentrations for each square kilometer of the San Joaquin Valley (Valley), not just the areas that currently have air quality monitoring stations.

This complexity is accounted for in the modeling and other scientific analyses conducted for this plan. The District, ARB, and researchers have developed and refined these analytical tools, including regional modeling, over many years. The District's regional modeling protocol, included as Appendix G to this plan, is over 150 pages and has been reviewed by other air agencies and by atmospheric chemists, atmospheric scientists and other air quality experts. This protocol notes that the Valley is one of the most studied airsheds in the world in terms of the number of publications in peer-reviewed scientific journals and other major reports. Such scientific analyses, and the field studies providing data for these analyses, are the foundation of the modeling efforts for this plan. Public and private sector partnership through the San Joaquin Valleywide Air Pollution Study Agency (Study Agency) provided funding and coordination for many of these studies.

This chapter provides an overview of the scientific foundation for this PM2.5 Plan. It describes Study Agency and other research efforts related to this plan, the nature of PM2.5 in the Valley, and PM2.5 species. It also summarizes the regional modeling effort and the results of the analyses conducted for this plan. These results show which emissions control strategies will most effectively assure attainment of the 2006 PM2.5 NAAQS and improved PM2.5 air quality throughout the Valley.

4.1 AIR QUALITY RESEARCH

The Study Agency has developed and funded extensive research on particulate matter in the Valley. The Study Agency was established in 1985 under a joint-powers agreement between local counties and includes input from districts, the State, EPA, public and private industry representatives, and other governmental agencies to create a cooperative and unbiased research program. The Study Agency's main purpose is to further the scientific understanding of regional air quality issues to assist regulatory agencies in the development of strategies to attain air quality standards by providing the best available science for policy decisions. In 1992, Study Agency expanded particulate matter research to include PM2.5.

The initial field program for PM10 and PM2.5 was the Integrated Monitoring Study (IMS95), which was a two month pilot study that started in December 1995. This short but informative study provided the foundation for successful PM10 and PM2.5 monitoring and analysis including the following:

- Evaluating which air monitoring techniques worked best for air quality research projects
- Investigating and improving innovative techniques for identifying airborne particulate matter with atmospheric tracers
- Developing a model for data collection
- Developing a day-specific emission inventory development

While the entire Valley was studied, special attention was given to Corcoran, Fresno, and Bakersfield, which had the highest levels of particulates.

This pilot program led to the Study Agency's largest PM2.5 sampling and research effort. The California Regional Particulate Air Quality Study (CRPAQS) commenced in December 1999 and continued through February 2001. The objectives of CRPAQS were to provide an improved understanding of PM emissions, composition, and the dynamic atmospheric processes surrounding them; establish a strong scientific foundation for informed decision making; and develop methods to identify the most efficient and cost-effective emission control strategies to achieve the PM10 and PM2.5 standards in Central California. This robust study collected PM2.5 data from both within the Valley and from areas outside the Valley that impact Valley air quality. The resulting dataset has been studied by many researchers using Study Agency funding totaling over $27.5 million. CRPAQS continues to support research and improve the understanding of PM2.5 in the Valley.

Results from IMS95 and CRPAQS have helped the District and other agencies understand differences in urban and rural PM episode development, the mechanisms for how nitric acid forms aloft and its contribution to regional ammonium nitrate, the role of NOx as the limiting precursor for ammonium nitrate formation, and the role of fog on secondary pollutant formation and removal.

This information greatly informed the development of effective PM10 and PM2.5 attainment plans for the District. Data collected from these studies have allowed the District, CARB, EPA, and others understand PM2.5 creation and movement in the Valley, model future year PM2.5 levels, and source apportion PM2.5 concentrations to the correct contributing sources. Study Agency projects and results have also been used to improve air pollutant emissions inventories.

The District's *2003 PM10 Plan*, *2006 PM10 Plan*, and *2008 PM2.5 Plan* included data and analyses from CRPAQS within the photochemical modeling performed for each plan. Similarly, research conducted through CRPAQS is being incorporated into photochemical modeling, PM2.5 trends evaluation, and weight-of-evidence analysis for this plan. Implementation of the plans that use CRPAQS information will result in significantly better visibility, improved health and well-being of the citizens of the Valley, and eventual attainment of the 2006 PM2.5 NAAQS. The District will continue to build on this foundational research and seek additional opportunities to support future research.

4.2 THE NATURE AND FORMATION OF PM2.5

Unlike ozone, which is a fairly simple molecule of three oxygen atoms, PM2.5 can be composed of any material that has a diameter of 2.5 microns or less. PM2.5 can be emitted directly as primary PM2.5 from various sources, or it can form secondarily through chemical reactions in the atmosphere. Among the chemical precursors that can form secondary PM2.5 are nitrogen oxides (NOx), volatile organic compounds (VOCs), sulfur dioxide (SO_2), and ammonia (NH_3). In addition, naturally occurring emissions from biogenic sources, such as plants, can also add to the formation of PM2.5.

The resulting ambient PM2.5 mixture can include aerosols (fine airborne solid particles and liquid droplets) consisting of components of nitrates, sulfates, elemental carbon, organic carbon compounds, acid aerosols, trace metals, geological materials, and more. The complex formation and composition of PM2.5 requires a robust planning effort, where various components of the mass can be targeted for reduction. A control strategy that targets reductions among the precursors of PM2.5 has been shown to have a positive impact in reducing the total formed mass. Both direct PM2.5 and its precursors are tracked and projected within the emissions inventory (see Chapter 3). The role of each potential precursor varies by region, and research and photochemical modeling determine which precursor reductions will contribute to a region's attainment.

As discussed in Chapter 2, there is considerable variation in the relative toxicity of the chemical species found in PM2.5. While attainment of the NAAQS is demonstrated through total PM2.5 mass reduction (which is the primary goal of District and ARB control strategies), the relative differences in toxicity of species within the total mass provides a justification for new source control measures that specifically target the more toxic species of PM2.5, especially primary PM2.5 generated by combustion.

4.3 PM2.5 SPECIES IN THE SAN JOAQUIN VALLEY

PM2.5 in the Valley is comprised of many species that contribute to the total PM2.5 mass. This complex mixture is attributable to stationary, mobile, and area-wide sources, as well as naturally occurring emissions. Although the list of species contributing to PM2.5 in the Valley is lengthy, it can be grouped into larger representative categories. The following is a brief description of how each of these larger species categories are formed and emitted into the atmosphere.

> **Organic Carbon—**As one of the major constituents of PM2.5 mass in the Valley, organic carbon is directly linked to emissions sources such as residential wood burning, agricultural burning, cooking, and direct tailpipe emissions from mobile sources. Smaller sources of organic carbon are attributable to road dust and natural biogenic sources.

Elemental Carbon—Incomplete combustion processes from diesel engines and other sources create elemental carbon, which is also called soot or black carbon.

Ammonium Nitrate—A portion of nitrogen oxide (NOx) emissions from motor vehicles and stationary combustion sources react through photochemical processes during the day, or react with ozone at night, to form nitric acid. When ammonia emissions react with the nitric acid, ammonium nitrate is created.

Ammonium nitrate is commonly the largest contributor to PM2.5 mass in the Valley, especially in the southern region of the Valley. Stagnant, cool, and damp conditions promote the formation and accumulation of ammonium nitrate. As such, ammonium nitrate is found mostly during winter conditions, transforming from gases to particles and back to gases during periods of higher temperature.

Ammonium Sulfate—Sulfur oxide (SOx) emissions from combustion sources undergo photochemical reactions in the atmosphere, sulfuric acid is formed. Similar to the ammonium nitrate photochemical reaction, sulfuric acid reacts with ammonia emissions to form ammonium sulfate.

Unlike ammonium nitrate, the peak season for ammonium sulfate is the summer. As a comparison, there is much less ammonium sulfate in the Valley atmosphere than ammonium nitrate.

Geologic Material—Geologic material consists primarily of road dust that is lifted into the air from passing vehicles as well as soil dust that is entrained into the atmosphere through farming and other activities and high-wind events. This category of species tends to be on the coarse side of the particulate matter spectrum, as opposed to the fine, and represents a small percentage of the overall PM2.5 mass.

Trace metals—Trace metals are present in soil dust and are emitted from mobile sources as part of combustion, engine wear, brake wear, and similar processes. Fireworks emissions have also been identified as a source of metals that impact health.

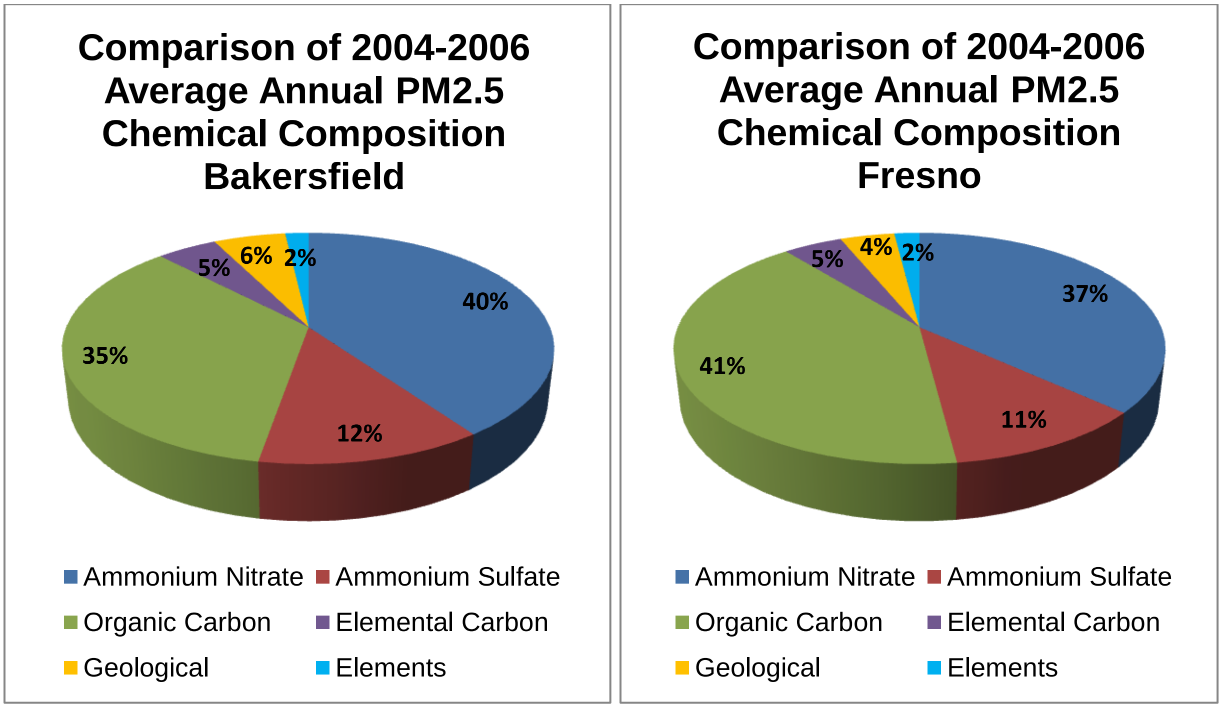
Sea Salt—Sodium chloride within sea spray can contribute to PM2.5 mass under meteorological conditions that allow transport of ocean air into the Valley. This represents a small portion of the overall mass and is only a contributor under specific transport conditions.

Secondary Organic Aerosol—As organic carbon is released into the atmosphere, photochemical reactions can occur to create organic aerosol, called secondary organic aerosol (SOA).

Combined Water—If a water molecule attaches itself to any of the above species, a combined water species is formed, adding to the total PM2.5 mass.

Figure 4-1 shows the relative chemical composition (major species components) of the average annual PM2.5 in Bakersfield and Fresno based on speciation data from 2004–2006.

Figure 4-1 Comparison of 2004–2006 Average Annual PM2.5 Chemical Composition



Note: "Elements" includes trace metals, chlorine, and silicon.

4.4 SCIENTIFIC FOUNDATION FOR THE *2012 PM2.5 PLAN*

As described in Chapter 3, the Valley's climate, topography, and emissions have contributed to a unique set of wintertime PM2.5 formation processes resulting in a low regional carrying capacity for PM2.5 and secondary precursors. The actual formation and makeup of PM2.5 includes a complex mixture of species that have different reaction capabilities and human toxicity.

Meeting the substantial attainment challenge created by the low regional carrying capacity requires new control measures that are feasible and effective based on the combined weight of scientific evidence surrounding the various PM2.5 species. For this plan, the development of new control measures is guided by two sources of scientific knowledge: prior research examining the key sources and processes governing PM2.5 species formation and substantiated evidence of reductions in ambient concentrations and key species resulting from existing control measures. In combination, this body of knowledge about key sources, their changing inventories, and the unique atmospheric processes found in the region is incorporated into the regional modeling developed for this plan, the results of which are discussed at the conclusion of this chapter.

The following is a review of each of these bodies of evidence with a focus on the predominant PM2.5 species of concern: organic carbon compounds (OC) and ammonium nitrate (NH_4NO_3). Prospective controls on these species lie at the heart of the regional modeling exercise discussed at the conclusion of this chapter and hold the key to attaining the 2006 PM2.5 NAAQS. Species of lesser importance, including geologic PM2.5, and VOCs are reviewed as well.

4.4.1 Ammonia Contribution to PM2.5 Concentrations

Ammonium nitrate contribution to total PM2.5 concentrations

Early air quality research in the Valley identified ammonium nitrate (nitrate) as a predominant secondary PM2.5 species in the region, with high concentrations forming during the winter months.[1] Studies have continued to show that ammonium nitrate is a primary component of wintertime PM2.5 in the Valley, followed by other species, such as organic carbon, ammonium sulfate, and geologic material.[2] In addition, PM2.5 speciation data, collected for many years at four Valley urban monitoring locations, also shows nitrate's substantial contribution to the Valley's total PM2.5 concentrations, especially on days when the 24-hour average concentration exceeds the 35 $\mu g/m^3$ 24-hour PM2.5 standard (see Appendix G).

Ammonium nitrate formation and precursors

Formation of ammonium nitrate is described by Kleeman et al. (2005, pp. 5326-7):[3]

> Particulate ammonium nitrate (NH_4NO_3) forms when the concentration product of gas-phase ammonia (NH_3) and nitric acid (HNO_3) exceeds a saturation point dependent on temperature, relative humidity, and the composition of the pre-existing particles that act as condensation substrate (Wexler and Seinfeld, 1991).[4] Ammonia is a relatively stable compound directly emitted to the atmosphere that does not undergo significant chemical reaction on the time scale of interest to regional air quality problems. Nitric acid is an end product of the photochemical transformation of NOx (NO + NO_2). The majority of the NOx in the SJV is emitted as NO that is then transformed into various species including NO_2, NO_3, HNO_2, HNO_3, HNO_4, Peroxy Acetyl Nitrate (PAN), Particulate Protein Nitrogen (PPN), particulate nitrate, etc. The sum of NOx and the entire family of NOx reaction products is called "reactive nitrogen" (NOy). The fraction of reactive nitrogen that forms HNO_3 and/or nitrate depends on the

[1] Smith, T.B.; Lehrman, D.E.; Reible, D.D.; and Shair, F.H. (1981). The origin and fate of airborne pollutants within the San Joaquin Valley: Extended summary and special analysis topics. Report No. 2. Prepared for the California Air Resources Board, and by the California Institute of Technology, Pasadena, CA.

[2] Ying, Q. & Kleeman, M.J., (2009). Regional Contributions to Airborne Particulate Matter in Central California during a Severe Pollution Episode. *Atmospheric Environment, 43*, 1218–1228.

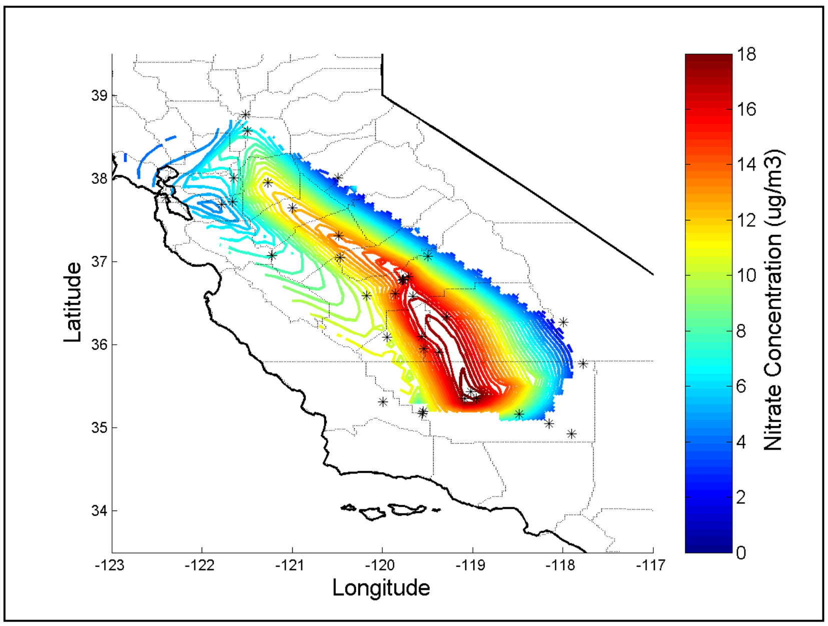
[3] Kleeman, M.J., Ying, Q., & Kaduwela, A. (2005). Control Strategies for the Reduction of Airborne Particulate Nitrate in California's San Joaquin Valley. *Atmospheric Environment, 39*, 5325–5341.

[4] Wexler, A.S., Seinfeld, J.H. (1991). 2nd-Generation inorganic aerosol model. *Atmospheric Environment Part a-General Topics 25 (12),* 2731–2748.

concentration of NOx and VOC as well on meteorological conditions such as temperature, relative humidity, and solar intensity (Aw and Kleeman, 2003; Nguyen and Dabdub, 2002).[5 6] Measurements taken at the remote Kern Wildlife Station in the San Joaquin Valley show that approximately 22% of the reactive nitrogen exists as particulate (ammonium) nitrate during typical winter conditions (Chow and Egami, 1997).[7]

Nitrate buildup is a signature outcome of multi-day stagnation periods during the winter (similar buildup is not observed during warmer seasons). The modeled regional variation of nitrate concentrations is shown in Figure 4-2. Higher concentrations of nitrate occur in the southernmost Valley as a result of slower wind speeds and higher levels of reactive nitrogen and ammonia.

Figure 4-2 Modeled Regional Distribution of Ammonium Nitrate[8]

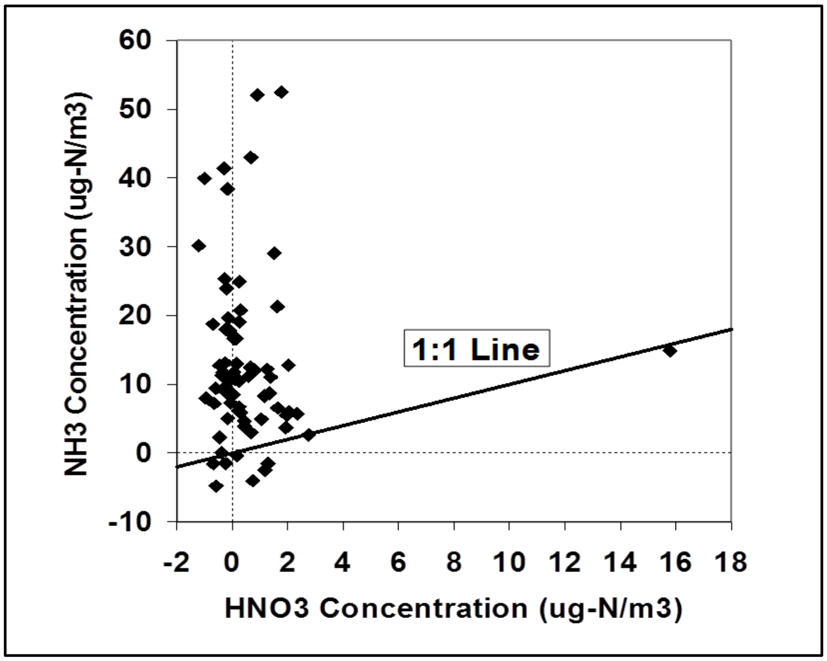


Both nitric acid and ammonia are needed to form ammonium nitrate. The extensive research conducted through CRPAQS and subsequent studies, as well as ongoing evaluation and modeling demonstrates that there is a relative abundance of ammonia

[5] Aw, J., Kleeman, M.J. (2003). Evaluating the First-Order Effect of Intra-Annual Temperature Variability on Urban Air Pollution. *Journal of Geophysical Research-Atmospheres 108 (D12).*
[6] Nguyen, K. & Dabdub, D. (2002). NOx and VOC Control and Its Effects on the Formation of Aerosols. *Aerosol Science and Technology 36 (5)*, 560–572.
[7] Chow, J.C. & Egami, R.T. (1997). San Joaquin Valley Integrated Monitoring Study: Documentation, Evaluation, and Descriptive Analysis of PM10 and PM2.5, and Precursor Gas Measurements. Technical support studies No. 4 and No. 8. Final Report prepared for the California Air Resources Board, Sacramento, CA. Desert Research Institute, Reno, NV.
[8] Chow, J.C., Chen, L.-W.A., Lowenthal, D.H., Doraiswamy, P., Park, K., Kohl, S., Trimble, D.L., & Watson, J.G. (2005). California Regional PM10/PM2.5 Air Quality Study (CRPAQS) – Initial Data Analysis of Field Program Measurements. Report No. 2497. Prepared for California Air Resources Board, Sacramento, CA, by Desert Research Institute, Reno, NV.

(NH_3) compared to nitric acid (HNO_3), and that the amount of nitric acid (resulting from NOx emissions) drives the ultimate formation of ammonium nitrate. Figure 4-3 illustrates this ammonia abundance at the rural Angiola (Fresno County) air monitoring site in the Valley during the CRPAQS field study. Ammonia concentrations are considerably higher than nitric acid concentrations throughout the Valley, including urban areas with concentrated NOx emissions.[9] See Appendix G for more information.

Figure 4-3 Ammonia versus Nitric Acid Measurements at Angiola[10]



Reducing ammonium nitrate

Because of the regional surplus in ammonia, even substantial ammonia emissions reductions yield a relatively small reduction in nitrate. Figures 4-4 and 4-5 provide a simplified illustration of this situation. As seen in Figure 4-6, a comparable modeling analysis based on CRPAQS observational data found a higher disparity between the efficiency of NOx versus ammonia controls. Reductions in nitrate concentrations of 30% to 50% were realized through a 50% reduction in NOx, while a 50% reduction in ammonia only realized less than 5% reductions in nitrate concentrations. Finally, Figure 4-7 provides clear correlative evidence from observed data that NOx controls are effectively reducing ammonium nitrate, despite an increase in the regional ammonia inventory over the same time period.

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9 Magliano, K. L. (2009) Science-Based Policies for Particulate Matter Air Quality Management in California. *International Aerosol Modeling Algorithms Conference.* Davis CA.

10 McCarthy, M. (2005) *The Role of Nighttime Chemistry in Winter Ammonium Nitrate Formation in the San Joaquin Valley*. American Association for Aerosol Research (AAAR), Supersites Conference, February 2005, Atlanta, GA.

Figure 4-4 Abundance of Ammonia in the San Joaquin Valley[11]

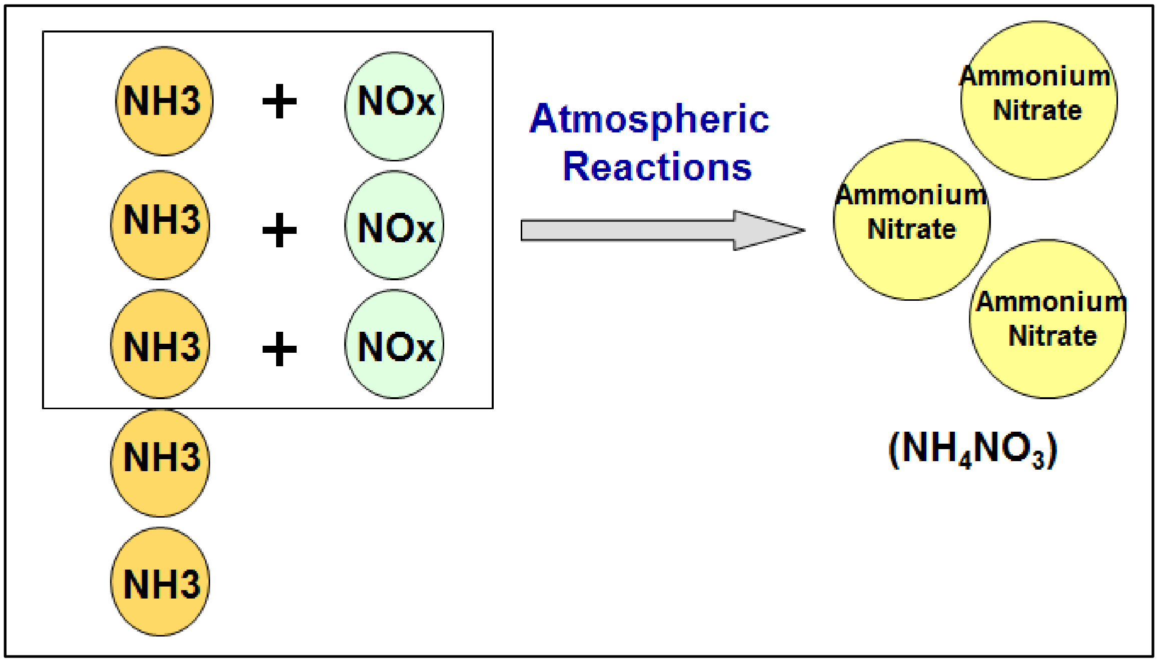
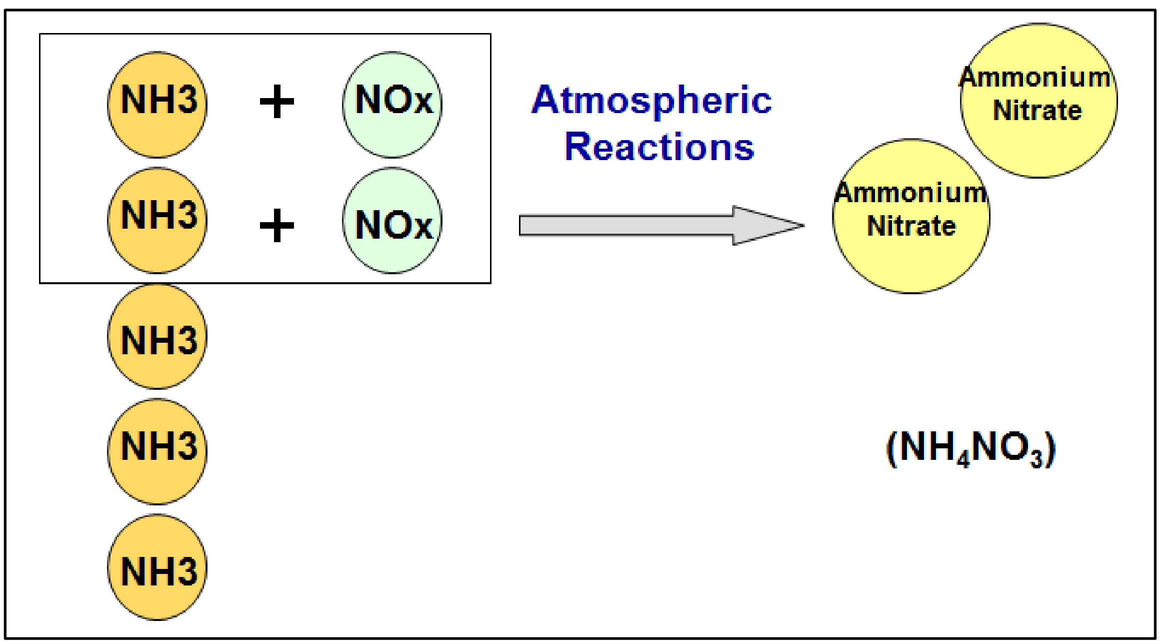


Figure 4-5 NOx Control Reduces Ammonium Nitrate Most Efficiently



[11] *Ibid*. 9

Figure 4-6 Modeled Ammonium Nitrate Response to Ammonia vs. NOx Controls[12]

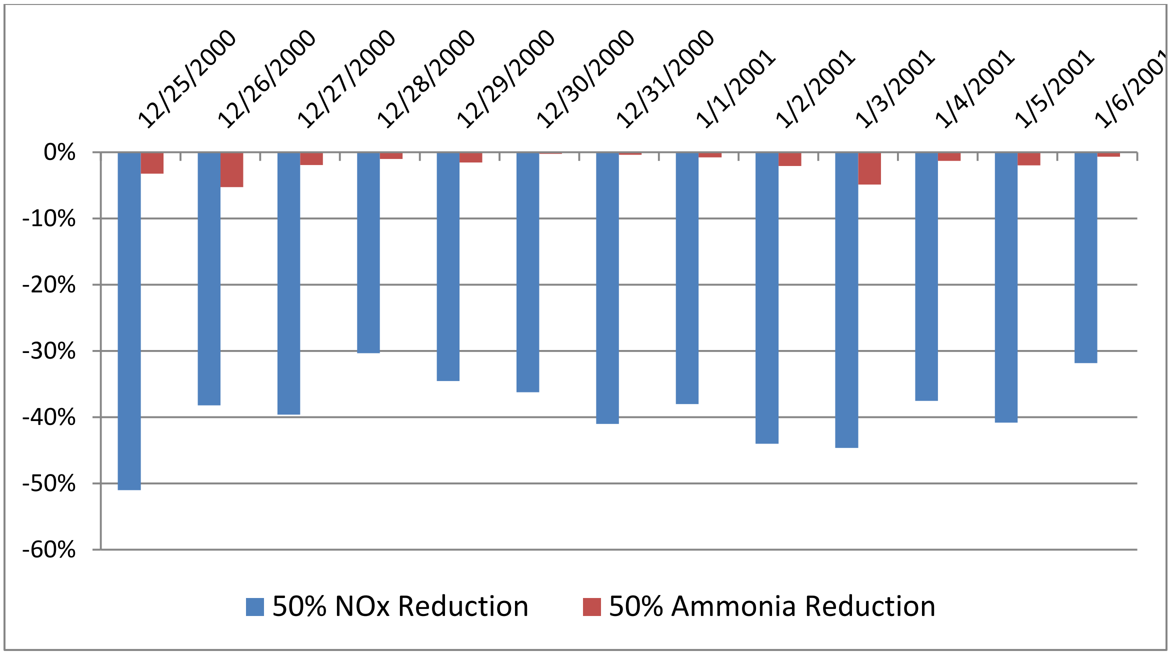
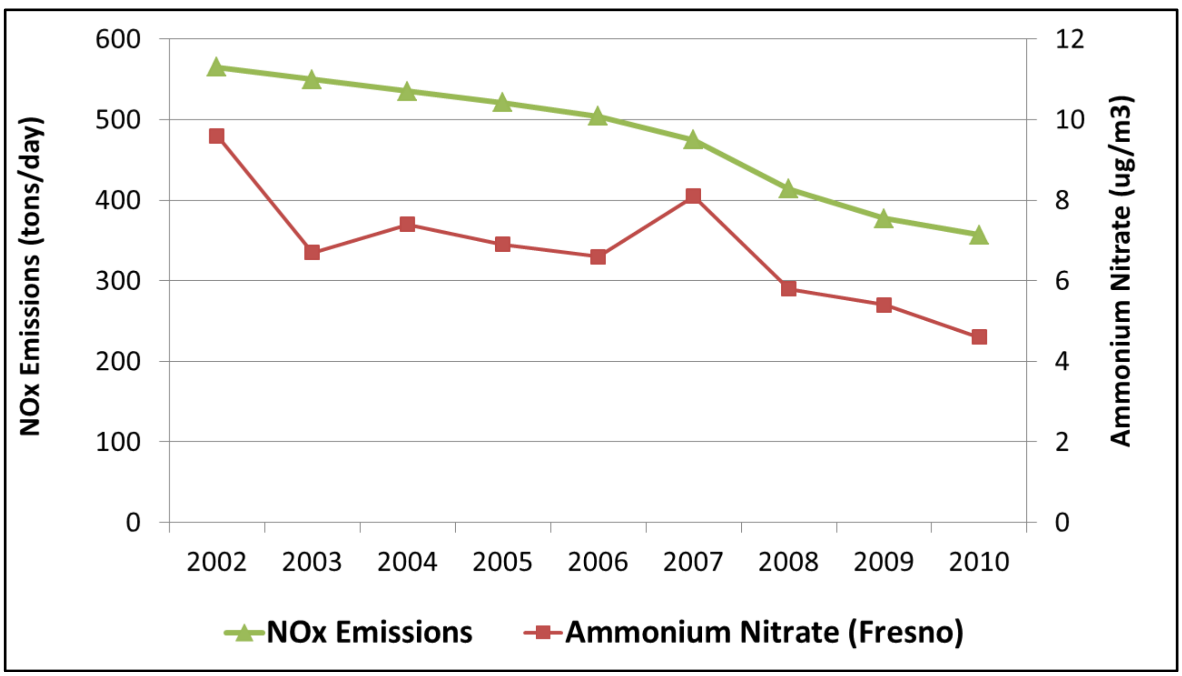


Figure 4-7 Correlation Between NOx Reductions and Observed Ammonium Nitrate in Fresno[13]



[12] *Ibid*. 9
[13] *Ibid*. 9

Due to this extensive body of science that clearly shows the much greater efficacy of reducing NOx emissions relative to ammonia, ammonia reductions have not historically been considered a significant precursor to PM2.5 formation in the San Joaquin Valley. However, the District and ARB have continued to examine the potential role of ammonia with regard to PM2.5 formation (see Appendices F and G).

The modeling sensitivity analysis conducted for this plan shows that reductions in ammonia emissions achieve insignificant reductions in the 2019 PM2.5 design values compared to reductions of direct PM2.5 and NOx emissions. As Appendix G details:

- A 1 ton reduction in the San Joaquin Valley's total direct PM2.5 emissions reduces the Bakersfield-California PM2.5 design value by 0.34 µg/m^3
- A 1 ton reduction in the San Joaquin Valley's total NOx emissions reduces the Bakersfield-California PM2.5 design value by a 0.08 µg/m^3
- A 1 ton reduction in in the San Joaquin Valley's total ammonia emissions reduces the Bakersfield-California PM2.5 design value by a mere 0.008 µg/m^3

Relative to the other pollutants, ammonia reductions at the Bakersfield-California site are only 2.3% as effective as direct PM2.5 reductions, and only 10% as effective as NOx reductions.

Furthermore, it would therefore take an unreasonable tonnage of ammonia reductions to reduce PM2.5 mass a significant amount. Since, as noted above, 1 ton of reduction in ammonia achieves a 0.008 µg/m^3 reduction in the PM2.5 design value, it would take a total ammonia reduction of 125 tons per day for the San Joaquin Valley to achieve only a 1 µg/m^3 reduction in the PM2.5 design value. Based on the total ammonia emissions inventory for the San Joaquin Valley in the year 2019, this would equate to a 34% reduction of the total tonnage. Thus, current technical analyses demonstrate that ammonia reductions would not significantly contribute to the Valley's attainment of the 2006 PM2.5 standard, so ammonia emissions do not need to be reduced under this plan.[14]

In the Reasonably Available Control Measures (RACM) analysis in Chapter 9, the District analyzed the amount of emissions reductions necessary to advance attainment by one year, from 2019 to 2018. The 2018 design value for Bakersfield-California is at least 1 µg/m^3 higher than the attainment level. As discussed in Chapter 5, the amount of ammonia reductions that could advance attainment by one year is an infeasible amount, since there are no control strategies that exist or have been identified which could achieve such large reductions.

In contrast, each ton of NOx reduced yields a summer ozone benefit and a winter reduction in nitrate. Additionally, NOx controls on mobile sources are largely based on new generation Tier IV engines (diesel) that generate OC at much lower rates. Given that the OC fraction of Valley PM2.5 is a primary driver of respiratory and cardiovascular

[14] Clean Air Fine Particle Implementation Rule [PM2.5 Implementation Rule]. 72 Fed. Reg. 79, pp. 20586–20667 at p. 20590 (2007, April 25). Retrieved from http://www.gpo.gov/fdsys/pkg/FR-2007-04-25/pdf/E7-6347.pdf#page=1

effects of PM2.5 exposure, the health benefits of mobile source NOx controls are considerable.

4.4.2 VOC Contribution to PM2.5 Concentrations

Volatile organic compound[15] (VOC) emissions have the potential to contribute to the formation of two different PM2.5 components: secondary organic aerosols (SOAs) and ammonium nitrate (nitrate). While these components contribute to observed PM2.5 concentrations in the Valley, their contribution is minimal. The anthropogenic VOC contribution (those not from biogenic sources) to both components is so minimal, that invoking a VOC-centric control strategy is much less effective that primary PM2.5 controls or NOx controls, as shown through the recent research and modeling.

VOC Contribution to SOA Formation. Secondary organic aerosols form when intermediate molecular weight VOCs emitted by anthropogenic and biogenic sources react and condense in the atmosphere to become aerosols. Lighter VOCs also participate in the formation of atmospheric oxidants, which then participate in the formation of SOA. SOAs derived from anthropogenic VOC emissions account for only 1% to 2% of the annual total PM2.5 concentrations throughout the Valley.

As part of the attainment demonstration for the District's *2008 PM2.5 Plan*, ARB used the Community Multiscale Air Quality (CMAQ) model to show that primary PM2.5 emissions are the main contributor to organic aerosols, with SOAs being a small fraction of the total organic aerosol concentration. Furthermore, SOAs are mostly formed during the summer and from predominantly biogenic sources, when total PM2.5 concentrations are low. As such, SOAs derived from anthropogenic VOC emission make up only 3% to 5% of the annual average organic aerosol concentrations.

Related to this finding, the California Regional Particulate Air Quality Study (CRPAQS) also found that because of the dominance of primary PM2.5 organic matter, overall, a 50% reduction in anthropogenic VOC emissions has limited effect on the modeled PM2.5 organic matter.[16] Together, these study results show that for SOAs, further VOC reductions would have very limited effectiveness in reducing PM2.5 concentrations.

VOC Contribution to Nitrate Formation. Nitrate forms by means of two primary chemical pathways: during the day, NO_2 is oxidized to nitric acid, some of which then reacts with ammonia to form nitrate through interactions with sunlight, VOCs, and background ozone; and during the night, when nitric acid is formed through oxidation of NO_2 (via N_2O_5) by background ozone, which then reacts with ammonia to form nitrate.

[15] EPA defines VOCs as any compound of carbon, excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates, and ammonium carbonate, that participates in atmospheric photochemical reactions to form ozone or particulates. A subset of non-reactive VOCs does not contribute to ozone or particulates and are exempt from regulatory controls. Many VOCs are human-made chemicals used and produced in the manufacture of paints, adhesives, petroleum products, pharmaceuticals. The full EPA definition is available at http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&rgn=div8&view=text&node=40:2.0.1.1.2.3.8.1&idno=40

[16] Pun, B.K., Balmori R.T.F, & Seigneur, C. (1998). Modeling Wintertime Particulate Matter Formation in Central California, *Atmospheric Environment, 43*, 402-409.

Several modeling studies[17,18,19,20] have investigated the relative veracity of these two mechanisms within the Valley and attempted to determine the specific role and contribution of VOCs on Valley nitrate concentrations. While the specific conclusions were mixed, there was general agreement that the nighttime formation of nitrate in the Valley would not be sensitive to VOC reductions.

Further modeling studies[21,22,23,24,25,26] evaluated the significance of VOC controls in reducing nitrate concentrations in the Valley. ARB evaluated each of these studies in the context of two key considerations: whether further VOC reduction would provide significant benefits to expedite attainment beyond the District's existing NOx control program, and what would be the feasible magnitude of any potential VOC reductions beyond the existing and already rigorous VOC control program. Nitrate was only responsive to a 50% reduction in VOCs at very high PM2.5 concentrations, concentrations that are no longer reached in the Valley. In contrast, a 50% reduction in NOx can reduce significantly more nitrate at current PM2.5 concentrations, one study[27] reporting a 38% reduction in nitrate.

Despite the insignificance of VOC emissions with regard to PM2.5 concentrations in the Valley, VOC emissions have been reduced and will continue to be reduced through implementation of the *2007 Ozone Plan.*

4.4.3 Geologic Contribution to PM2.5 Concentrations

Geologic dust is not a major PM2.5 emission source in the Valley. As shown in Figure 4-1, based on speciation date from 2004–2006, geologic dust accounts for between 4% and 5% in Fresno and Bakersfield, respectively. In addition, studies have shown that geologic dust, by itself, has relatively low toxicity.

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[17] Pun, B.K., & Seigneur, C. (1998) *Conceptual Model of Particulate Matter Pollution in the California San Joaquin Valley.* Prepared for Pacific Gas & Electric, Document CP045-1-98.

[18] Pun, B.K. (2004). *CRPAQS Task 2.7 when and where does high O3 correspond to high PM2.5? How much PM2.5 corresponds to photochemical end products?* Prepared for the San Joaquin Valleywide Air Pollution Study Agency.

[19] Lurmann, F.W., Brown, S.G., McCarthy, M.C., & Roberts, P.T. (2006). Processes Influencing Secondary Aerosol Formation in the San Joaquin Valley during Winter. *Journal of Air and Waste Management Association, 56*, 1679-1693.

[20] Ying, Q., Lu, J., & Kleeman, M. (2009). Modeling Air Quality during the California Regional PM10/PM2.5 Air Quality Study (CRPAQS) Using the UCD/CIT Source-Oriented Air Quality Model – Part III Regional Source Apportionment of Secondary and Total Airborne Particulate Matter. *Atmospheric Environment, 43*, 419-430.

[21] Stockwell, W.R., Watson, J.G., Robinson, N.F., Steiner, W., & Sylte, W.W. (2000). The Ammonium Nitrate Particle Equivalent of NOx Emissions for Wintertime Conditions in Central California's San Joaquin Valley, *Atmospheric Environment, 34*, 4711-4717.

[22] Pun, B.K., & Seigneur, C. (2001). Sensitivity of Particulate Matter Nitrate Formation to Precursor Emissions in the California San Joaquin Valley. *Environmental Science and Technology, 35*, 2979-2987.

[23] Kleeman, M.J., Ying, Q., & Kaduwela, A. (2005). Control Strategies for the Reduction of Airborne Particulate Nitrate in California's San Joaquin Valley. *Atmospheric Environment, 39*, 5325-5341.

[24] Meng, Z., Dabdub, D., & Seinfeld, J.H. (1997) Chemical Coupling Between Atmospheric Ozone and Particulate Matter. *Science, 277,* 116-119. DOI:10.1126/science.277.5322.116

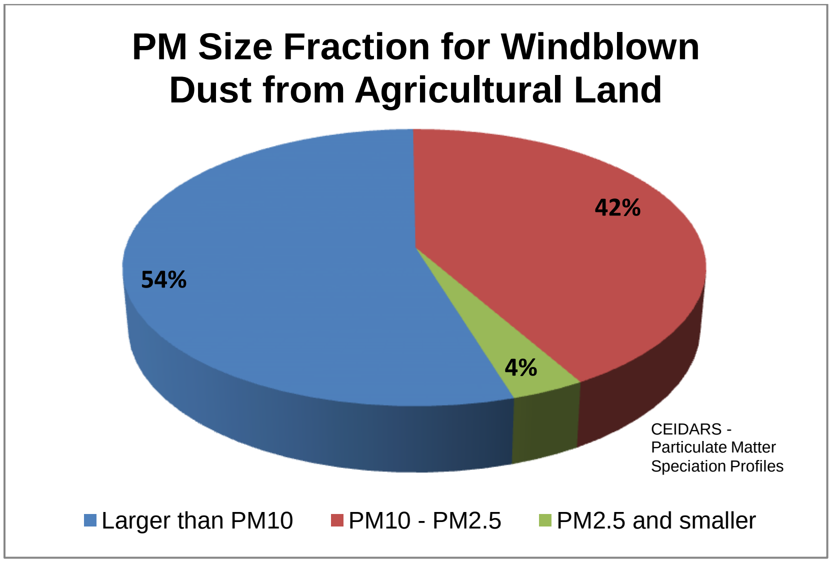
[25] Livingstone, P.L., Magliano, K., Gürer, K., Allen, P.D., Zhang, K.M., Ying, Q., … Byun, D. (2009). Simulating PM Concentrations during a Winter Episode in a Subtropical Valley: Sensitivity Simulations and Evaluation Methods. *Atmospheric Environment, 43*, 5971-5977.

[26] Pun, B.K., Balmori R.T.F, & Seigneur, C. (2009). Modeling Wintertime Particulate Matter Formation in Central California. *Atmospheric Environment, 43*, 402-409.

[27] *Ibid.* 25

Fugitive dust rules were critical in the District's attainment of the PM10 NAAQS. However, PM2.5 from geologic dust makes up a very small portion of overall geologic dust fraction. The California Emission Inventory and Reporting System (CEIDARS) published particulate matter speciation profiles in 2009. As shown in Figure 4-8, for windblown dust from agricultural land, there was only a 4% geologic source contribution of PM2.5.

Figure 4-8 PM Size Fraction for Windblown Dust from Agricultural Land



Geologic dust emissions are lowest in the winter when the majority of the District's PM2.5 24-hour exceedances occur. The Valley receives the majority of its precipitation during the winter, and the emissions inventory methodologies assume that as little as 0.01 inches of rainfall on any day suppresses geologic dust for 24 hours. Based on precipitation data from airports throughout the Valley, 71% of the days with at least 0.01 inches of precipitation occur during the winter months. Additionally, U.S. Forest Service and National Park unpaved roads, another source of geologic dust, are inaccessible or snow packed, during the winter, thus reducing emissions during those months.

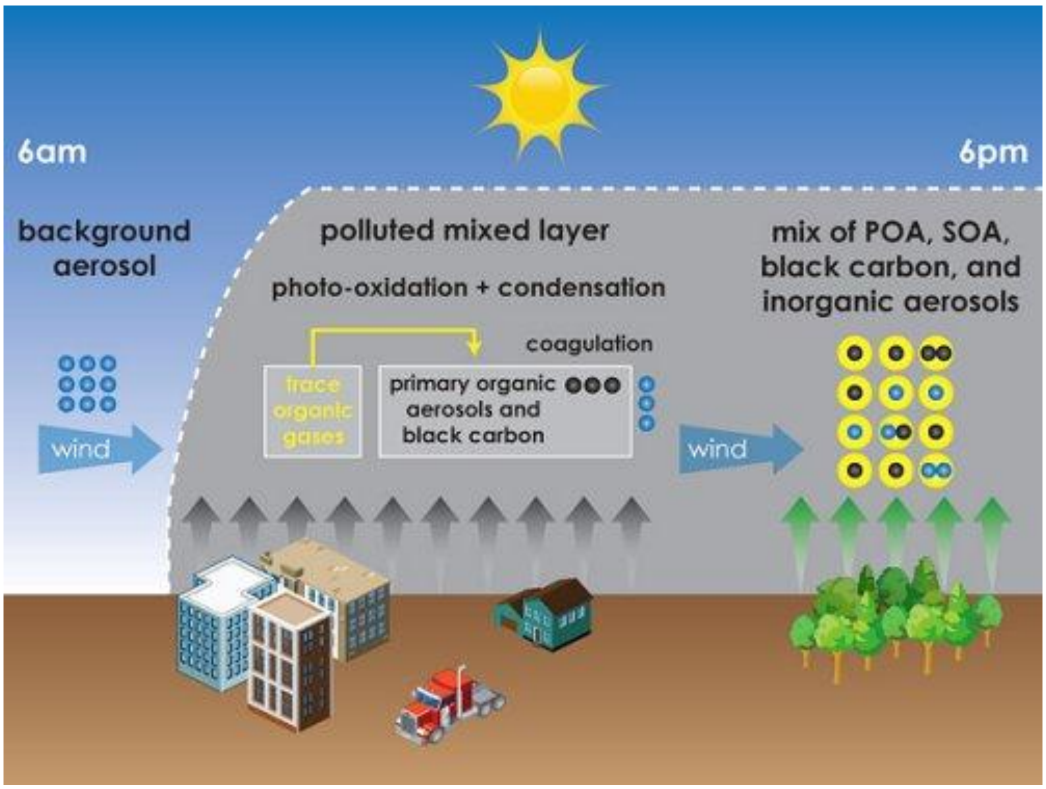
Not only is the geologic dust contribution to the total PM2.5 mass extremely low, the overall toxicity of geologic dust, which consists mainly of oxides of aluminum, silicon, calcium, titanium, iron, and other metals, is relatively low. As discussed in Chapter 2, geologic PM2.5 by itself is not a major threat to human health.

4.4.4 Organic Carbon Formation: Summary of Research Findings

Carbon-based aerosols contained within the PM2.5 fraction include organic carbon (OC), elemental carbon (EC), and carbonate minerals; however, it is the OC species that are particularly relevant to reducing the most negative health effects of PM2.5. Chapter 2 of this plan discusses the chemical complexity and resultant capacity of organic carbon species to impact cardiovascular and respiratory functioning. This section provides a brief overview of organic carbon aerosol (OA) atmospheric chemistry, a review of its implications for human exposure and health effects within the context of the District's Risk-based Strategy, and the primary sources of OA, including hydrocarbon combustion, residential wood combustion (RWC), motor vehicles operation, and meat charbroiling.

Organic Aerosol in the Environment. Organic aerosols (OA) and ammonium nitrate are the two largest contributors to PM2.5 mass in the Valley; however, the chemical complexity is very different between these two species. Many anthropogenic and biogenic sources of OA produce hundreds of primary organic aerosol (POA) species and hundreds of secondary organic aerosol species (SOA), which emerge from chemical aging and photolysis (photo-oxidation). The basic sources and processes that govern the dynamic relationship between POA and SOA are shown in Figure 4-9.

Figure 4-9 POA and SOA Formation Processes and Atmospheric Interactions[28]

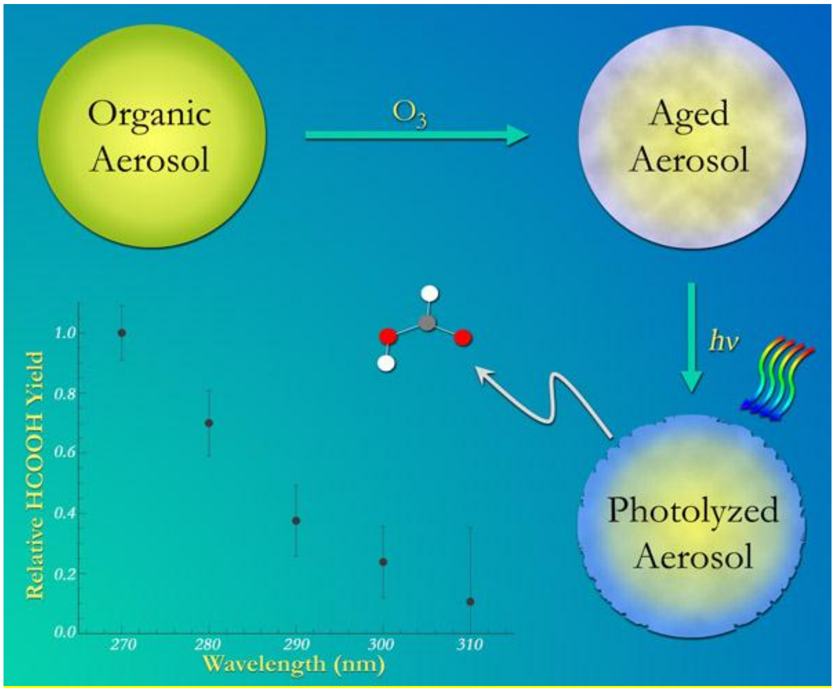


Primary Organic Aerosol Formation, Aging, and Photolysis. As opposed to SOAs, which appear in the atmosphere as a result of VOC chemical reactions, primary organic aerosols (POA) are released directly into the atmosphere by their sources. Most anthropogenic POA originates from the combustion of hydrocarbons (primarily coal, petroleum fuels, natural gas, and biomass) and the charbroiling of meat. Such particles are typically coated by an outer layer of fairly hydrophobic organic material. Over several hours or days, this layer is slowly oxidized by hydroxides (OH), ozone, and nitrogen oxides in a process known as *chemical aging*. As shown in Figure 4-10, these

[28] U.S. Department of Energy, Pacific Northwest National Laboratory: A Chemistry Tale of Two Carbons. (2012, August). Retrieved from http://www.pnl.gov/science/highlights/highlight.asp?id=1193

particles are subsequently subject to photolysis (chemical decomposition induced by light energy), which results in the creation of a breakdown product, HCOOH--formic acid, with a yield dependence on the reacting energy wavelength.

Figure 4-10 POA Aging and Photolysis[29]



Volatility of POA and Impact on SOA Formation. Volatility is a key construct necessary for understanding the chemical transport and fate of OA. A traditional assumption in chemical transport models (CTMs) has been that POA is emitted to the atmosphere as non-volatile compounds and remains in a non-reactive state. In fact, a substantial fraction of POA is semi-volatile, including one of the most important categories from a public health perspective, polycyclic aromatic hydrocarbon (PAH). In this case, PAH species range from the totally condensed coronene to completely volatile naphthalene. As such, all OA can be categorized along a volatility continuum according to their partitioning coefficient, i.e. that mass fraction that is condensed in a given air volume under standard atmospheric conditions.[30] As POA species evolve through oxidation, their partitioning coefficient changes as well, leading to movement into the aerosol state or back to gas, depending on current chemical composition, relative dilution, and atmospheric conditions. These new findings have made it clear that POA, once volatilized, can and does contribute to subsequent SOA species.

VOCs and SOA Formation. Until the 1950s, scientists assumed that smoke dominated by carbon black was the primary source of organic aerosol into the environment. By

[29] University of California, Irvine, Department of Chemistry: Photochemistry of Organic Aerosols. (2012). Retrieved September 17, 2012 from http://aerosol.chem.uci.edu/research/photochemistry.htm
[30] Donahue, N.M., Robinson, A.L. & Pandis, S.N. (2009). Atmospheric Organic Particulate Matter: From Smoke to Secondary Organic Aerosol. *Atmospheric Environment 43*, 94-106.

1952, however, Hagen-Smit had discovered, while studying Los Angeles smog, that non-volatile SOA was being formed from the oxidation of VOCs generated by motor vehicles.[31] Further laboratory studies conducted two decades later proved that oxidation of organic vapors can create products with low volatility that ultimately condense to form a fraction of tropospheric OA.[32] Just as VOCs react in the presence of NOx and sunlight to form ozone, VOC reactions with oxidants, i.e. ozone, OH, and NO3, often lead to partitioning from gas to a particle phase forming secondary organic aerosols. Many biogenic and anthropogenic volatile compounds yield less-volatile products, in effect driving the process of SOA formation.[33]

Despite exponential growth of global fossil fuel combustion since the late nineteenth century, SOAs resulting from the oxidation and condensation of VOCs emitted naturally from vegetation still exceeds production from anthropogenic sources.[34] In fact, Zimmerman et al. have estimated that global terpenes (the primary category of biogenic VOC) released by plants are approximately eight times the volume of total anthropogenic emissions of non-methane hydrocarbons.[35] Recent studies have quantified the contribution that VOC emissions from natural vegetation and crops is making to the formation of ozone and SOAs, with natural vegetation being the largest contributor.[36] This suggests that a substantial fraction of the haze found in Valley foothills is the result of SOA formed by the oxidation and photolysis of biogenic VOCs.

On an annual average basis, secondary organic aerosols derived from anthropogenic VOC emissions account for only 1% to 2% of the annual total PM2.5 concentrations throughout the Valley. ARB air quality modeling exercises conducted as part of the District's *2008 PM2.5 Plan* attainment demonstration analysis using the CMAQ model showed that primary PM2.5 emissions are the main contributor to organic aerosols and SOA contribute to only a small extent. Furthermore, SOA are mostly formed during the summertime, when total PM2.5 concentrations are low, and are mainly derived from biogenic emission sources. As a result, annual average SOA derived from anthropogenic VOC emissions are a small part of the organic aerosol concentrations (3% to 5%).

Key POA Sources and Species of Concern in the Valley. Within the Valley and globally, biomass and fossil fuel combustion are the most important sources of POA.[37]

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[31] Haagen-Smit, A.J. (1952). Chemistry and Physiology of Los Angeles Smog. *Analytical Chemistry 44*, 1342–1346.
[32] McMurry, P.H. & Grosjean, D. (1985). Photochemical Formation of Organic Aerosols: Growth, Laws, and Mechanisms. *Atmospheric Environment 19*, 1445–1451.
[33] Donahue, N.M., Robinson, A.L., Stanier, C.O., & Pandis, S.N. (2006). Coupled Partitioning, Dilution, and Chemical Aging of Semivolatile Organics. *Environmental Science & Technology 40(8)*, 2635–2643.
[34] Duce, R.A., Mohnen, V.A., Zimmerman, R., Grosjean, D. Grosjean, Cautreels, W., …& Wallace G.T. (1983). Organic Material in the Global Troposphere, *Reviews of Geophysics*, *21(4)*, 921–952.
[35] Zimmerman, P.R., Chatfield, R.B., Fishman, J, Crutzen, P., & Hanst, P.L. (1978). Estimates of the Production of CO and H2 from the Oxidation of Hydrocarbon Emissions from Vegetation. *Geophysical Research Letters*, *5(8)*, 679–682.
[36] Goldstein, A.H. & Karlik, J.F. (2011). Flux Measurements of Biogenic Precursors to Ozone and Particulate Matter in the Central Valley. Final Report, Contract No. 06-329. Prepared for the California Air Resources Board and the California Environmental Protection Agency. August 16, 2011. Available at http://www.arb.ca.gov/research/apr/past/06-329.pdf
[37] Liousse, C., Penner, J.E., Chuang, C., Walton, J.J., Eddleman, H., & Cachier, H. (1996). A Global Three-Dimensional Model Study of Carbonaceous Aerosols. *Journal of Geophysical Research*, *101(D14),* 19,411–19,432.

Unlike SOA, which tends to be more evenly distributed between source and non-source areas, POA is concentrated in areas near emissions sources, e.g. urban areas, freeways, railways, and shipping ports. In the case of fossil fuels, motor vehicles are the primary source of POA in urban areas. Rogge et al. conducted a series of speciation studies in the Los Angeles basin and found that motor vehicle exhaust contributed 21% of the POA in that area, characterized by a variety of cyclic and polycyclic compounds, with PAH being the most significant in terms mass contribution and potential public health impacts.[38] In addition, meat charbroiling was also found to contribute 21%, with residential wood combustion contributing up to 30% in winter.[39,40] Finally, 16% was contributed from road dust, tires, and brake dust.[41]

The source contribution percentages from the Los Angeles research are comparable to POA source contributions in the Valley, with the exception of POA from wood smoke. In the case of residential wood combustion (RWC), a Fresno PM2.5 speciation study based on the use of levoglucosan as a tracer for wood smoke collected during the CRPAQS winter-intensive study in 2000–2001 concluded as follows: "Combined, the emissions from wood smoke, meat charbroiling, and motor vehicles appear to contribute 65–80% to measured OC, with wood smoke, on average, accounting for approximately 41% of OC and approximately18% of PM2.5 mass."[42]

The contribution of OC as a fraction of the total PM2.5 mass has decreased over the last nine years as shown in Figure 4-11. This provides evidence that more stringent controls on POA from motor vehicles and RWC control measures put in place by ARB and the District over that time period have been effective in reducing emissions. The District's stringent RWC controls were implemented just prior to the 2003–2004 winter season and were further strengthened prior to the 2008–2009 winter season. Overall, the total winter PM2.5 concentration has decreased since the 1999–2000 winter season (Figure 4-12). Reductions in potassium levels, a key indicator species for wood combustion, provide further evidence of reductions in winter season wood combustion (Figure 4-13).

[38] Rogge, W.F., Hildemann, L.M., Mazurek, M.A., Cass, G.R., & Simoneit, B.R.T. (1993). Sources of Fine Organic Aerosol, 2, Noncatalyst and Catalyst-Equipped Automobiles and Heavy-Duty Diesel Trucks. *Environmental Science & Technology*, *27(4)*, 636–651.
[39] Rogge, W. F., L. M. Hildemann, M. A. Mazurek, G. R. Cass, and B. R. T. Simoneit. (1991) Sources of fine organic aerosol, 1, Charbroilers and meat cooking operations, *Environ. Sci. Technol*., *25*, 1112–1125.
[40] Rogge, W. F., L. M. Hildemann, M. A. Mazurek, G. R. Cass,and B. R. T. Simoneit. (1998) Sources of fine organic aerosol, 9, Pine, oak and synthetic log combustion in residential fireplaces, *Environ. Sci. Technol*., *32*, 13–22.
[41] Rogge, W. F., L. M. Hildemann, M. A. Mazurek, G. R. Cass, and B. R. T. Simoneit. (1993) Sources of fine organic aerosol, 3, Road dust, tire debris, and organometallic brake lining dust—Roads as sources and sinks, *Environ. Sci. Technol*., *27*, 1892–1904.
[42] Gorin, C, J. Collett, and P. Herckes. (2006) Wood Smoke Contribution to Winter Aerosol in Fresno, CA. *Journal of the Air and Waste Management Association* 56: 1584-1590 (quote on p. 1584).

Figure 4-11 Valley Trend of OC Mass as a Fraction of PM2.5 Mass

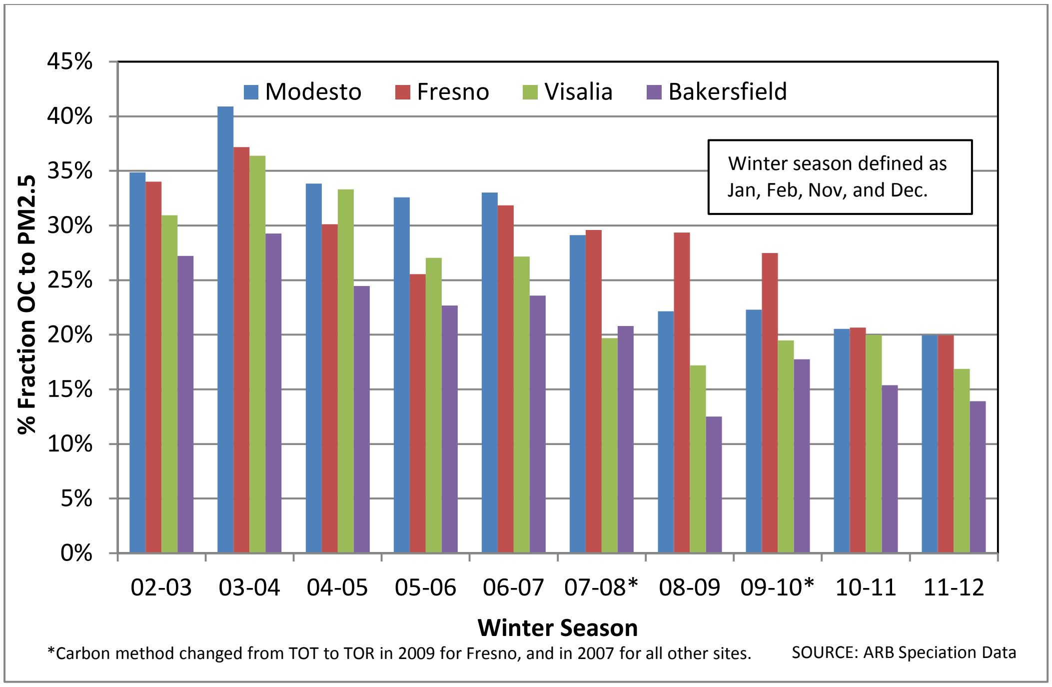


Figure 4-12 Winter Season Trend of Valley Average Daily PM2.5 Mass

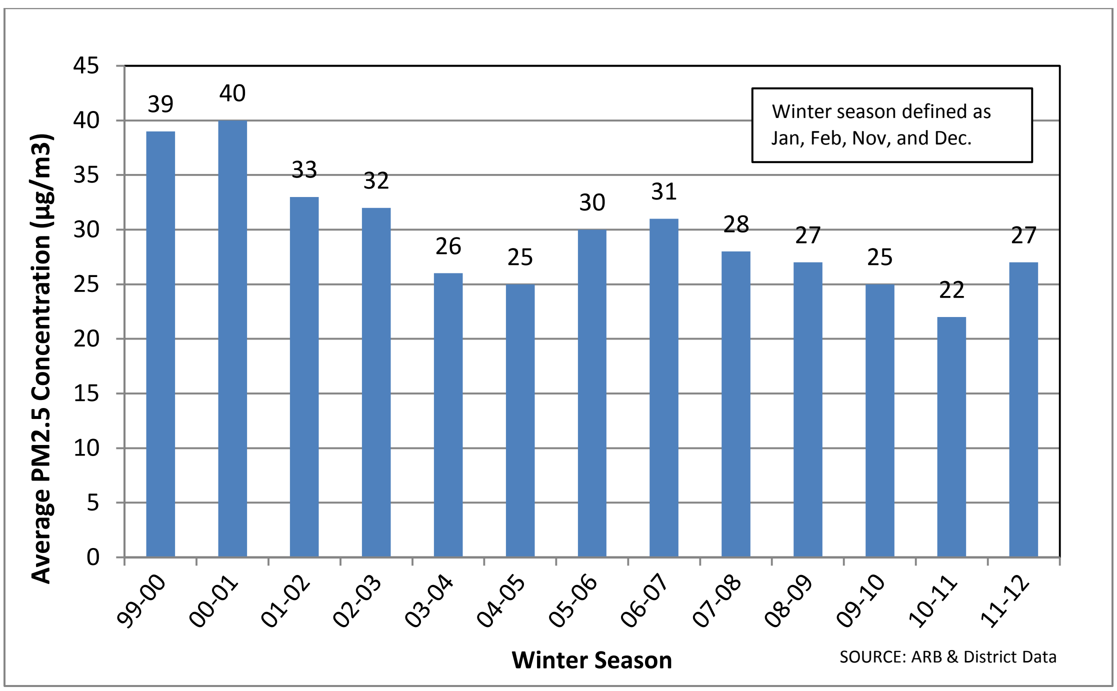
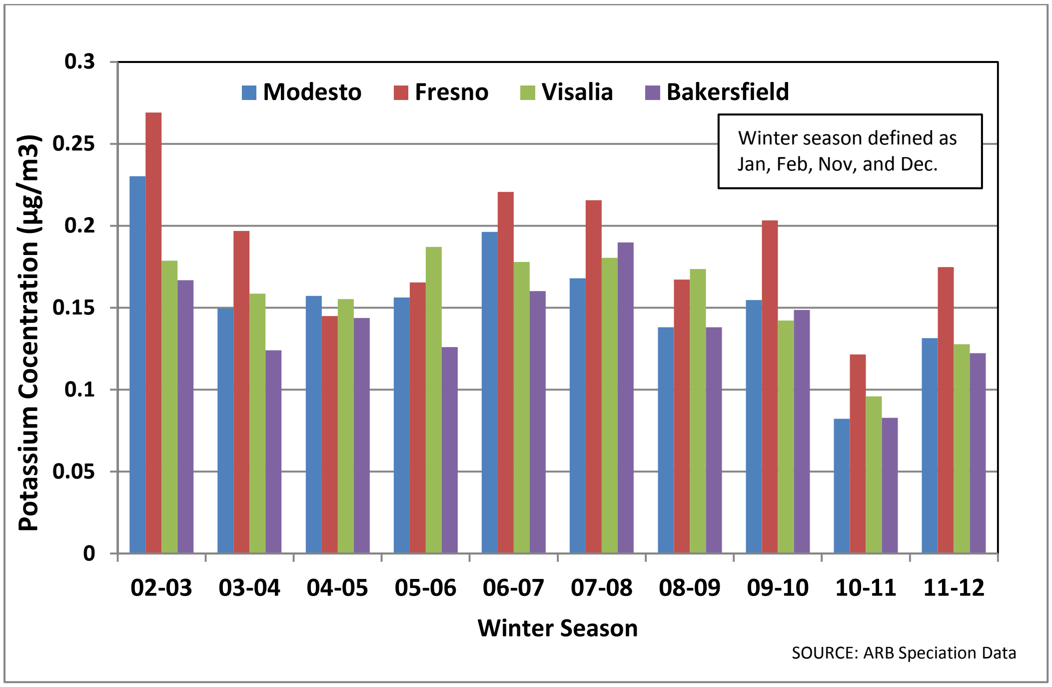


Figure 4-13 Average Winter Season Potassium Concentration in the San Joaquin Valley



4.4.5 Controlling Organic Aerosol under the Risk-Based Strategy

While reducing ammonium nitrate concentrations through NOx reductions is important for attainment, strategies that reduce organic aerosols provide opportunities for not only addressing the standard, but also providing much greater relative health benefits.

Relevance to attainment. New controls on the creation of primary organic aerosol via combustion processes hold the promise of a win-win outcome—providing substantial reductions in health risk as well as making a significant reduction in PM2.5 mass. The attainment strategy discussed below, therefore, is centered on POA reduction based on scheduled emission controls by ARB on motor vehicles, especially heavy duty trucks, combined with further restrictions on RWC, new controls on commercial charbroiling, and incentives for zero-emission lawn care equipment.

Species toxicity of POA and SOA. As discussed on Chapter 2, both combustion POA, such as PAH, and downstream SOA species have been implicated in a wide range of health effects, including cardiovascular and respiratory inflammation and carcinogenesis. Unlike other aerosol precursors such as NOx and VOCs that are currently being reduced through ongoing ozone control measures, reductions in POA (and the subsequent SOA that is produced by downstream oxidation and photolysis of POA) necessitates direct controls on primary emission sources. From a public health perspective, reductions in POA mass will result in a compounding of risk reduction that significantly exceeds the proportional contribution of those controls to PM2.5 mass reduction. This is because the chemical aging of SOA is responsible for some of the most toxic OA species such as quinones.

Particle size and deposition. POA generated by combustion as well as the SOA that emerges from the chemical processing of POA and VOC condensation are largely concentrated in the ultrafine (PM0.1) and fine (PM2.5) particle size categories. Inhalation of these particles results in deposition in the alveolar and thoracic zones of the lungs with potential impacts spanning the cardiovascular, immune, nervous, and respiratory systems. Individuals with pre-existing health conditions and those subject to high concentrations in urban areas or near high-volume roadways are especially vulnerable to inhalation of concentrated POA and SOA species that result from POA processing.

Proximity to ultrafine particles. POA is highly concentrated in freshly emitted ultra-fine particles (UFP), or those particles less than 0.1 microns (PM0.1). Because of their ability to pass through protective epithelium in the lung,[43] enter the brain via the olfactory bulb,[44] and enter the bloodstream in the alveolar region,[45] UFP-induced health effects are disproportionately high relative to their mass. In the case of POA, however, their ability to penetrate past the body's normal particle defense mechanisms is magnified by the relative toxicity of POA species, PAH in particular. In the case of combustion POA, its chemical toxicity has been shown to be magnified by the presence of metals, including iron, vanadium, and nickel.[46]

Population intake fraction. POA emitted by internal combustion engines, residential wood combustion, and meat charbroiling is highly concentrated in urban areas where population density is greatest. Whether inhaled as freshly-emitted UFP or as larger fine particles, the net effect is a much larger intake fraction for these sources relative to comparable emission sources located in less populated, rural areas. Furthermore, heavy concentrations of vehicular POA from roadways located near urban neighborhoods may result in intake fractions that are an order of magnitude greater then outlying suburban areas within the same metro area. This elevated health risk from elevated POA exposure is especially relevant to health impacts from RWC, particularly given that UFP from wood combustion results in sustained high levels of indoor UFP during nocturnal inversions.[47] This high level of sustained exposure to PAH-laden UFP places the exposed individuals at risk to immune system sensitization and heightened vulnerability to subsequent exposure.[48]

[43] Donaldson, K., V. Stone, A. Clouter, L. Renwick, and W. MacNee. (2001) Ultrafine Particles. *Occupational Environmental Medicine* 58: 211–216.
[44] Oberdorster, G.,Z. Sharp, V. Atudorei, A. Elder, R. Gelein, and W. Kreyling. (2004) Translocation of Inhaled Ultrafine Particles to the Brain. *Inhalation Toxicology* 16:437–445.
[45] Delfino, R.J, S. Constantinos, and S. Malik. (2005) Potential Role of Ultrafine Particles in Associations between Airborne Particle Mass and Cardiovascular Health. *Environmental Health Perspectives* 113 (8): 934-946.
[46] Chen, L., and M. Lippmann (2009) Effects of Metals within Ambient Air Particulate Matter (PM) on Human Health. *Inhalation Toxicology* 21: 1–31.
[47] Thatcher, T., and T. Kirchstetter (2011) Assessing Near-Field Exposures from Distributed Residential Wood Smoke Combustion Sources. Report prepared for the California Air Resources Board. California State Polytechnic University; Lawrence Berkeley National Laboratory. September.
[48] Li, N., Harkema, J.R., Lewandowski, R.P., Wang, M., Bramble, L.A., Gookin, G.R., Ning, Z., Kleinman, M.T., Sioutas, C., and Nel, A.A. (2010) Ambient Ultrafine Particles Provide a Strong Adjuvant Effect in the Secondary Immune Response: Implication for Traffic-Related Asthma Flares. *American Journal of Physiology: Lung and Cell Molecular Physiology* 299 (3): L374-83.

4.4.6 Condensable Particulates

Certain high-temperature processes emit gaseous pollutants that rapidly condense into particle form in the ambient air. After January 1, 2011, PM2.5 nonattainment areas are to consider these condensable particulates for purposes of establishing the emissions limits for Reasonable Further Progress (RFP), Reasonably available control technology (RACT), and reasonably available control measures (RACM).[49] In December 2010, EPA revised its "Method 202" stationary source test method to measure condensable particulate matter.[50]

While this issue may be new and more relevant to other regions, the District has historically included condensable particulate emissions in its definition of total particulate emissions, well ahead of federal and other states' efforts to address this issue. This has included instituting permit requirements for various emissions sources that include condensable particulates as part of total particulate emissions limitations, and associated emissions testing requiring that condensable particulates be measured (including utilizing an EPA-approved modified test method ahead of EPA's official test method, Method 202). Condensable particulates are thus a part of the total PM2.5 inventory, and reductions in condensable particulate matter emissions were included in the District's evaluation of various emission reduction opportunities for directly emitted PM2.5.

4.5 PROJECTED FUTURE AIR QUALITY AND IDENTIFYING THE GOAL

[This section was prepared by the California Air Resources Board (ARB)]

Consistent with EPA guidelines, ARB modeled air quality to predict future PM2.5 concentrations at each monitoring site in the Valley. This modeling shows attainment of the 24-hour PM2.5 standard by 2019 based on implementation of the ongoing control program in all counties except Kern and Kings. In Kern and Kings Counties, additional focused emission reductions are needed to provide for attainment. Additional analyses confirmed that attainment is predicted throughout each county (i.e. in each modeled grid cell; see Appendix G - Appendix 6). This section summarizes these efforts and results. Additional information is available in Appendices F and G. Additional technical information can be found on ARB's website:
http://www.arb.ca.gov/planning/sip/sjvpm25/24hrsjvpm25.htm

4.5.1 Modeling Overview

The modeling analysis includes new emission reductions each year between now and 2019 from implementation of a combination of adopted ARB and District programs. As a result, most sites in the northern and central Valley are expected to attain before

[49] 40 CFR 51.1002(c)
[50] http://www.epa.gov/ttn/emc/methods/method202.html

2019. As required by EPA, the modeling replicates the base year 2007 meteorological conditions for each calendar day in the year 2019. The 2007 meteorological conditions included several periods of time especially conducive to the formation of PM2.5. However, that modeling indicated that only two areas (Corcoran and Bakersfield) would not attain with the new emission reductions from adopted measures with implementation between now and 2019.

ARB staff then modeled a scenario with an enhanced wood-burning curtailment program, which would be designed to prevent wood burning on days that may lead up to a PM2.5 exceedance. The predicted design values for each site from this modeling scenario are shown in Table 4-1.

Table 4-1 2019 Modeled 24-hour PM2.5 Design Values with Enhanced Residential Wood-Burning Curtailment Program

Monitoring Site	Design Value (µg/m^3)
Bakersfield - California	35.7
Bakersfield - Planz	32.9
Corcoran - Patterson	32.1
Visalia - N. Church	29.4
Fresno - Hamilton	28.6
Fresno - First	30.5
Clovis	28.6
Merced	22.6
Modesto	24.7
Stockton	21.4

Additional emissions reductions from Rule 4901 bring Corcoran (Kings County) into attainment, and brings Bakersfield (Kern County) closer to attainment. As a result of implementation of the ongoing control program, coupled with the enhanced wood-burning curtailment measure, ammonium nitrate concentrations are predicted to decrease by over 45%, and combustion-related carbon concentrations by approximately 65%. Like the rest of the Valley, PM2.5 concentrations at the Bakersfield-California site are also projected to significantly decrease as emissions are further reduced. While adoption of a more stringent wood-burning curtailment program brings the Bakersfield-California site very near attainment, further reductions are still needed and will be provided through a measure to achieve additional emission reductions from commercial cooking operations. The final attainment demonstration for the Bakersfield-California design site is provided in Table 4-2 below:

Table 4-2 Attainment Demonstration—Bakersfield-California Design Value Site

2007 Design Value (µg/m^3)	**2019 Design Value with Wood Burning Program Enhancement** (µg/m^3)	**2019 Final Design Value** (µg/m^3)
66	35.7	35.4

Note: The benchmark for attainment is a design value that is equal to or less than 35.4 µg/m^3

As noted above, the design value in column 2 of Table 4-2 reflects the implementation of ongoing control programs, as well as implementation of an enhanced residential wood burning curtailment program. The final design value reflects the combined impact of further reductions in commercial cooking, as well as a small increase in motor vehicle emissions resulting from updated vehicle activity data from Valley Metropolitan Planning Organizations (MPOs). Based on a modeling sensitivity run, implementation of further controls on commercial cooking in Kern County is expected to result in a 0.6 µg/m^3 reduction in the baseline design value. The revised MPO activity data represents approximately 1% of Valley-wide NOx emissions. Based on modeling sensitivity runs, this is estimated to result in a design value increase of 0.2 µg/m^3. In aggregate, the modeling demonstrates that with the total plan control strategy, including adopted control measures as well as new control measures in Kings and Kern Counties, the modeled Bakersfield-California design value meets EPA's attainment target of less than or equal 35.4 µg/m^3.

4.5.2 Measuring the Benefit of Control Measure Reductions

In order to determine where to focus the remaining emission reductions needed to bring Bakersfield-California into attainment, ARB staff conducted additional modeling sensitivity runs to assess the relative efficacy of further reductions of different PM2.5 precursors. The current 24-hour PM2.5 standard modeling demonstrates that on a relative basis the greatest benefits are achieved from reductions in sources of directly emitted PM2.5, followed by NOx, based on EPA's relative response factor procedure. ARB also conducted Kern County-specific model sensitivity runs for NOx and PM2.5 to evaluate the specific benefits of emission reductions focused on the nonattainment sub-area. The Kern County sensitivity runs demonstrated that

- One ton per day of directly emitted PM2.5 reductions provides a 1.0 µg/m^3 improvement in the Bakersfield-California design value; and
- One ton per day of NOx reductions provides for a 0.12 µg/m^3 improvement in the Bakersfield-California design value.

Therefore, to bring Bakersfield-California into attainment, this plan's control strategy focuses on opportunities to further reduce direct PM2.5 and NOx emissions. As discussed above, ARB and the District are proposing two control measures with a potential emphasis on Kern County that would provide for attainment in 2019. In addition, benefits from incentive programs will be used for contingency purposes. Incentive programs provide an effective means to accelerate fleet turnover and the conversion to cleaner engine technologies. Both ARB and the District are committed to pursuing the needed funding, as well as targeting the incentive programs to those areas and sources that will provide for expeditious attainment. The role of incentive funding also highlights the need for continued legislative reauthorization of incentive funding mechanisms such as the Carl Moyer program. See Chapter 9 for more information.

4.5.3 Modeling Requirements

Following EPA guidance and procedures, the attainment demonstration was conducted through a modeled attainment test. Photochemical modeling relates measured PM2.5 levels to modeled PM2.5 concentrations, using precursor emissions and meteorology in the region to simulate future PM2.5 levels based on changes in emissions. This modeling is used to identify the most expeditious attainment date, the relative benefits of controlling different PM2.5 precursor pollutants, and the magnitude of emission reductions needed from each pollutant.

This is the first time that modeling has been applied to demonstrate attainment for the 24-hour PM2.5 standard using revised procedures recently issued by EPA[51]. This requires modeling of the most severe air quality days, which relies on the proper characterization of episodic daily emissions. Developing day-specific emission estimates and forecasting what those emissions will be on episodic days in the future is a complex process that is further described in Appendix F of this plan. The following sections summarize the photochemical modeling performed and results.

Under the Clean Air Act, areas are presumed to have five years from the date of nonattainment designation to attain the standard, with a potential five-year attainment date extension. In the case of the 24-hour PM2.5 standard, this corresponds to attainment dates of 2014 and 2019. The benchmark for attainment is a design value that is equal to or less than 35.4 $\mu g/m^3$.

4.5.4 Base and Future Years for Modeling

As required by EPA, ARB conducted a speciated modeled attainment test (SMAT). The SMAT is necessary because of the multiple constituents that form PM2.5 and their different relative responses to emission reductions. This test provides a method to link PM2.5 constituents with the appropriate emission sources. SMAT requires base and future years for the modeling. The base year is used for two purposes: to validate that the model is working properly and is able to replicate observed air quality and meteorological data, and as the starting year for projections of emissions and air quality predictions. For this effort, 2007 was chosen as the base year and 2019 as the attainment year for the modeling. The design values recorded in 2007 were some of the highest in recent years. In addition, analysis of the impacts of meteorology on PM2.5 levels in the Valley over the last ten years indicate that the 2007 meteorology

[51] U.S. EPA. (2011, June 28). *Memorandum: Update to the 24 Hour PM2.5 NAAQS Modeled Attainment Test*. Air Quality Modeling Group, U.S. EPA, Research Triangle Park, North Carolina.

was one of the most conducive to PM2.5 formation. Thus, the selection of 2007 represents a health-protective approach to the attainment demonstration modeling.

4.5.5 Air Quality and Meteorological Models

The Mesoscale Meteorological Model version 5 (MM5)[52] was used to generate the three-dimensional meteorological fields used for this effort. MM5 is a mesoscale, limited-area, non-hydrostatic numerical model developed by Penn State and the National Center for Atmospheric Research (NCAR). It uses a terrain-following, Lambert Conformal, sigma coordinate system. MM5 has been improved on an ongoing basis over the last two decades by contributions from a broad scientific community and has been maintained by NCAR along with necessary meteorological and geographical input data. Based on the complexity of terrain in northern and central California, the MM5 model represents an appropriate tool for resolving dynamics and thermodynamics using nesting capabilities. ARB has also been using the MM5 model over the last two decades, since it has been widely used and tested for various meteorological regimes over the world and has been supported by NCAR.

The Community Multiscale Air Quality (CMAQ) Modeling System was used for the air quality modeling. The CMAQ model, a state-of-the-science “one-atmosphere” modeling system developed by EPA, was designed for applications ranging from regulatory and policy analysis to understanding of the atmospheric chemistry and physics. It is a three-dimensional Eulerian modeling system that simulates ozone, particulate matter, toxic air pollutants, visibility, and acidic pollutant species throughout the troposphere[53]. The CMAQ model has undergone peer review every few years and was found to be state-of-the-science[54]. The CMAQ model is regularly updated to incorporate new mechanisms, algorithms, and data as they become available in the scientific literature[55]. In addition, the CMAQ model is well documented in terms of its underlying scientific algorithms as well as guidance on operational uses.[56]

[52] Grell, G. A., Dundhia, J., and Stauffer, D. R., 1994, A description of the Fifth-Generation Penn State/NCAR Mesoscale Model (MM5), National Center for Atmospheric Research, Boulder, CO, USA, NCAR/TN-398+STR, 122pp.

[53] 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

[54] Aiyyer, A., Cohan, D., Russell, A., Stockwell, W., Tanrikulu, S., Vizuete, W., and Wilczak, J., 2007, Final Report: Third Peer Review of the CMAQ Model, submitted to the Community Modeling and Analysis System Center, University of North Carolina, Chapel Hill.

[55] For example, 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.

[56] For example:
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.
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.

4.5.6 Modeling Domains

Meteorological Modeling Domains: The MM5 meteorological modeling domain consists of three nested grids of 36 km, 12 km, and 4 km with uniform, horizontal-grid spacing. The coarse 36 km grid (D01) provides synoptic-scale conditions to the 12 km grid (D02), which in turn provides the same to the 4 km grid (D03). The two coarse grids were run simultaneously, and the D03 grid was run independently using the output of its coarser, parent D02 grid as input. The D03 grid is intended to resolve the fine details of atmospheric motion and is used to feed the air quality modeling simulations. The vertical layer structure consists of 30 layers.

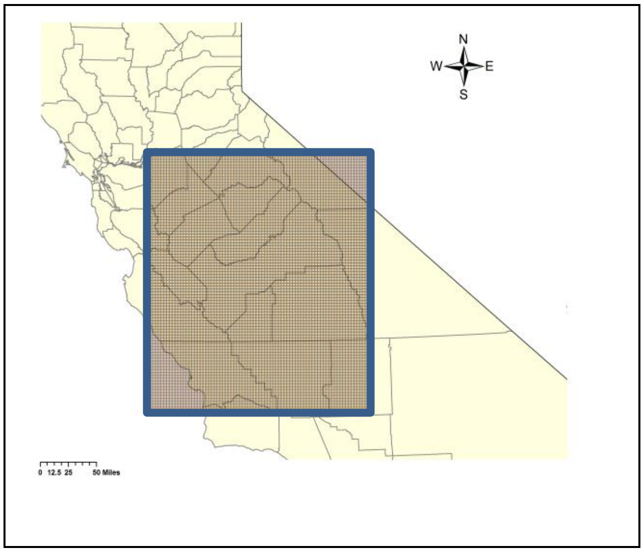
Air Quality Modeling Domains: The principle determinants of the extent of the air quality modeling domain are the nature of the PM2.5 problem and the scale of the emissions that impact the nonattainment area. The modeling domain used for this plan is shown in Figure 4-14. This is the same modeling domain used for the previous annual PM2.5 plan, which has been approved by the EPA.[57] This domain provides the high-resolution modeling results that are used in SMAT. This domain fully encompasses the Valley 24-hour PM2.5 non-attainment area. Consistent with EPA guidance[58], the modeling also includes a larger outer domain to provide for boundary conditions and initial inputs to the nonattainment area domain. The coarse domain 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.

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.
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.
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.
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

[57] Approval and Promulgation of Implementation Plans; California; 2008 San Joaquin Valley PM2.5 Plan and 2007 State Strategy, 76 Fed. Reg. 134, pp. 41337–41363. (2011, July 13). (to be codified at 40 CFR Part 52)
AND Approval and Promulgation of Implementation Plans; California; 2008 San Joaquin Valley PM2.5 Plan and 2007 State Strategy; Final Rule. 76 Fed. Reg. 217, pp. 49896–49926. (2011, November 9). (to be codified at 40 CFR Part 52)

[58] 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.

Figure 4-14 Air Quality Modeling Domain



For the coarse portions of nested regional grids, EPA guidance 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 grid cells about 4 km.[59] The defined modeling domains for the 24-hour PM2.5 plan are consistent with the guidance.

EPA guidance 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 100 mb) employ 12 to 21 vertical layers. For the present plan, 15 vertical layers are used in the CMAQ model, extending from the surface to 100 mb, consistent with the number of vertical layers used for the previous annual PM2.5 plan. The majority of the layers are in the planetary boundary layer.

Model Performance Evaluation: As recommended by EPA, the model performance evaluation consists of a number of metrics to evaluate performance for PM2.5 mass as well as PM2.5 components. These metrics include mean fractional bias (MFB), mean fractional error (MFE), normalized mean bias (NMB), and normalized mean error (NME). In addition, the evaluation includes other statistics such as mean bias, mean error, and the correlation coefficient whenever they provide meaningful information. Various forms of graphics are created to visually examine comparison of the model predictions to observations. Model performance goals are based on EPA guidance as well as performance recommendations proposed in peer-reviewed journal articles.[60]

Emission Inventory Preparation and Gridding: The process of preparing base-year emission inventories and future-year emission forecasts is described in appendices to

[59] *Ibid.*
[60] For example, Boylan, J.W. and 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. *AND 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.*

this plan. The gridding process, in which county-level emissions are allocated spatially and temporally, as well as chemically- and size-resolved, is described in the Modeling Protocol prepared for this effort (Appendix F). Development of the base-year emission inventories and the future-year forecasts involved a comprehensive review of the methodologies used to estimate key emission categories. As noted earlier, modeling of the 24-hour PM2.5 standard requires detailed information on the timing and locations of emission sources on the most severe air quality days. This poses a unique challenge to translate regional, annual emission estimates into the temporal and spatial resolution needed for 24-hour modeling. Special attention was paid to determining the sources and pollutants that had the largest effect on PM2.5 concentrations in the portions of the Valley with the highest concentrations, and focusing emissions improvement efforts on these areas. An iterative process was used as a means to refine the spatial, temporal, and chemical characteristics of modeling emission inputs to better reflect observed conditions expected at a local, 24-hour scale. Model-simulated concentrations were compared with chemical species present in the ambient monitoring data, maps of emission sources known to surround the monitoring stations, and temporal trends in the monitoring data. This led to updates in the spatial, temporal, and chemical allocation of the gridded emissions used in the modeling.

Attainment Demonstration Modeling Results: The SMAT process produces future year design values by monitoring site for comparison to the applicable ambient air quality standard. The first step in the future year modeling is to model the 2019 forecasted emissions. This modeling run includes all adopted regulations plus an enhanced wood burning curtailment program along with estimated population and economic growth. The modeled, future year projected design values are presented in Table 4-1.

Precursor Sensitivity Modeling Runs: Ambient PM2.5 is comprised of many different constituents and as a result, there are multiple precursor pollutants that lead to PM2.5 formation (directly emitted PM2.5, NOx, SOx, VOCs, and ammonia). EPA's PM2.5 implementation rule specifies that a precursor is considered "significant" for control strategy development purposes when a significant reduction in the emissions of that precursor pollutant leads to a significant decrease in PM2.5 concentrations. Such pollutants are known as *PM2.5 attainment plan precursors.*[61] The EPA's implementation rule also establishes a presumption that PM2.5, NOx, and SOx are attainment plan precursors, while VOCs and ammonia are not. For the annual PM2.5 plan, PM2.5, NOx, and SOx were identified and approved as the only attainment plan precursors by EPA. Results of the annual PM2.5 modeling showed that of these three pollutants, reductions in directly emitted PM2.5 was the most effective—reducing one ton of directly emitted PM2.5 was approximately nine times more effective than reducing one ton of NOx. The evaluation of the 24-hour PM2.5 attainment plan precursor focus is on the two winter quarters when peak PM2.5 concentrations occur in the Valley. Because annual average concentrations are heavily influenced by winter time levels, results for the 24-hour PM2.5 standard are expected to be similar to those for the annual standard.

[61] Clean Air Fine Particle Implementation Rule; Final Rule. 72 Fed. Reg. 79, pp. 20586–20667. (2007, April 25). (to be codified at 40 CFR Part 51)

In order to identify the PM2.5 attainment plan precursors and better understand the effectiveness of emission reductions for primary PM2.5 and precursors, the model is typically exercised with varying combinations of precursor reductions from anthropogenic sources. The results of these runs are plotted on isopleth diagrams, also referred to as carrying capacity diagrams. These carrying capacity diagrams shows the level of emissions that the atmosphere can "carry" and still demonstrate attainment. These diagrams help show what combinations of precursor emissions reductions (including which precursors are most effective to reduce as well as the magnitude of reductions needed) might lead to attainment, informing the development of a corresponding control strategy. The carrying capacity diagrams presented in Figures 4-15 through 4-24 show that NOx and directly-emitted PM2.5 are the most effective precursors to reduce to improve 24-hour PM2.5 design values.

Assessment of Grid Cell Concentrations: Modeling must demonstrate that the standard is attained in every modeling grid cell. In the Valley, the extensive monitoring network captures population exposure. Demonstration of attainment at these monitors, combined with the modeling grid cell evaluation will ensure that all regions in the Valley are in compliance with the 24-hour PM2.5 standard. EPA recommends combining interpolated spatial fields and modeled gradients to generate the gradient adjusted spatial fields for PM2.5. Future year estimates for all grid cells are created by applying the grid specific relative reduction factors to the gradient adjusted spatial fields. This analysis confirms that all areas of the Valley will reach attainment with this plan's control strategy.

Figure 4-15 Bakersfield-California Carrying Capacity Diagrams

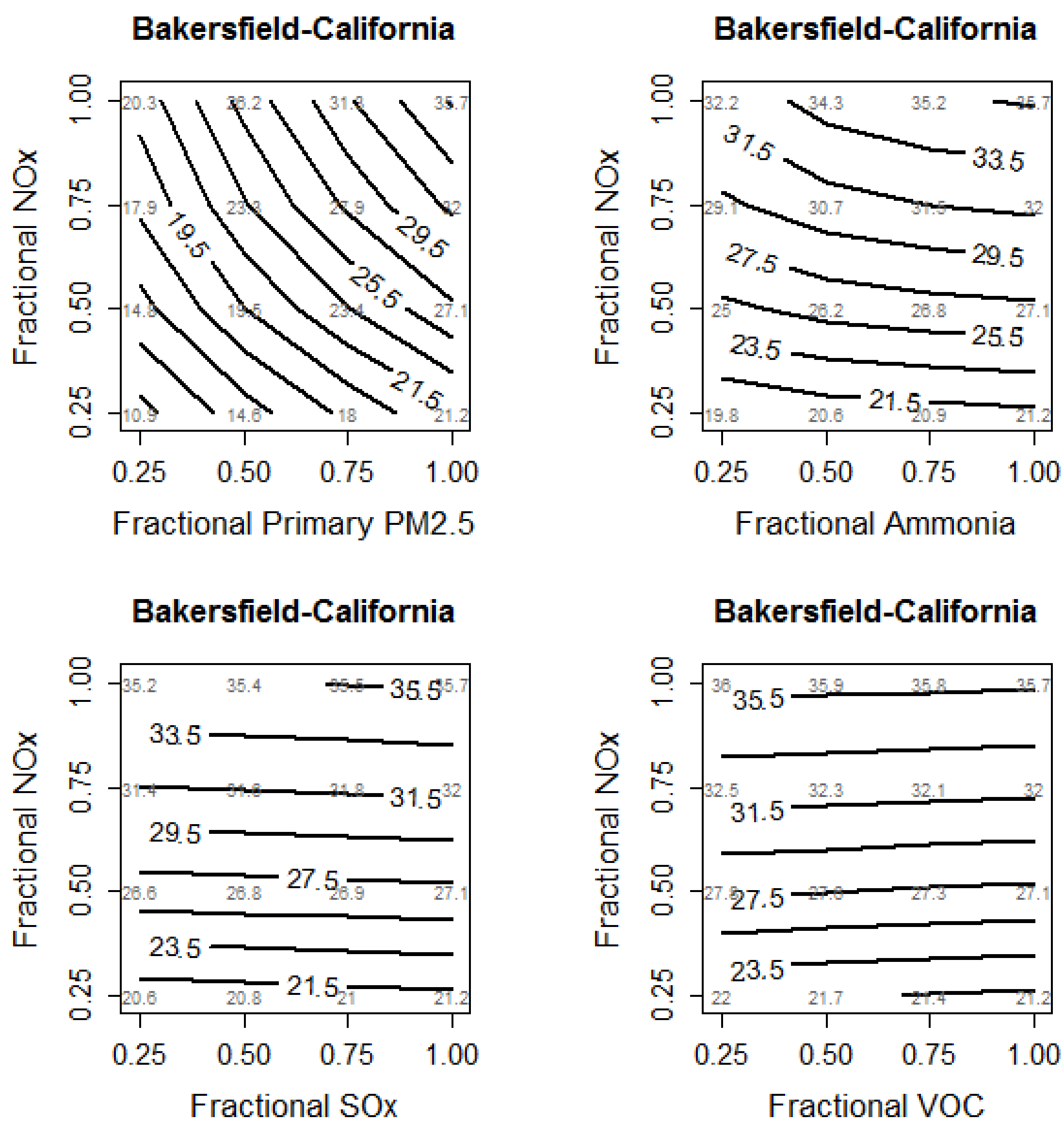


Figure 4-16 Bakersfield-Planz Carrying Capacity Diagrams

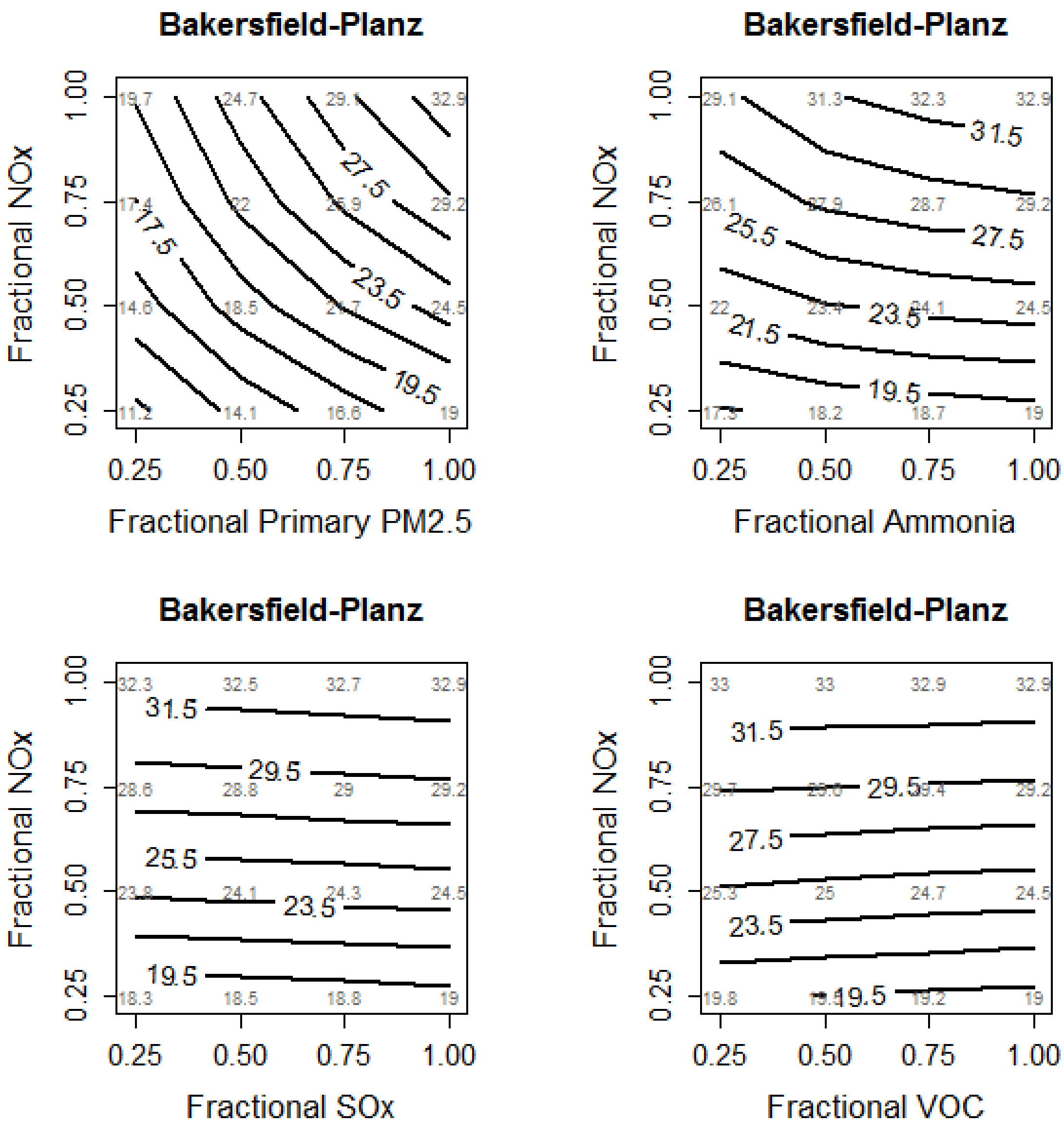


Figure 4-17 Fresno-1st Carrying Capacity Diagrams

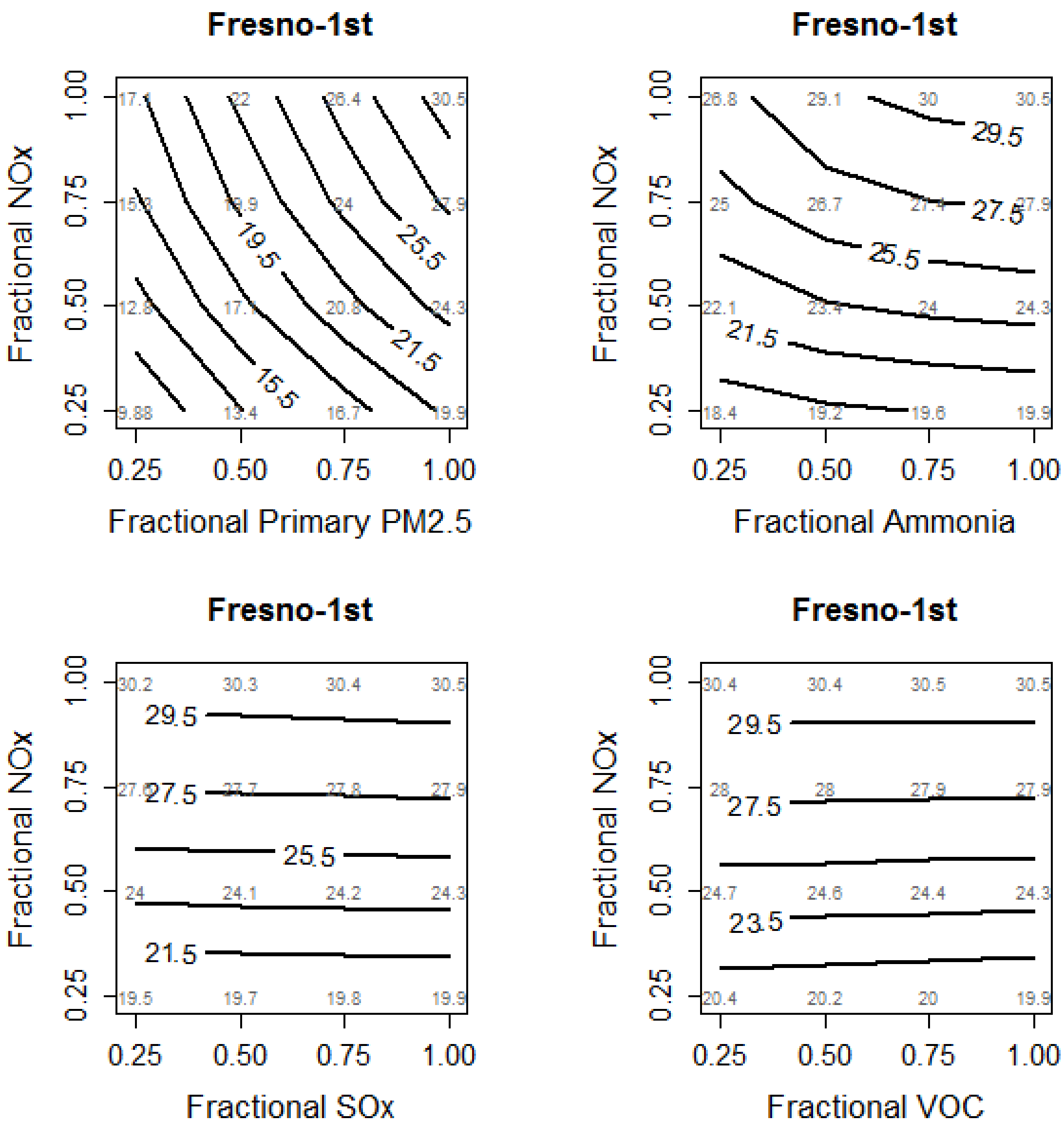


Figure 4-18 Fresno-HW Carrying Capacity Diagrams

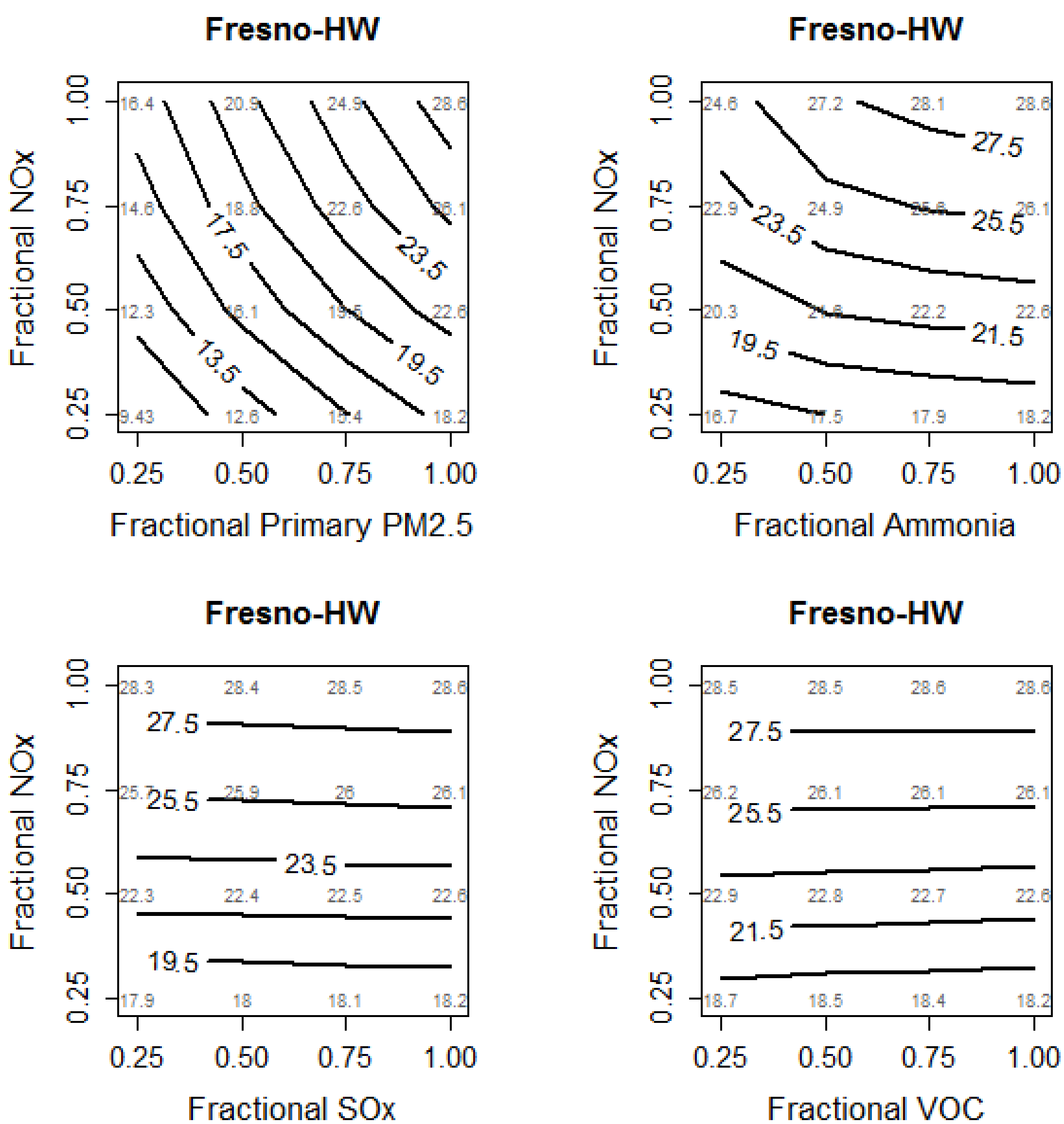


Figure 4-19 Clovis Carrying Capacity Diagrams

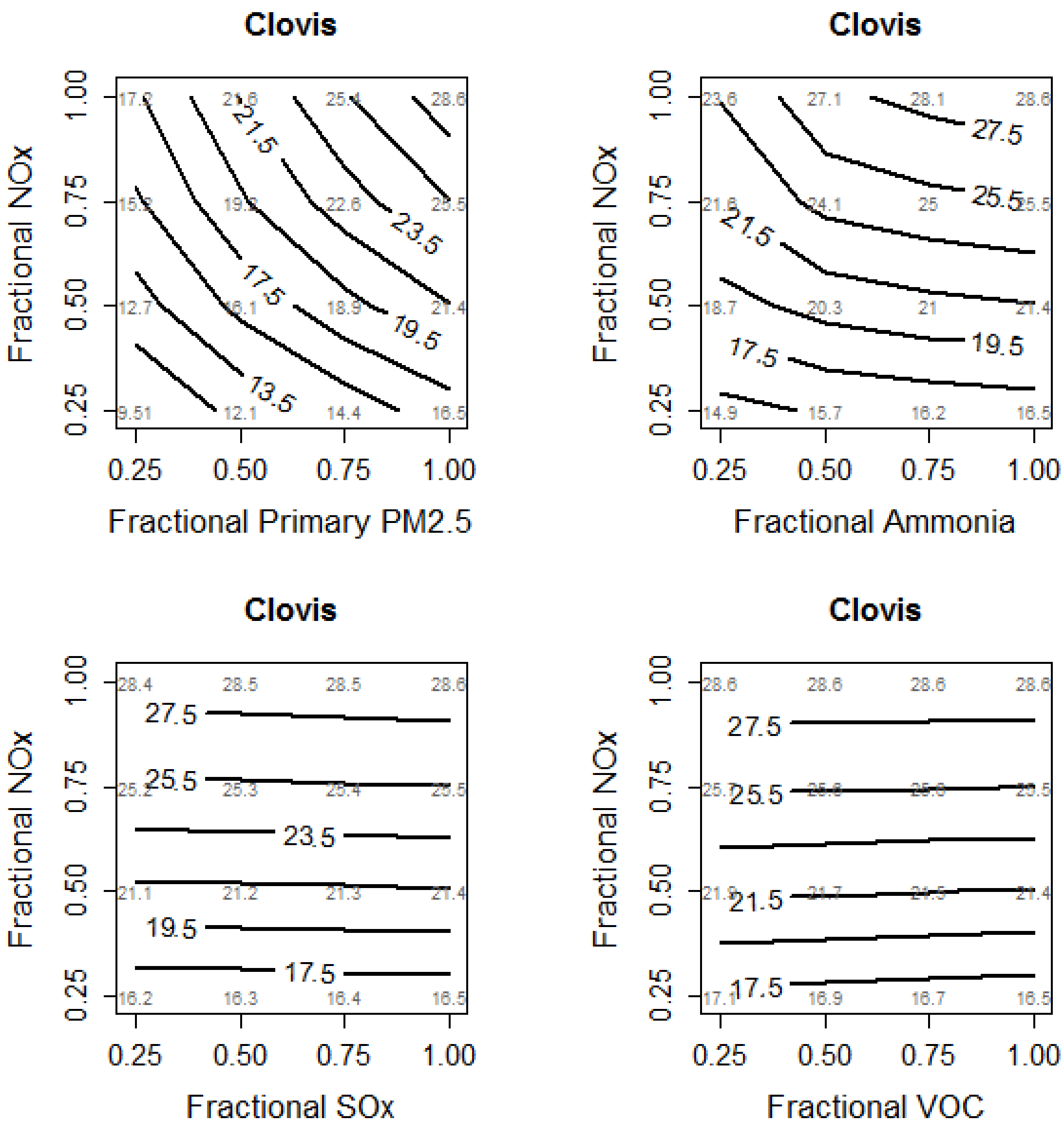


Figure 4-20 Modesto Carrying Capacity Diagrams

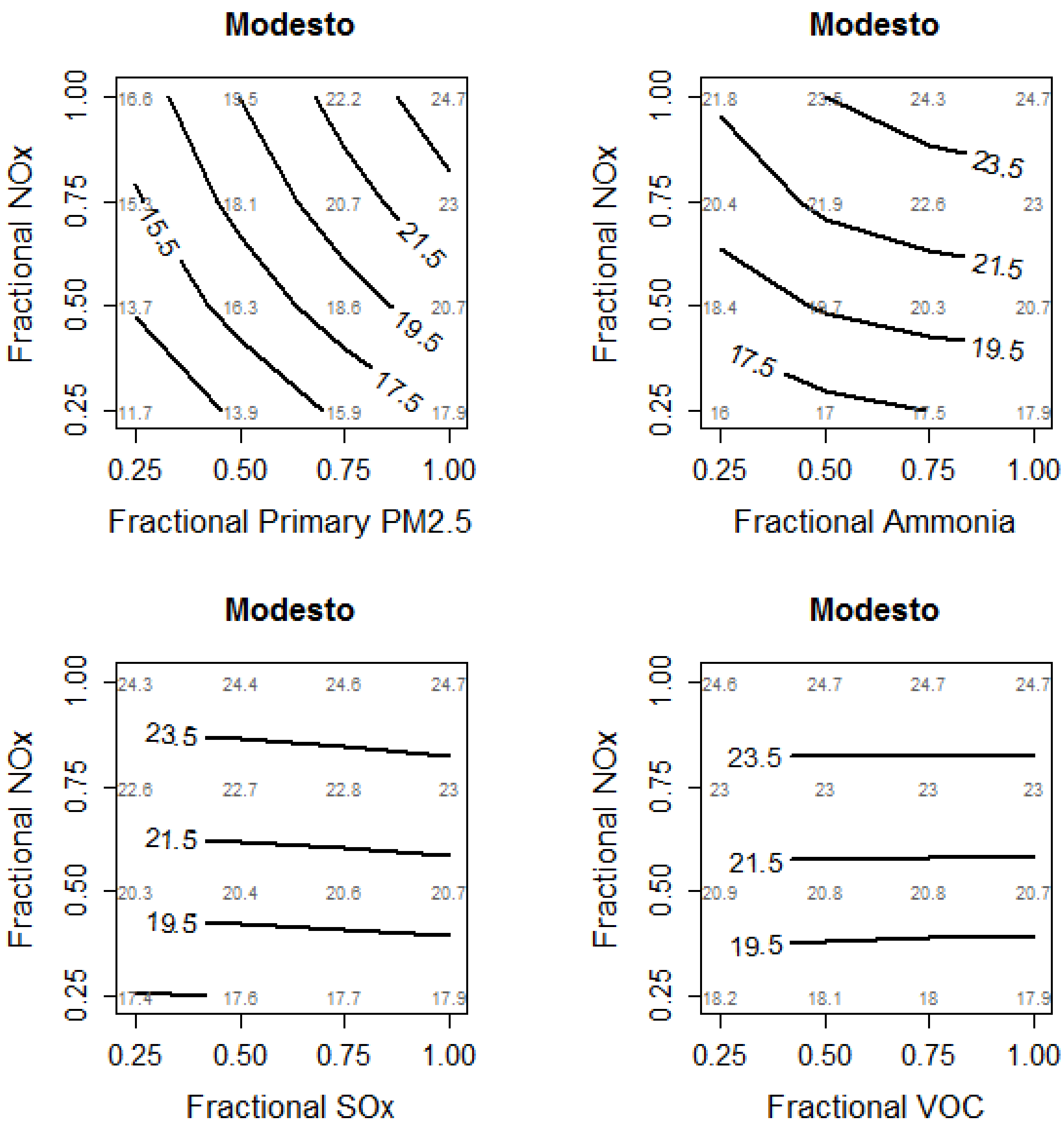


Figure 4-21 Merced Carrying Capacity Diagrams

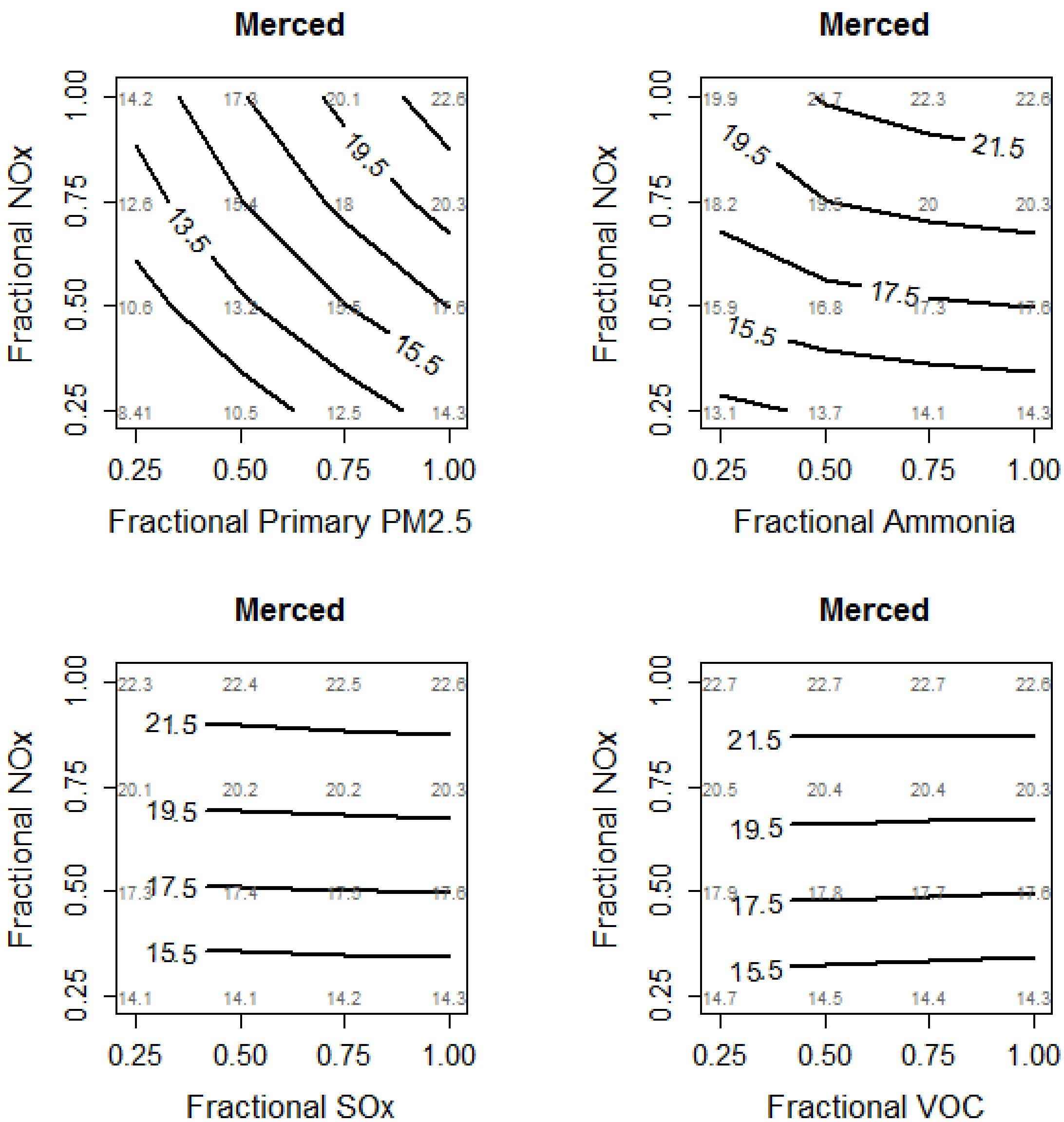


Figure 4-22 Stockton Carrying Capacity Diagrams

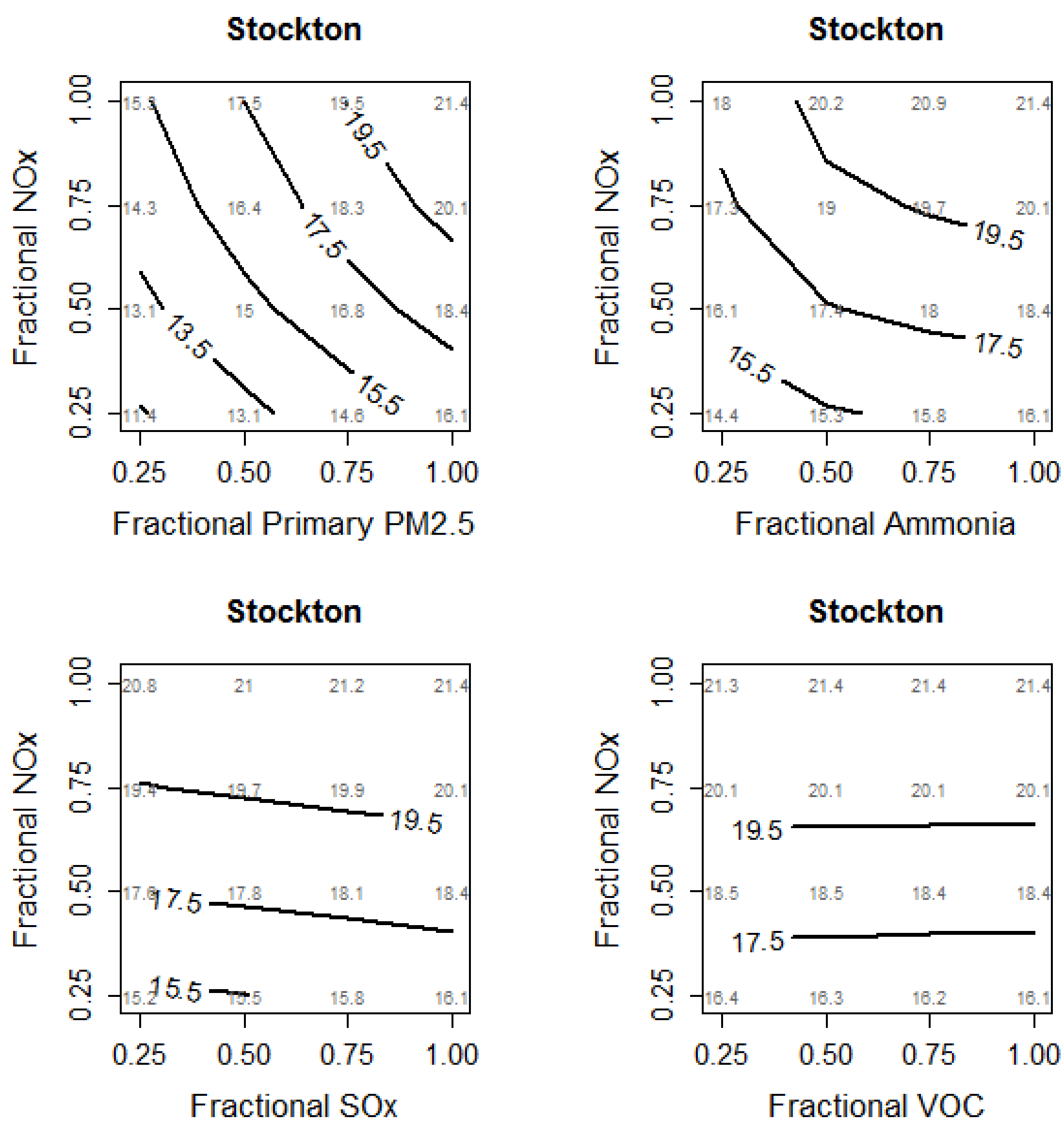


Figure 4-23 Visalia Carrying Capacity Diagrams

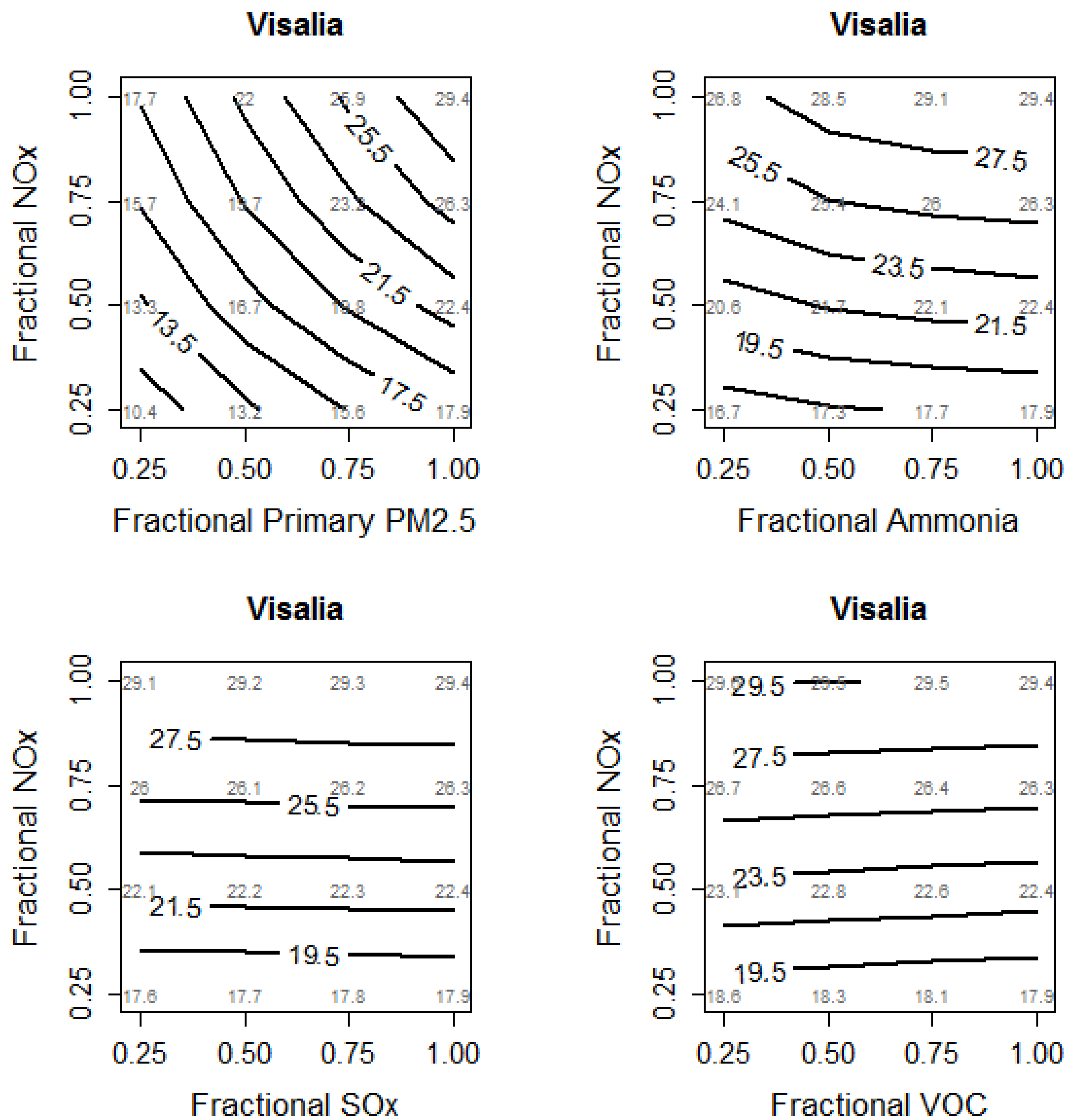
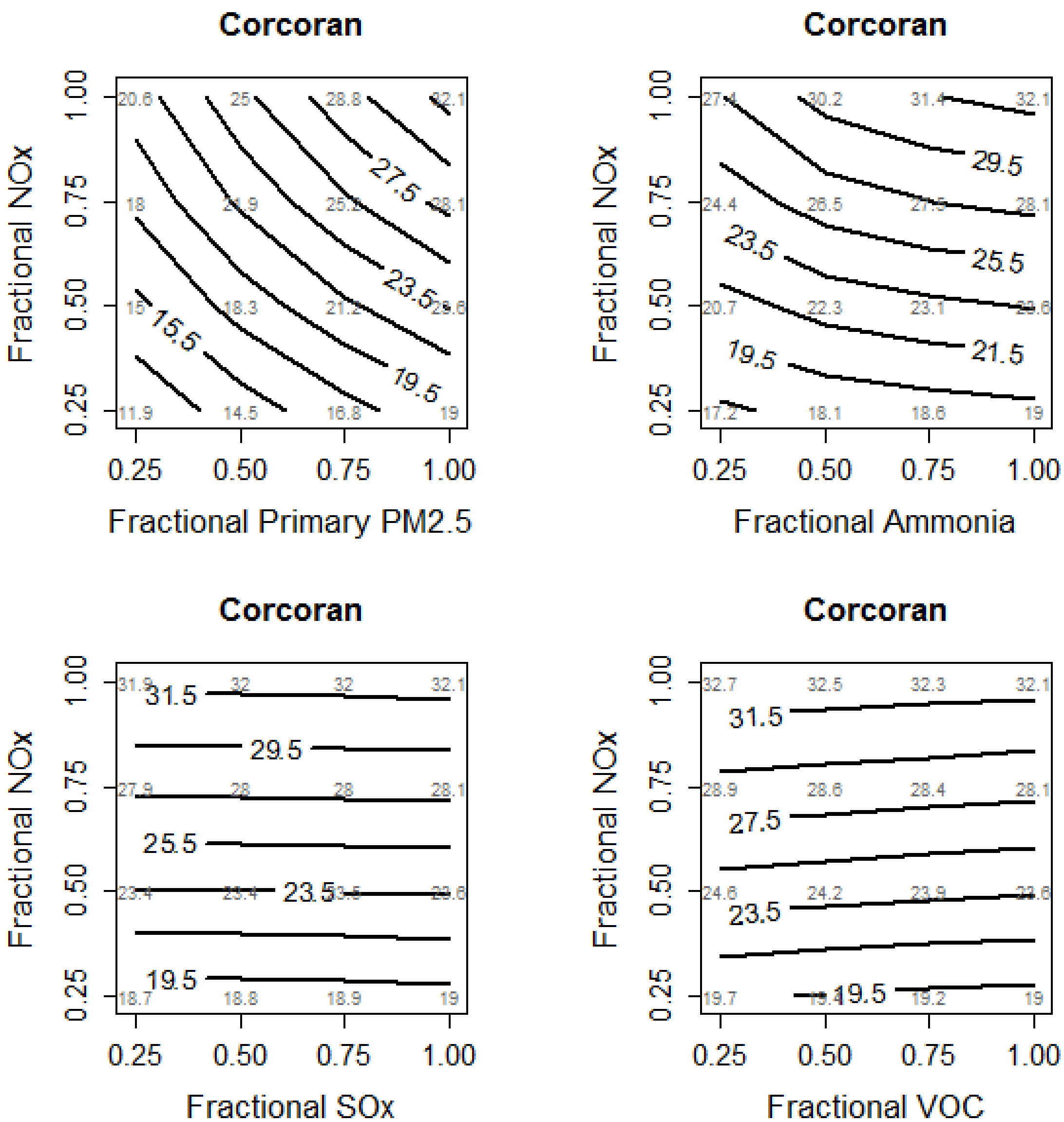


Figure 4-24 Corcoran Carrying Capacity Diagrams



Chapter 5

Control Strategy

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Chapter 5: Control Strategy

The District's strategy for attaining the 2006 PM2.5 standard is a multifaceted approach that utilizes a combination of conventional and innovative control strategies. This comprehensive strategy includes regulatory actions; incentive programs; technology advancement programs; policy and legislative platforms; public outreach, participation and communication; and additional strategies. Not only does this strategy consist of conventional and innovative strategies, but it also builds off of existing strategies, thus making this plan a fusion of existing and new measures.

This chapter focuses on regulatory control actions and additional strategies while incentives, technology advancement, and the legislative platform and community outreach efforts are discussed in Chapters 6, 7, and 8, respectively.

5.1 COMPREHENSIVE REGULATORY CONTROL STRATEGY

The San Joaquin Valley Air Pollution Control District has implemented a comprehensive regulatory control strategy over the past couple of decades. Since 1992, the District has adopted over 500 new rules and amendments to implement this aggressive control strategy. Many current rules are fourth or fifth generation, meaning that they have been revised and emission limits have been lowered, as new emission control technology has become available and cost-effective.

Air quality improvements in the Valley document the success of the District's innovative and effective rules. Previously adopted *2012 PM2.5 Plan* regulatory control measures are achieving 247.8 tons per day (tpd) of NOx reductions and 15.7 tpd of PM2.5 reductions; these measures include both stationary and area source control measures as well as ARB rules for mobile sources (see Section 5.1.2 for a listing of ARB rules and a brief discussion). The District's regulatory authority is centered on stationary sources and some area-wide sources, and the District's stringent and innovative rules on these sources, such as those for residential fireplaces, glass manufacturing, and agricultural burning, have set benchmarks for California and the nation. States and the federal government—but not regional agencies like the District—can directly regulate tailpipe emissions from mobile sources. ARB has adopted tough regulations for heavy-duty trucks, off-road equipment, and other mobile sources. However, the District has also adopted innovative regulations such as Indirect Source Review and Employer-based Trip Reduction to reduce emissions from mobile sources within the District's limited jurisdiction over these sources.

These and other District and ARB rules already guarantee that emissions will continue to be reduced over the coming years. New rules and rule amendments identified in this plan combined with other control strategies discussed in Chapters 6 through 8 will provide necessary emissions reductions to complement those already being achieved and contribute to PM2.5 air quality improvements in the Valley.

5.1.1 District Regulations Contributing to Continued PM2.5 Improvement

The District's current rules and regulations reflect technologies and methods that are far beyond minimum required control levels. In December 2010, the California Air Resources Board (ARB) determined that, based on the District's State Implementation Plans (SIP) and the evaluation of control feasibility in all rulemaking actions, the District has undertaken *all feasible measures* to reduce nonattainment air pollutants from sources within the District's jurisdiction and regulatory control.[1] This determination considered all air pollution controls and standards applicable to all source categories under the District's authority based on maximum reductions achievable as well as technological, social, environmental, energy and economic factors, including cost-effectiveness.[2]

The aggressive regulations already adopted under previous attainment plans also serve as control measures for the *2012 PM2.5 Plan.* These adopted regulations will dramatically reduce directly emitted PM2.5 and PM2.5 precursors (NOx and SOx) as they are fully implemented over the next few years, greatly contributing to the Valley's progress toward the 2006 PM2.5 standard. EPA prefers reliance on control measures that have already been adopted over ones that have yet to be approved. EPA has gone so far as to disapprove attainment plans that demonstrated an over-reliance on unapproved measures. As such, the recognition of recently adopted and implemented District and ARB control measures is an important component of this plan.

Table 5-1 and the discussion that follows summarize adopted District rules achieving new emissions reductions after 2007, the base year for this plan. However, even pre-2007 emissions reductions, such as those achieved through the District's Conservation Management Practices (CMP) rule (Rule 4550) and Regulation VIII (Fugitive PM10 Prohibitions), are contributing and will continue to contribute to the Valley's progress toward the 2006 PM2.5 standard.

[1] ARB Executive Order G-10-126. (2010, December 10), required under California Health and Safety Code §40612.
[2] California Administrative Code, Title 17 §70600(a)(1). (2012)

Table 5-1 Adopted District Rules

District Rule	Adoption/ Amendment Date(s)	Emissions Reduced[1] (tons per day)
Rule 4103 Open Burning	05/19/2005 05/17/2007 04/15/2010	0.12 tpd NOx 0.34 tpd PM2.5
Rule 4106 Prescribed Burning and Hazard Reduction Burning	1/21/2001	NQ [4]
Rule 4204 Cotton Gins	2/17/2005	0.79 tpd PM
Rule 4307 Boilers, Steam Generators, and Process Heaters 2 to 5 MMBtu/hr	12/15/2005 04/20/2006 10/16/2008 05/19/2011	3.36 tpd NOx
Rule 4308 Boilers, Steam Generators, and Process Heaters 0.075 to <2 MMBtu/hr	10/20/2005 12/17/2009	3.30 tpd NOx
Rule 4309 Dryers, Dehydrators, and Ovens	12/15/2005	0.65 tpd NOx
Rule 4311 Flares	06/15/2006 06/18/2009	0.06 tpd SOx
Rules 4306 & 4320 Boilers, Steam Generators, and Process Heaters >5 MMBtu/hr	03/17/2005 10/16/2008	3.50 tpd NOx 3.60 tpd SOx
Rule 4352 Solid Fuel Fired Boilers, Steam Generators and Process Heaters	05/18/2006 12/15/2011	NQ [4]
Rule 4354 Glass Melting Furnaces	08/17/2006 10/16/2008 09/16/2010 05/19/2011	3.37 tpd NOx 1.70 tpd SOx 0.11 tpd PM2.5
Rule 4550 Conservation Management Practices	08/19/2004	34.2 tpd PM
Rule 4692 Commercial Charbroiling	09/17/2009	0.08 tpd PM2.5
Rule 4702 Internal Combustion Engines	6/16/2005 04/20/2006 01/18/2007 08/18/2011	22.43 tpd NOx
Rule 4703 Stationary Gas Turbines	08/17/2006 09/20/2007	2.20 tpd NOx
Rule 4901 Wood Burning Fireplaces and Wood Burning Heaters	10/16/2008	2.40 tpd PM2.5 [2]
Rule 4902 Residential Water Heaters	03/19/2009	1.03 tpd NOx
Rule 4905 Natural Gas-Fired, Fan-Type Residential Central Furnaces	10/20/2005	2.6 tpd NOx
Regulation VIII Rules Fugitive PM10 Prohibitions	08/19/2004	20.4 tpd PM
Rule 9310 School Bus Fleets	09/21/2006	0.8 tpd NOx 0.03 tpd of PM2.5
Rule 9410 Employer-based Trip Reduction	12/17/2009	0.6 tpd NOx
Rule 9510 Indirect Source Review	12/12/2005	2.2 tpd NOx [3] 1.4 tpd PM

1. Total emissions reduced upon full implementation of all listed rule amendments.
2. As an average for November – April; the reductions on any given "No Burn" day are much higher.

3. Though ISR is achieving real emissions reductions, these reductions are not credited in the State Implementation Plan, per EPA's May 9, 2011 approval of the ISR rule. http://www.gpo.gov/fdsys/pkg/FR-2011-05-09/pdf/2011-11133.pdf. As such, the emissions reductions from ISR are not incorporated in this plan's emissions inventories, nor are these emissions reductions credited in this plan's Reasonable Further Progress (RFP) or the attainment demonstrations.
4. NQ = not quantified

Rule 4103 Open Burning

The provisions of Rule 4103 apply to open burning conducted in the Valley and, in conjunction with the District's Smoke Management System (SMS), have reduced the total acreage of agricultural materials burned in the Valley by 80% since 2002. After working extensively with stakeholders to understand viable alternatives to burning and associated costs, the District provided recommendations for allowing or prohibiting the open burning of agricultural material categories in the District's *2010 Final Staff Report and Recommendations on Agricultural Burning*. The April 2010 amendments to Rule 4103 incorporate California Health and Safety Code requirements and require the District to review its determinations for any postponed crops and materials at least once every five years. The recommendations adopted as a result of the *2010 Final Staff Report and Recommendations on Agricultural Burning* result in a reduction of 0.12 tons per day (tpd) of NOx and 0.34 tpd of PM2.5 emissions.

Rule 4106 Prescribed Burning and Hazard Reduction Burning

Since the adoption of Rule 4106, the District has developed cooperative relationships with land management agencies (LMAs), which are the agencies that regularly conduct prescribed burning operations. The District advises LMAs on which days would be the most conducive for igniting a burn project, based on air quality and meteorological conditions. This collaborative effort ensures that the ignition of burn projects occurs when air quality and dispersion conditions are favorable, thus lessening the health impacts on Valley citizens and on air quality in the Valley. The adoption of Rule 4106 was not aimed at reducing the total emissions from this category, as the District recognizes the importance of both prescribed burning and hazard reduction burning; rather, the adoption of Rule 4106 established tools that the District could use to manage smoke emissions in the Valley.

Rule 4204 Cotton Gins

Rule 4204 is among the most stringent rules in the nation for cotton gins and cotton ginning operations. Agricultural stakeholders and interested groups participated extensively throughout the rule development process in 2005. The rule requires the installation of 1D-3D cyclones, a PM control device, onto each cotton gin which has significantly reduced PM emissions from this source category. The final compliance deadline for these units came into effect in 2008. This rule results in 0.79 tpd of PM emissions reductions.

Rule 4307 Boilers, Steam Generators, and Process Heaters 2 to 5 MMBtu/hr

Rule 4307 is the most stringent rule in the country for controlling emissions from fuel combustion-producing heat and energy for manufacturing and processing purposes. Emissions from these units are generally controlled through either combustion modification or exhaust gas treatment. Recent amendments strengthened the rule by removing some exemptions, imposing NOx limits of 9 or 12 ppmv for new and replacement units, and adding a menu approach for particulate matter control that includes SOx controls. While offering affected businesses cost-effective compliance options, this rule will generate 3.36 tpd of NOx reductions by the final compliance deadline in 2015.

Rule 4308 Boilers, Steam Generators, and Process Heaters 0.075 to < 2 MMBtu/hr

Adopted in 2005 and amended in 2009 to enforce lower NOx limits, Rule 4308 controls emissions from boilers, steam generators, and process heaters in the size range of 0.075 to less than 2 MMBtu/hr. The District amended this rule through an extensive public process involving the public and other air districts to receive feedback on what emissions limits were feasible and could achieve the greatest emissions reductions. As a point-of-sale rule, and not a rule forcing replacement by a particular date, emissions are reduced when consumers replace older units with newer, low-NOx units as of the January 1, 2011, compliance date. The District will achieve 1.64 tpd of NOx reductions by 2019 and 3.30 tpd of NOx reductions by full implementation in 2031, based on an average equipment life of 20 years.

Rule 4309 Dryers, Dehydrators, and Ovens

The District adopted Rule 4309 in 2005 to enforce NOx emission limits between 3.5-12 ppmv for four categories of equipment. Representatives of affected industries and interested groups participated extensively throughout the rule development process. The rule requirements limit combustion NOx emissions from dryers, dehydrators, and ovens. These sources generally use either combustion modification technologies or post combustion flue gas clean-up to achieve the NOx limits in the rule. The final compliance deadline for these units came into effect in 2009. This rule results in 0.65 tpd of NOx emissions reductions.

Rule 4311 Flares

Amended on June 18, 2009, Rule 4311 controls emissions from industrial flares used at oil and gas production facilities, sewage treatment plants, waste incineration and petroleum refining operations. The 2009 amendments require flare operators to submit flare minimization plans, perform additional monitoring and record keeping, submit reports of planned and unplanned flaring activities to the District, and meet petroleum refinery SO2 performance targets. When fully implemented in 2017, this rule is expected to reduce SOx emissions by 0.06 tpd.

Rule 4320 Boilers, Steam Generators, and Process Heaters > 5 MMBtu/hr

The District adopted Rule 4320 in 2008, with multiple generations of Rules 4305 and 4306 preceding this rule to regulate this source category. This rule is the most stringent rule in the nation for controlling emissions from fuel combustion-producing heat and energy for manufacturing and processing purposes, and it is equivalent to BACT standards for this source category. Facilities generally control emissions from these sources through combustion modification or exhaust gas treatment. This rule and the 2005 amendment of Rule 4306 will generate 3.5 tpd of NOx reductions and 3.6 tpd of SOx reductions upon full implementation in 2014. Rule 4306 generated 0.2 tpd of NOx reductions with the 2005 rule amendment, assuming 25% of the food industry took advantage of the enhanced NOx limits option put into the rule. The remaining 3.3 tpd of NOx reductions and 3.6 tpd of SOx reductions come from the 2008 adoption of Rule 4320. However, per EPA's approval of Rule 4320, Rule 4320 emission reductions cannot be directly credited in the District's SIP because a portion of the reductions result from an emissions fee compliance option.[3]

Rule 4352 Solid Fuel Fired Boilers, Steam Generators, and Process Heaters

Rule 4352 was adopted in 1994 and has since been amended three times. It is one of the most stringent rules in the country for this source category. Facilities subject to this rule have invested millions of dollars to implement innovative control technologies and have significantly reduced emissions from solid fuel fired boilers. Previous rule-amending projects for Rule 4352 have not quantified specific emissions reductions because the rule amendments were meant to satisfy EPA RACT requirements and all units were determined to be operating at or below the proposed emission limits. However, the increased presence of biomass facilities in the Valley, from either new facilities or other solid fuel fired boilers that have converted to biomass, continues to significantly reduce NOx and PM emissions from open burning practices. To date, agricultural burning has been reduced by 70% and approximately 90% of agricultural burning is projected to be eliminated in the coming years. In addition, the NOx limits in Rule 4352 have continually been revised to ensure that facilities are complying with the most stringent NOx limits possible, and that new facilities would also be required to implement effective emission control technologies to comply with the stringent emissions limits.

Rule 4354 Glass Melting Furnaces

District Rule 4354, adopted in 1994 and subsequently amended six times, is one of the most stringent rules in the nation for controlling NOx, SOx, and PM emissions from industrial glass manufacturing plants that make flat glass (window and automotive windshields), container glass (bottles and jars), and fiberglass (insulation). Recent amendments include more stringent NOx emission limits based on BACT level controls for container glass, fiberglass, and flat glass. The rule gives special consideration to container glass and fiberglass manufacturers who use 30% post-consumer materials under the state glass recycling regulations. The rule also includes a technology forcing limit for flat glass furnaces. As a result of this stringent prohibitory rule and continuing efforts on behalf of this industry to reduce emissions, the Valley's glass melting furnaces use low-NOx firing technology. With compliance deadlines through January 1, 2014, this rule is expected to reduce an additional 3.28 tpd of NOx emissions, 1.12 tpd of SOx emissions, and 0.11 tpd of PM2.5 emissions when fully implemented.

Rule 4550 Conservation Management Plans

Rule 4550 was adopted to help bring the Valley into attainment of federal PM10 standards, and applies to on-field farming and agricultural operation sites located within the Valley. Rule 4550 was the first rule of its kind in the nation to target fugitive

[3] Revisions to the California State Implementation Plan (SJVUAPCD Rule 4320); Proposed and Final Rules. 75 Fed. Reg. 214, pp. 68294–68296. (2010, November 5). Retrieved from http://www.gpo.gov/fdsys/pkg/FR-2010-11-05/pdf/2010-28019.pdf. And 76 Fed. Reg. 58. (2011, March 25). Retrieved from http://www.gpo.gov/fdsys/pkg/FR-2011-03-25/pdf/2011-7090.pdf.

particulate emissions from agricultural operations, and it has served as a model for other regions. The District worked extensively with numerous stakeholders, growers, and the Agricultural Technical Committee for the San Joaquin Valleywide Air Pollution Study Agency (AgTech) for two years prior to developing the Conservation Management Practices (CMP) Rule. The District also worked with agricultural stakeholders and other agencies, such as the Natural Resources Conservation Service (NRCS), following rule adoption to ensure affected sources were assisted as much as possible in understanding and complying with the requirements of Rule 4550. Through this rule, PM emissions have been reduced by 35.3 tons per day. Similarly, implementation of Rule 4550 by agricultural operations has resulted in the reduction of PM2.5 emissions through the reduction of passes of agricultural equipment and implementation of other conservation practices.

Rule 4692 Commercial Charbroiling

District Rule 4692 reduces PM emissions by requiring catalytic oxidizers for chain-driven charbroilers, including those used in many typical fast-food restaurants. Rule 4692 is among the most stringent rules in the nation for controling emissions from commercial charbroiling operations. The original rule, adopted in March 2002, reduced PM2.5 emissions from chain-driven charbroilers by 84%. The September 2009 rule amendment expanded rule applicability to more chain-driven charbroilers. Rule 4692 has been fully implemented since 2011, reducing PM2.5 emissions by 0.018 tpd. The District also created a $500,000 pilot Charbroiler Incentive Program (CHIP) to fund the installation of PM2.5 controls on under-fired charbroilers and further investigate the economic feasibility and availability of such controls.

Rule 4702 Internal Combustion Engines

The District has amended Rule 4702 four times since 2005 to implement NOx limits for agricultural operations engines, implement more stringent NOx limit for non-agricultural operations (non-AO) engines, and to extend rule applicability to units 25–50 brake horsepower (bhp). With multiple generations of rule amendments, Rule 4702 is the most stringent rule in the nation for this source category. Facilities generally control NOx emissions that result from the fuel combustion of internal combustion engines with advanced technologies, such as selective non-catalytic reduction and selective catalytic reduction. The most recent rule amendments in 2011 lowered NOx limits for non-AO engines and will achieve an additional 1.43 tpd in NOx reductions by the final compliance deadlines in 2018.

Rule 4703 Stationary Gas Turbines

The District most recently amended Rule 4703 in September 2007 to reduce the NOx limits for existing stationary gas turbines that are 10 megawatts (MW) or less. This amendment achieved additional NOx emissions reductions from turbines used for cogeneration of electrical energy and steam for thermally enhanced oil recovery operations in the Valley. This rule equals or exceeds the most stringent source control of any air district in California by requiring BACT at these facilities. The District designed compliance schedules to allow reasonable time for completing modification and retrofit actions during scheduled overhauls of the gas turbines. The most recent rule amendment achieves an additional 2.2 tpd of NOx reductions upon full implementation and compliance deadline of January 1, 2012.

Rule 4901 Wood-Burning Fireplaces and Wood-Burning Heaters
The District amended Rule 4901 on October 16, 2008 nearly one year ahead of the deadline in the corresponding plan commitment to reduce the wood-burning curtailment threshold. Through this rule and the District's corresponding Check-Before-You-Burn program, the District prohibits use of wood-burning fireplaces and wood-burning heaters in areas with natural gas service when air quality is forecast to be above 30 µg/m³ of PM2.5. Rule amendments have reduced PM2.5 emissions by an average 2.4 tpd, as averaged over the months of November through April; reductions on any given No-Burn day are much higher.

Rule 4902 Residential Water Heaters
The District adopted Rule 4902 on July 17, 1993 to control NOx emissions from natural gas-fired residential water heaters with heat input rates less than or equal to 75,000 Btu/hr by enforcing NOx emissions limit of 40 nanograms of NOx per Joule of heat output (ng/J). The District amended Rule 4902 in 2009 to strengthen the rule by lowering the limit to 10 ng/J for new or replacement water heaters and to a limit of 14 ng/J for instantaneous water heaters. Retailer compliance dates ranged from 2010 to 2012, depending on the unit type. On and after the applicable compliance date, retailers have been required to sell only units complying with the new limits. As a point-of-sale rule, complying units are installed as pre-existing units require normal replacement and as other new units are needed. The rule has controlled NOx emissions by approximately 88% for this source category. The 2009 amendments reduced an additional 0.5 tpd of NOx.

Rule 4905 Natural Gas-Fired, Fan-Type Residential Central Furnaces
Rule 4905 was adopted in 2005 to establish NOx limits for residential central furnaces supplied, sold, or installed in the Valley with a rated heat input capacity of less than 175,000 Btu/hour. The rule set a NOx emission limit of 0.093 pounds per million Btu of heat output (lb/MMBtu) for all units. As a point-of-sale rule, and not a rule forcing replacement by a particular date, emissions are reduced when consumers replace older units with newer, low-NOx units as of the January 1, 2007 compliance date. The current rule will achieve 2.6 tpd of NOx reductions. The District has committed to amending Rule 4905 in 2014, which will lower NOx emission limits for these units even further and create additional NOx emissions reductions for this source category.

Rule 9310 School Bus Fleets
The District adopted Rule 9310 in September 2006 to limit NOx, PM, and diesel toxic air contaminants from school bus fleets. Diesel-fueled school bus fleet operators must replace or retrofit all of their school buses to meet the applicable ARB and EPA emission standards for engines by 2016. The rule also requires all existing gasoline or alternative-fueled school buses and any diesel school buses manufactured after October 1, 2002 to be operated according to manufacturer specifications and, if replaced, shall meet all applicable ARB and EPA current-year emissions standards for the year of delivery of that school bus engine and fuel type.

Rule 9410 Employer-Based Trip Reduction (eTRIP Rule)
Although the District does not have authority to regulate tailpipe emissions, the District can adopt regulatory approaches to promote the reduction of vehicle miles traveled. The goal of the eTRIP Rule is to reduce single-occupancy-vehicle work commutes. The eTRIP Rule requires the Valley's larger employers, representing a wide range of locales and sectors, to select and implement workplace measures that make it easier for their employees to choose ridesharing and alternative transportation. Because of the diversity of employers covered by the eTRIP Rule, the rule was built with a flexible, menu-based approach. Using the Employer Trip Reduction Implementation Plan (eTRIP), employers choose from a list of measures, each contributing to a workplace that encourages employees to reduce their dependence on single-occupancy vehicles. Each eTRIP measure has a point value, and employer eTRIPs must reach specified point targets for each strategy over a phased-in compliance schedule (2010 – 2015). The District has continually provided employer assistance through training, guidance materials, promotional information, and online reporting options. Upon full implementation, the eTRIP Rule will reduce NOx and VOC emissions from passenger vehicle commute trips by approximately 1.2 ton per day. See www.valleyair.org/tripreduction.htm for further information about the eTRIP Rule.

Rule 9510 Indirect Source Review (ISR)
The District's adoption of Rule 9510 in 2005 was the first time in the nation that an air agency used regulation to control emissions from indirect sources. Clean Air Act Section 110(a)(5)(C) defines an indirect source as a "facility, building, structure, installation, real property, road, or highway which attracts, or may attract, mobile sources of pollution." The District's ISR rule reduces mobile source emissions from new development projects. ISR's on-site mitigation component encourages beneficial changes in land development patterns and practices. The off-site mitigation option applies assessed ISR fees to the District's cost-effective emissions reductions incentive programs. The District conducts extensive outreach on ISR and prepares an annual report on ISR implementation. The District's 2010, 5-year evaluation of ISR implementation noted that, in spite of economic downtown in the construction industry, ISR has achieved emission reductions and has resulted in positive changes in land development practices and processes in the Valley. No other air district has a rule quite like the District's ISR rule. As such, the District's rule is the most stringent and effective ISR rule.

Regulation VIII Fugitive PM10 Prohibitions
In 2004, the District adopted amendments to Regulation VIII to upgrade existing RACM level rules to meet the more stringent BACM level required in serious PM10 nonattainment areas. These regulations are just as stringent if not more stringent than fugitive dust regulations at other air districts and comparable federal regulations. Regulation VIII prohibitory standards are performance based, whereby the operators are allowed to determine the control technique sufficient to limit visible dust emissions to 20 percent opacity and, in certain instances, to implement requirements for a stabilized surface. Dust control plans, test methods and standards, and recordkeeping requirements are the major provisions required under Regulation VIII. The 2004 amendments to Regulation VIII achieved approximately 20.4 tons per day of PM

reductions and were critical in the District's attainment of the National Ambient Air Quality Standard for PM10.

5.1.2 ARB Regulations Contributing to Continued PM2.5 Improvement

Since 1989, ARB has adopted and amended a number of regulations aimed at reducing exposure to diesel PM and NOx from fuel sources, freight transport sources like heavy-duty diesel trucks, transportation sources like passenger cars and buses, and off-road sources like large construction equipment. These regulations have significantly reduced PM2.5 precursors and direct PM2.5 emissions throughout the Valley.

Table 5-2 below includes a list of all the regulations adopted or amended by ARB from 2000 to 2011. Phased implementation of these regulations are producing increasing emission reduction benefits until 2019 and beyond as the regulated fleets are retrofitted, and as older and dirtier fleet units are replaced with newer and cleaner models at an accelerated pace. Several rules in particular; including Cleaner In-Use Heavy Duty Trucks, Cleaner In-Use Off-Road Equipment, Advanced Clean Car Program, Enhanced Fleet Modernization Program, and the Enhanced Smog Check Program, will be achieving significant emissions reductions critically needed to attain the standard under this plan.

In addition, ARB and District staff are working closely to identify and distribute incentive funds to accelerate dirty engine replacement. Key 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.

Table 5-2 Adopted ARB Regulations

ARB Regulation	Adoption Date	Category
Advanced Clean Car Program	1/27/2012	On-road
Expanded Off-Road Recreational Vehicle Emission Standards	12/16/2011	Off-road
Cleaner In-Use Off-Road Equipment	12/17/2010	Off-road
Port Truck Modernization	12/17/2010	Off-road
Cleaner In-Use Heavy-Duty Trucks	12/16/2010	On-road
Accelerated Introduction of Cleaner Line-Haul Locomotives	06/24/2010	Other
Enhanced Fleet Modernization Program (formerly called the Expanded Vehicle Retirement Program)	06/24/2010	On-road
Smog Check Improvements	08/31/2009	On-road
Portable Outboard Marine Tanks	09/25/2008	Off-road
Clean Up Existing Harbor Craft	11/15/2007	Other
Voluntary Accelerated Retirement Regulation	12/07/2006	On-road
Emergency Regulation for Portable Equipment Registration Program, Airborne Toxic Control Measures and Portable and Stationary diesel-Fueled Engines	12/06/2006	Off-road
Airborne Toxic Control Measure for Stationary Compression Ignition Engines (Agricultural Eng. Exemption removal)	11/16/2006	Other
Distributed Generation Guidelines and Regulations	10/19/2006	Other

ARB Regulation	Adoption Date	Category
Zero Emission Bus Regulation	10/19/2006	On-road
Heavy-Duty In-Use Compliance Regulation	09/28/2006	On-road
On-Board Diagnostic II	09/28/2006	On-road
Off-Highway Recreational Vehicles and Engines	07/20/2006	Off-road
California Motor Vehicle Service Information Rule	06/22/2006	On-road
Portable Equipment Registration Program	06/22/2006	Off-road
Fork Lifts and Other Industrial Equipment (Large Off-Road Spark Ignition Engines > 1 liter)	05/26/2006	Off-road
Technical Amendments to Evaporative Exhaust and Evaporative Emissions Test Procedures	05/25/2006	On-road
Diesel Verification Procedure, Warranty & In-Use	03/23/2006	On-road
AB1009 Heavy-Duty Vehicle Smoke Inspection Program	01/26/2006	On-road
Diesel Particulate Matter Control Measure for On-Road Heavy-Duty Diesel-Fueled Vehicles Owned or Operated by Public Agencies and Utilities	12/08/2005	On-road
Mobile Cargo Handling Equipment at Ports and Intermodal Rail Yards	12/08/2005	Off-road
Marine Inboard Sterndrive Engines	11/17/2005	Off-road
Requirements to Reduce Idling Emissions from New and In-Use Trucks, Beginning in 2008	10/20/2005	On-road
2007-2009 Model-Year Heavy Duty Urban Bus Engines and the Fleet Rule for Transit Agencies	09/15/2005	On-road
Portable Fuel Containers (PFC) [Part 1 of 2]	09/15/2005	Off road
Portable Fuel Containers (PFC) [Part 2 of 2]	09/15/2005	Off road
On-Board Diagnostic System Requirements for 2010 and Subsequent Model-Year Heavy-Duty Engines (HD OBD)	07/21/2005	On-road
Airborne Toxic Control Measure for Stationary Compression Ignition Engines amendments	05/26/2005	Other
Transit Fleet Rule	02/24/2005	On-road
Off-Road Compression Ignition Engines	12/09/2004	Off-road
Emergency Regulation for Temporary Delay of Diesel Fuel Lubricity Standard	11/24/2004	Fuels
Diesel Fuel Standards for Harbor Craft & Locomotives	11/18/2004	Fuels
Greenhouse Gas	09/23/2004	On-road
Airborne Toxic Control Measure for Diesel Particulate from Diesel Fueled Commercial Vehicle Idling	07/22/2004	On-road
Urban Bus Engines/Fleet Rule for Transit Agencies	06/24/2004	On-road
Engine Manufacturer Diagnostic System Requirements for 2007 and Subsequent Model Heavy Duty Engines	05/20/2004	On-road
Heavy Duty Diesel Engine-Chip Reflash	03/27/2004	On-road
Airborne Toxic Control Measure for Diesel-Fueled Portable Engines	02/26/2004	Off-road
Modifications to the Statewide Portable Equipment Registration Program (PERP) Regulations	02/26/2004	Off-road
CA Motor Vehicle Service Information Rule	01/22/2004	On-road
Airborne Toxic Control Measure for Diesel Particulate for Transport Refrigeration Units	12/11/2003	On-road
Airborne Toxic Control Measure for Stationary Compression Ignition Engines	12/11/2003	Other
Diesel Retrofit Verification Procedure, Warranty and In-Use Compliance Requirements Amendments	12/11/2003	On-road
Small Off-Road Engines (SORE)	09/25/2003	Off-road
Solid Waste Collection Vehicles	09/24/2003	On-road
Off-Highway Recreation Vehicles	07/24/2003	Off-road

ARB Regulation	Adoption Date	Category
Specifications for Motor Vehicle Diesel Fuel	07/24/2003	Fuels
Zero Emission Vehicle Amendments for 2003	03/25/2003	On-road
Airborne Toxic Control Measure for Diesel Particulate from School Bus Idling	12/12/2002	On-road
Low Emission Vehicles II. Align Heavy Duty Gas Engine Standards with Federal Standards; minor administrative changes	12/12/2002	On-road
Revision to Transit Bus Regulations Amendments	10/24/2002	On-road
Diesel Retrofit Verification Procedure, Warranty and In-Use Compliance Requirements	05/16/2002	On-road
On-Board Diagnostic II Review Amendments	04/25/2002	On-road
Airborne Toxic Control Measure for Outdoor Residential Waste Burning	02/21/2002	Other
Voluntary Accelerated Light Duty Vehicle Retirement Regulations	02/21/2002	On-road
California Motor Vehicle Service Information Rule	12/13/2001	On-road
Distributed Generation Guidelines and Regulations	11/15/2001	Other
Low Emission Vehicle Regulations	11/15/2001	On-road
Heavy Duty Diesel Engine Standards for 2007 and Later	10/25/2001	On-road
Marine Inboard Engines	07/26/2001	Off-road
Zero Emission Vehicle Infrastructure and Standardization of Electric Vehicle Charging Equipment	06/28/2001	On-road
Zero Emission Vehicle Regulation Update	01/25/2001	On-road
Heavy Duty Diesel Engines "Not-to-Exceed (NTE)" Test Procedures	12/07/2000	On-road
Light-and Medium Duty Low Emission Vehicle Alignment with Federal Standards. Exhaust Emission Standards for Heavy Duty Gas Engines	12/07/2000	On-road
Air Toxic Control Measure for Chlorinated Toxic Air Contaminants from Automotive Maintenance and Repair Facilities	04/27/2000	Other
Transit Bus Standards	02/24/2000	On-road
Off-Road Compression Ignition Engines	01/27/2000	Off-road

Some of the most significant regulations adopted by ARB in recent years, such as the Truck and Bus Regulation and the Off-Road Regulation, depend on truck and equipment owners playing a key role in implementation. Accordingly, ARB's approach to ensuring compliance is based on a comprehensive outreach and education effort. ARB staff develops regulatory assistance tools, conducts and coordinates compliance assistance and outreach activities, administers incentive programs, and actively enforces the entire suite of diesel regulations. ARB's goal is to provide readily accessible and clear information for all diesel rules and incentive programs.

ARB compliance assistance and outreach activities also include the following:

- Training and implementation classes conducted by ARB staff in classroom settings throughout the State, including at community colleges
- Participation at business events throughout California, giving presentations, displaying materials, providing handouts, and responding to questions
- Marketing efforts such as advertisements, press releases, a television presence, and radio spots, including public service announcements statewide
- Websites for ARB's multiple programs

Complementing these efforts, ARB and District enforcement actively provide a level playing field for the regulated entities and ensure the emission reduction benefits are achieved.

The following summaries highlight ARB's most recent key regulations, the roll out of their phased implementation deadlines and corresponding emission reduction schedule, and supporting outreach and enforcement efforts.

Cleaner In-Use Heavy-Duty Trucks (Truck and Bus Regulation)
One of the most significant rules adopted by ARB within the past five years is the Truck and Bus Regulation, adopted in December 2008. 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 these businesses and the corresponding decline in their emissions. This rule represents a multi-year effort to turn over the legacy fleet of engines and replace them with the cleanest technology available.

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 will need to be upgraded to have exhaust emissions meeting 2010 model year engine emissions levels. Replacing older, dirtier trucks sooner than they otherwise would have been retired results in lower NOx and PM2.5 emissions in 2019.

The regulation applies to nearly all privately and federally owned diesel-fueled trucks and buses with a gross vehicle weight rating (GVWR) greater than 14,000 pounds, 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.

In addition to the Truck and Bus Regulation, separate regulations reduce emissions from other public fleets, solid waste collection trucks, and transit buses. Trucks that transport marine containers must comply with the drayage truck regulation.

ARB compliance assistance and outreach activities in support of the Truck and Bus Regulation include the following:

- 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
- Out-of-state training sessions conducted by a contractor

January 1, 2012 was the first deadline for trucks to install diesel particulate filters, with reporting required by the end of March 2012. Over 200,000 trucks reported by the required deadline. To ensure the success of these requirements, in the three-month period before the compliance deadline, ARB staff spoke with over 16,000 people by phone and sent notification postcards to over 200,000 people in California and neighboring states.

ARB and District enforcement provides a level playing field for the regulated entities and ensures the emission reduction benefits are achieved. ARB staff enforce diesel regulations addressing idling, transport refrigeration units (TRU) and drayage trucks, and recently began enforcing the Truck and Bus regulation as it came up to its first compliance deadline in 2012.

In general, enforcement is conducted by doing unscheduled roadside inspections. An inspection team may typically focus on truck stops, rest stops, industrial areas, ports, environmental justice areas, and cold storage facilities. Vehicles are audited for all applicable requirements, including smoke, emission control labels, and diesel particulate filters. To expand enforcement capabilities, ARB contracts with the District and the Bay Area Air Quality Management District to conduct inspections in their respective jurisdictions.

Cleaner In-Use Off-Road Equipment (Off-Road Regulation)
Another significant rule adopted by ARB within the past five years is the Off-Road Regulation, which was first approved in 2007 and amended in 2010 in response to 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 by requiring their owners to modernize their fleets and install exhaust retrofits. 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.

Once ARB receives authorization from EPA, fleets will be subject to increasingly more 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 BACT requirements. The performance requirements of the Off-Road Regulation will be phased in from January 1, 2014, through January 1, 2019. The combined impact of the performance requirements results in steady declines in NOx and PM2.5 emissions from 2014 to 2019 and beyond.

Compliance assistance and outreach activities in support of the Off-Road Regulation include the following:

- 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 regulated operators with answers (in English, Spanish, and Punjabi) about the regulations and access to ARB staff
- The Off-road Listserv, providing equipment owners and dealerships with timely announcement of regulatory changes, regulatory assistance documents, and reminders for deadlines

ARB staff began compliance outreach in 2008 in preparation for the initial 2010 deadline. Staff is again ramping up outreach efforts in preparation for the 2014 deadline. ARB staff has sent over 50,000 postcards with compliance information to equipment owners. ARB staff began planning outreach efforts for owners of on-road trucks with two diesel engines in spring of 2012.

In general, enforcement is conducted through unscheduled fleet audits. Fleet audits are conducted when inspectors notice a trend of violations occurring for a given business. Vehicles are audited for all applicable requirements, including smoke, emission control labels, and diesel particulate filters.

Advanced Clean Cars (ACC)

Many gasoline engines now emit at near-zero emission levels of smog-forming emissions. Conventional hybrid electric vehicles have been commercialized, and the number of models offered for sale is quickly expanding. Recently, battery-electric vehicles and plug-in hybrid-electric vehicles have been introduced for sale, and fuel cell electric vehicles are expected to be sold beginning in 2015. This movement towards commercialization of advanced clean cars has occurred because of ARB's Zero Emission Vehicle (ZEV) regulation, which affects passenger cars and light-duty trucks.

Continuing its leadership role in developing innovative and ground-breaking emission control programs, ARB's ACC Program, approved in January 2012, is a pioneering *package* of regulations, that although separate in construction, each regulation is 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 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. The ZEV amendments for 2018 and subsequent model years in the ACC program approved by ARB in January 2012 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 will produce increasing benefits over time as new cleaner cars enter the fleet displacing older and dirtier vehicles. In this manner, the benefits in 2019 will be realized through the cumulative reduction in emissions achieved by new cars entering the fleet in 2017 through 2019. This program will continue to provide benefits well after 2025 as vehicles meeting the new standards replace older, higher-emitting vehicles.

Expanded Passenger Vehicle Retirement
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. Reducing emissions from the existing fleet is a component of California's SIP, which outlines the State's strategy for meeting health-based ambient air quality standards. Both State and local vehicle retirement programs are available.

California's updated 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. These vehicles are a key element of California's strategy for meeting health based air quality standards and climate change goals.

The CVRP is administered statewide by the California Center for Sustainable Energy (CCSE). In fiscal years 2009–2012, $26.1 million, including $2 million provided by the California Energy Commission, funded approximately 2,000 rebates. In June 2012, the ARB allocated $15–21 million to the CVRP as outlined in the AQIP FY2012–2013 Funding Plan.

Improvements and Enhancements to California's Smog Check Program
The following requirements were added to improve and enhance the Smog Check Program, making it more inclusive of motor vehicles and effective on smog reductions:

- Low pressure evaporative test;
- More stringent pass/fail cutpoints;
- Visible smoke test; and
- Inspection of light- and medium-duty diesel vehicles.

AB 2289, adopted in October 2010, is a new law restructuring California's Smog Check Program, streamlining and strengthening inspections, increasing penalties for misconduct, and reducing costs to motorists. This new law, sponsored by ARB and BAR, promises faster and less expensive Smog Checks by talking advantage of diagnostic software installed on all vehicles since 2000. The new law also directs vehicles without this equipment to high-performing stations, helping to ensure that these cars comply with current emission standards.

This program will reduce consumer costs by having stations take advantage of diagnostic software that monitors pollution-reduction components and tailpipe emissions. This technology, known as On-Board Diagnostics (OBD), has been required on all new vehicles since 1996. Under the new law, testing of passenger vehicles using OBD will begin mid-2013 on all vehicles model years 2000 or newer. This should result in reduced consumer costs by up to $180 million annually.

5.1.3 District VOC Regulations

The rules identified in Section 5.1.1 are adopted District rules that reduce directly emitted PM2.5 and PM2.5 precursors (NOx and SOx). As discussed in detail in Chapter 4 (Scientific Foundation and PM2.5 Modeling Results), VOCs have the potential to contribute to the formation of two different PM2.5 components: secondary organic aerosols (SOAs) and ammonium nitrate (nitrate). Recent research and modeling shows that the contribution of these components to the Valley's total observed PM2.5 concentrations is minimal, as is the contribution of anthropogenic VOCs (those not from biogenic sources) to the formation of these PM2.5 components. As such, a VOC-centric control strategy is much less effective for reducing PM2.5 concentrations than are primary PM2.5 controls or NOx controls.

Although reducing VOC emissions does not contribute to attainment of the PM2.5 standard, it does contribute to improved ozone air quality in the Valley. The District has successfully reduced VOC emissions through numerous rules adopted or amended under the *2007 Ozone Plan*. For a detailed discussion on VOC rules and emissions reduced, refer to the *2007 Ozone Plan* and the *2009 RACT SIP Demonstration* report. Two examples of VOC reducing rules include:

- **Rule 4570 Confined Animal Facilities**
  Amended on October 21, 2010, uses a best management practices approach to reduce emissions from confined animal facilities. The 2010 amendment relied on the latest scientific research and reduced 31.8 tpd VOC emissions.

- **Rule 4566 Organic Material Composting Operations**
  Adopted August 18, 2011, Rule 4566 is the result of collaborative efforts with affected stakeholders and the utilization of the best scientific information available; the rule reduces emissions through the use of watering systems or compost cover, reducing 19 tpd of VOC emissions.

5.1.4 District Ammonia Regulations

Although ammonia is among the chemical precursors that can form secondary PM2.5, research shows that ammonia controls are not effective for reducing ammonium nitrate in the Valley (see Chapter 4). Additionally, as the modeling sensitivity analysis has shown in Appendix G, reductions in ammonia emissions achieve insignificant reductions in the 2019 PM2.5 design value mass compared to reductions of direct PM2.5 and NOx emissions.

The District has already achieved significant ammonia emissions reductions through several amendments of Rule 4570, Confined Animal Facilities, which has required best management practices for manure management and other areas to reduce VOC and ammonia emissions. Despite the insignificant contribution of ammonia reductions towards attainment of the PM2.5 standard, the District has evaluated the feasibility of obtaining additional ammonia emissions reductions and has been unable to identify any additional reasonable measures. As discussed in Section 5.3.3 below, the District explored the possibility of requiring the application of sodium bisulfate (SBS), as included as a potential control measure in the South Coast Air Quality Management District's (SCAQMD) 2012 Air Quality Management Plan (AQMP), and determined that this control strategy would be ineffective, extremely costly, has potential detrimental unintended consequences, and is likely infeasible for dairies within the San Joaquin Valley. While reducing ammonia is not an effective strategy for reducing PM2.5

concentrations in the San Joaquin Valley, the District commits to continue to analyze and support studies regarding ammonia emissions at confined animal facilities, for the purpose of evaluating the potential effectiveness of additional ammonia controls on confined animal facilities in reducing PM2.5 concentrations in the Valley (discussed in more detail in Section 5.3.3, Further Study Measures).

5.2 Evaluating Control Measures for New Control Strategy Opportunities

For this plan, the District thoroughly analyzed opportunities to further reduce emissions of directly-emitted PM2.5, NOx, and SOx.[4] Appendices C and D of this plan present this analysis, organized by practice or equipment type. The control strategy resulting from this analysis reflects a multi-faceted approach to implementing emissions control technologies and practices.

While the adopted regulations noted above are achieving significant emissions reductions, more emissions reductions are needed to meet current EPA air quality standards. The District and ARB must continue to consider new control measure opportunities to ensure expeditious attainment of the 2006 PM2.5 standard.

5.2.1 Evaluation of Control Measures

The District has evaluated all sectors and equipment types for additional emission reduction opportunities. This analysis is presented in Appendices C and D of this plan. In particular, Appendix D (Stationary and Area Source Control Strategy Evaluation) focuses on sources under the District's regulatory control. The District has used the following key factors to evaluate potential emission reduction opportunities:

- **Technological Feasibility.** The District looked for any control technologies not already required that might be available to further reduce emissions from sources of air pollution in the Valley. This includes new technologies and technologies that may not have been cost-effective in the past. The technologies used in BACT guidelines; permits; and other air districts' rules, regulations, guidelines, and studies were reviewed for their feasibility, including how commercially available the technology currently is and whether the technology has been used in practice.

- **Cost-Effectiveness**. Cost-effectiveness is the cost of emissions controls compared to the amount of emissions reductions that would be achieved by those controls. The District does not have a pre-determined cost-effectiveness threshold, but control options with extremely high cost-effectiveness (high dollars per ton of pollutant reduction) can be deemed unreasonable and inappropriate for regulation.

- **Risk-based Strategy**. Through its Risk-based Strategy (RBS), the District is maximizing public health improvements resulting from the District's attainment

[4] As noted in Chapter 4 and other areas of this plan, VOC and ammonia reductions to not significantly contribute to the Valley's attainment of the 2006 PM2.5 standard.

strategies and related initiatives. As described in Chapter 2 of this plan, the District uses a five-factor exposure assessment methodology to evaluate the PM2.5 attainment strategy under the RBS and prioritize control measures that maximize public health.

Embedded in the technological feasibility and cost-effectiveness analysis is the District's evaluation of RACT and RACM. A PM2.5 plan must demonstrate that RACT and RACM are in place for direct PM2.5 and the area's relevant precursors.[5]

- **Reasonably Available Control Technology (RACT).** RACT is the lowest reasonable emissions limit that a particular source is capable of meeting, considering technological and economic feasibility of the technology. RACT changes over time as new technologies become feasible and cost-effective, thus making them reasonable to require. Therefore, the District focuses its review on changes in technologies since the last RACT demonstration. The District has conducted comprehensive reviews of all NOx and VOC rules for compliance with federal RACT requirements. For these reviews, the District evaluates all District rules against federal rules, regulations, and technology guidelines, as well as any comparable rules from California's most technologically progressive air districts. In response to the District's *2009 RACT Demonstration for Ozone State Implementation Plans* (2009 RACT SIP) and related rule amending projects, EPA has issued federal actions documenting their approval of District rules and their concurrence that District rules are at least as stringent as RACT. These efforts show that many District rules are more stringent than established RACT standards. RACT is the minimum level of control that nonattainment areas must achieve for existing sources, but because of the Valley's extensive air quality challenges, the District must continuously look beyond RACT.

- **Reasonably Available Control Measures (RACM).** Whereas RACT is specific to an emissions source, RACM is a collection of measures that, taken as a group, advance attainment of an air quality standard by at least one year.

RACT and RACM are, by definition, reasonable. Although air quality attainment plans must include a thorough analysis of reasonably available measures, it need not analyze every conceivable measure; reasonableness must drive the analysis. The District would not require any measure that is absurd, unenforceable, impractical, or that would cause severely disruptive socioeconomic impacts (e.g., gas rationing and mandatory source shutdowns). RACT is discussed throughout Appendix D. Chapter 9 of this plan synthesizes how this plan's control strategy meets RACM requirements.

[5] Clean Air Fine Particle Implementation Rule [PM2.5 Rule], 72 Fed. Reg. 79, pp. 20610-20612. (2007, April 25). Available at http://www.gpo.gov/fdsys/pkg/FR-2007-04-25/pdf/E7-6347.pdf

5.2.2 Control Strategy Commitments

The District's thorough evaluation of control measures for potential opportunities to further reduce emissions, as discussed in Section 5.2.1, resulted in numerous commitments for future actions on the part of the District, not all of which are regulatory actions. As noted at the beginning of this chapter, the District is using a multi-faceted emissions control approach to reach beyond traditional regulations with innovative approaches. Some control measure opportunities are not appropriate for regulatory commitments at the time of plan adoption. Reasons for this include limits on the District's regulatory authority, costs, a need for additional information, the need for technology development, and the need to demonstrate the technology in practice. The opportunities that are better suited for incentive programs, technology demonstration, and other approaches are discussed in Chapters 6, 7, and 8. These combined efforts expedite emissions reductions and pave the way for future regulatory measures that might be needed under upcoming attainment plans for future EPA air quality standards.

5.3 NEW CONTROL MEASURES

The District is committing to five rule projects, including one new rule and four amendments to existing rules. The District evaluated these control measures based on the review criteria described in Section 5.2 and will develop the rule projects using a public rule development process as described in Section 5.3.2.

5.3.1 Regulatory Control Measure Commitments

Based on the control measure analyses in Appendices C and D, and the attainment needs identified through the photochemical modeling and other air quality analyses of this plan, the District proposes the regulatory control measures shown in Table 5-3, and as discussed in further detail below.

Table 5-3 Regulatory Control Measure Commitments

Rule	Amendment Date	Compliance Date	Emissions reductions*
Rule 4308 Boilers, Steam Generators, and Process Heaters 0.075 to <2 MMBtu/hr	2013	2015	TBD
Rule 4692 Commercial Charbroiling	2016	2017	0.4 tpd PM2.5
Rule 4901 Wood Burning Fireplaces and Wood Burning Heaters	2016	2016/2017	1.5 tpd of PM2.5
Rule 4905 Natural Gas-Fired, Fan-Type Residential Central Furnaces	2014	2015	TBD
Rule 9610 SIP-Creditability of Incentives	2013	2013	TBD
* Based on full implementation and best available information as of this plan. A more thorough evaluation of control techniques and feasibility will be conducted at the time of rule development.			

Rule 4308 Boilers, Steam Generators, and Process Heaters 0.075 to <2 MMBtu/hr

Analysis for this *2012 PM2.5 Plan* indicates that lowering the NOx emission limit for instantaneous water heaters in the size range of 0.075–0.4 MMBtu/hr is technologically feasible and cost-effective. The District therefore commits to amend Rule 4308 in 2013 to lower the NOx emission limit for instantaneous water heaters in the size range of 0.075–0.4 MMBtu/hr from the current level of 55 ppmv to 20 ppmv with an anticipated compliance date of 2015.

Rule 4692 Commercial Charbroiling

Existing Rule 4692 achieves significant emissions reductions from chain-driven charbroilers; however, the rule does not require emissions controls for under-fired charbroilers. Analysis for the *2012 PM2.5 Plan* indicates that extending the applicability of the rule to under-fired units could further reduce PM2.5 emissions by 20% (0.4 tpd PM2.5) from the baseline inventory for under-fired charbroilers upon implementation in 2017. The modeling conducted for this plan shows that reducing emissions from under-fired charbroiling by 20% in Kern County is necessary for attainment; thus, by reducing emissions 20% Valley-wide, the District achieves significant health benefits Valley-wide per the District's Risk-based Strategy. Research and demonstration projects are underway to evaluate emission control technologies for under-fired charbroilers in support of this measure. Therefore, the District commits to amend Rule 4692 in 2016 to add requirements for under-fired charbroilers, with an anticipated compliance date of 2017.

Rule 4901 Wood Burning Fireplaces and Wood Burning Heaters

Since 2003, District Rule 4901 and the associated Check-Before-You-Burn program have reduced harmful species of PM2.5 when and where those reductions are most needed—in urbanized areas when the local weather conditions are forecast to inhibit PM dispersion. Analysis for this *2012 PM2.5 Plan* indicates that lowering the threshold level for calling wood-burning curtailments could further reduce emissions from this source category by 1.5 tpd of PM2.5. The amended rule would also include a new contingency provision (see Chapter 9). The District commits to amend Rule 4901 in 2016 with enforcement to begin the 2016/2017 winter season. This is a four-part commitment (refer to Appendix D for more details):

1. Lower the threshold level for calling wood-burning curtailments from the current 30 $\mu g/m^3$ to ≥ 20 $\mu g/m^3$
2. Review the meteorological conditions that lead to elevated PM2.5, to prevent the buildup of PM2.5 that may lead to a potential exceedance day
3. Consider expanding the wood burning season to include October and/or March
4. Analyze the feasibility of allowing the use of the cleanest certified wood burning devices at specified curtailment levels. Enforcing this added flexibility would be difficult given the challenge in distinguishing wood smoke emissions from various wood burning devices, and the District would explore various options during the rule development process for ensuring that this issue is addressed.

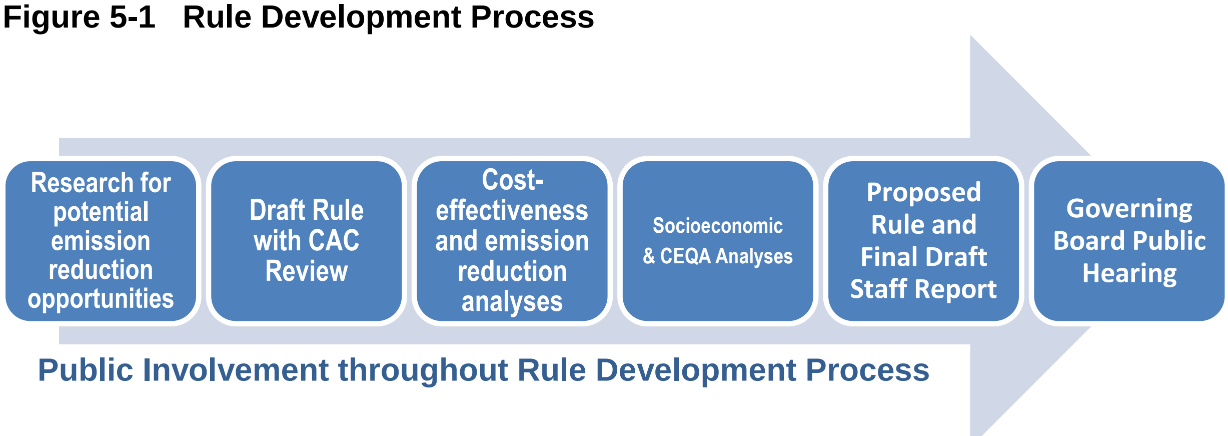
Rule 4905 Natural Gas-Fired, Fan-Type Residential Central Furnaces
In the *2008 PM2.5 Plan,* the District committed to amend Rule 4905 in 2014 to establish more stringent NOx emission limits for new and replacement natural gas-fired, fan-type residential central furnaces. Based on the preliminary results of a SCAQMD study of emissions control technologies for furnaces, the technology required to meet new NOx standards will be available by 2015. Analysis for this *2012 PM2.5 Plan* also suggests that emissions may be reduced by extending the applicability of the rule to include commercial units, though additional analysis is needed to confirm the technological feasibility and cost-effectiveness of incorporating commercial units into Rule 4905. This will be further evaluated during the rule-amending project. The District commits to amend Rule 4905 in 2014 to lower the NOx emission limits for residential furnaces and to examine the possibility of incorporating NOx limits for natural gas-fired, fan-type, commercial central furnaces into the rule, with an anticipated compliance date of 2015.

Rule 9610 SIP Creditability of Incentives
The District's successful incentive-based measures have been reducing pollutant emissions above and beyond reductions being achieved through traditional regulations. Historically, EPA has not granted credit for incentive-based reductions for use in SIPs to meet Clean Air Act obligations. This new District rule will establish appropriate mechanisms for the District to take SIP credit for eligible incentive programs. Once given credit, SIP-creditable, incentive-based emissions reductions will be used alongside regulatory measures to meet federal Clean Air Act requirements, such as requirements for contingency reductions and reasonable further progress (see Chapter 6 for more information).

5.3.2 Rule Development Process

After plan adoption, the District adopts or amends rules per the plan's regulatory control measure commitments. In these efforts, the District is committed to a transparent public process that includes stakeholder, industry, and other-agency input at every step possible.

Figure 5-1 Rule Development Process



Contrasting the broader plan development effort, the rule development process allows greater focus on a single sector or technology area. Early in the rule development process, prior to preparing a draft rule, staff researches technologies and explores options for emissions reductions, gathering preliminary data and performing literature reviews of relevant studies. Through a series of public workshops and focus group meetings, staff presents draft rule concepts and receives feedback on specific technology costs, technical insight, and general public comments. Staff uses this information gathering and discussion to refine the rule throughout the rule development process. Using this iterative process of gathering the most up-to-date cost and technical information, staff analyzes cost-effectiveness and potential emissions reductions. These analyses are shared with the public throughout the rule development process.

During the ongoing public workshop process, the District enlists the services of an economic consultant to analyze the proposed rule's socioeconomic impact, pursuant to California Health and Safety Code Section 40728.5. As with draft versions of the rule, the District gives the public and stakeholders the opportunity to review the analysis and provide further feedback. To the extent possible, the District minimizes significant economic and socioeconomic impacts by evaluating viable alternatives, adjusting proposed limits, or extending compliance schedules.

Staff presents the final draft version of the staff report and proposed rule, including the cost-effectiveness analysis, socioeconomic impact report, emissions reductions analysis, RACT analysis, and California Environmental Quality Assessment (CEQA), to the Governing Board during a public hearing. The Governing Board ultimately determines the balance between air quality improvement and rule impacts when adopting proposed rules.

Once adopted, the District forwards the rule through ARB to EPA for inclusion into the SIP, as appropriate. EPA evaluates the rule, determines if the rule meets federal requirements, and provides an opportunity for further public comment. After this review and comment period, EPA will amend the SIP to include the new rule, as appropriate.

Beyond the rule development and adoption process, District staff will continue to engage the public and affected source operators throughout implementation and compliance. Additionally, District staff continues public outreach and education through notifications to stakeholders of the rule adoption, issuance of compliance bulletins, and assistance through the District's Small Business Assistance program.

5.3.3 Further Study Measures

As discussed in this chapter and Appendices C and D, the District thoroughly reviewed the Valley's current emissions sources and emissions control measures to search for additional control measure opportunities. Chapters 5, 6, 7, and 8 outline a number of specific actions that are being taken to reduce emissions for this plan. In some cases, though, additional information is needed regarding the current emissions inventory, the effectiveness of current controls, and the potential of additional controls. The District will continue to review these areas as *further study measures*, summarized in Table 5-4. These analyses can provide the foundation for related control measure commitments in future attainment plans.

Table 5-4 Further Study Measures

Control Measure	Description	Completion Date
Rule 4103 Open Burning	Evaluate the feasibility of postponed burning activities every 5 years, as outlined in the current rule.	2015
Rule 4106 Prescribed Burning	Examine the feasibility of implementing a biomass removal program similar to one in Placer County.	2013
Rule 4311 Flares	Review flare minimization plans and annual reports for further emission reduction opportunities.	2013
Rule 4550 Conservation Management Plans	Analyze existing studies and support new studies to establish a more accurate inventory of PM2.5 emissions and identify potential additional emission reduction opportunities.	2014
Rule 4570 Confined Animal Facilities	Analyze existing studies on ammonia at confined animal facilities and evaluate potential ammonia controls for their effectiveness in reducing PM2.5 concentrations in the Valley.	2017
SC 001 Lawn Care Equipment	Evaluate emissions inventory and technology demonstration efforts to identify potential emission reduction opportunities.	2013
SC 005 Asphalt/Concrete Operations	Examine feasibility of warm-mix asphalt as a potential emission reduction opportunity.	2013

Rule 4103 Open Burning

The District recently re-evaluated the *2010 Final Staff Report and Recommendations on Agricultural Burning* in May 2012 and found there were no significant changes in the economic feasibility of various alternatives to agricultural burning. Annually, the District evaluates each crop category still allowed to burn and determines a cost threshold based on the economic feasibility of alternatives to burning. The District carefully manages the remaining agricultural burning under its Smoke Management System to ensure that burning is only allowed on days when the amount burned would not cause or contribute to an exceedance of any air quality standard, and to ensure that there are no cost-effective alternatives available. The District will continue to consider the economic feasibility of burning alternatives on a case-by-case basis and continue with the five-year evaluation period outlined in Rule 4103.

Rule 4106 Prescribed Burning

Placer County Air Pollution Control District has implemented a successful program for reducing emissions from hazard reduction burning by removing biomass from the area and sending it for combustion at a biomass plant. The District has considered the feasibility of implementing a similar program in the Valley; however, the unique Valley geography presents several challenges in implementing a comparable program. Such challenges need to be evaluated before determining whether a biomass removal program could be implemented successfully and result in cost-effective emissions reductions for the Valley. The District commits to further evaluating these challenges and the potential for such a program in the future.

Rule 4311 Flares

Effective July 1, 2012, facilities subject to the flare minimization plans (FMPs) provision in Rule 4311 are required to submit annual reports to the District with *reportable flaring event* and *annual monitoring report* data. The information in these annual reports could potentially provide insight for further emissions reduction opportunities for this source category. The first reports under this Rule 4311 provision were not due to the District until July 31, 2012. Given the time necessary to thoroughly analyze the FMPs, reportable flaring event reports, and annual monitoring reports, the District commits to analyzing these documents in the future.

Rule 4550 Conservation Management Practices (CMPs)

The District will continue to look for opportunities to reduce fugitive dust and emissions from agricultural operations through its Technology Advancement Program and through its collaboration with other agencies, such as the Natural Resources Conservation Service (NRCS), and other agricultural stakeholders. Collaborative research, such as the District's involvement with EPA's Regional Applied Research Effort (RARE), is investigating the effectiveness of CMPs on the PM2.5 fraction of fugitive dust and evaluating particulate emissions related to conventional tilling methods versus CMP tillage methods using new technology.

Rule 4570 Confined Animal Facilities

District Rule 4570 is among the most stringent rules in the nation for confined animal facilities (CAF). Rule 4570 uses a menu-based approach to require the implementation of best management practices to reduce emissions from confined animal facilities. As a part of the 2010 rule-amendment process, the District devoted extensive resources to evaluating and furthering science in the area of CAF-related emissions and potential mitigation measures. The combined efforts of the District, researchers, and agricultural stakeholders yielded profound new information that was used to develop the 2010 amendments. In particular, scientific research shed new light on dairy silage emissions and potential mitigation measures. As a result of these collaborations and efforts, Rule 4570 is expected to reduce 100 tpd of ammonia emissions in the Valley[6].

In ongoing efforts to further reduce CAF-related emissions in the Valley, the District continues to work closely with researchers, other agencies, and ag stakeholders to seek out new technologies, work practices, and other methods. That said, no achieved-in-practice controls have been identified that could potentially further reduce CAF emissions beyond current controls. The District has explored the possibility of

[6] (2010). *Final Draft Staff Report for Revised Proposed Amendments to Rule 4570 (Confined Animal Facilities)*. Fresno, CA: San Joaquin Valley Air Pollution Control District. http://valleyair.org/Board_meetings/GB/agenda_minutes/Agenda/2010/October/Agenda_Item_7_Oct_21_2010.pdf

implementing ammonia controls during periods of high PM2.5 concentrations; however, the available information indicates that this control strategy would not be feasible or effective in the Valley. The limited amount of nitric acid and sulfuric acid available in the atmosphere to react with the large quantities of ammonia present in the Valley generally renders ammonia emissions controls as ineffective in reducing PM2.5.

Recent studies have cited the episodic application of sodium bisulfate (SBS) onto manure at dairies as a potential control strategy to reduce ammonia emissions. The South Coast Air Quality Management District identified this episodic application of SBS as a potential control measure within their 2012 Air Quality Management Plan. The District also evaluated this option and determined that for a variety of reasons, as discussed in this chapter, this control strategy is infeasible and ineffective for the Valley.

Most dairies in the Valley utilize a freestall design and generally restrict the cows' access to corrals during the winter months, since the corrals are wet and muddy. As a result, there would be very little or no fresh manure excreted in corrals during the winter. In addition, once wet conditions set in, it is not feasible to utilize tractors in the corrals to apply SBS, since the tractors would tend to get stuck. Application by hand at large dairies would be labor intensive, time consuming, and expensive, and would potentially pose health and safety risks to the workers.

Although SBS is generally safe in small quantities, excessive loading of salts is a major water quality concern in the central and southern regions of the Valley, where many dairies are located. Applying large quantities of SBS to manure that will eventually be applied to land may not be practical or feasible. A dairy would need to work with the Regional Water Quality Control Board to determine if this would be allowed, and a dairy's nutrient management plan would need to be revised. It may require hauling manure a significant distance to areas without the same salinity concerns and possibly increasing mobile emissions from hauling.

There are also significant costs associated with the application of SBS. Iowa State University Extension estimates the costs of SBS to be $660/ton. District estimates show that 1,304 lb-1,955 lb/cow-yr of SBS would be needed for application to one entire corral area, costing $430 - $645/cow-yr. Using the District's corral ammonia emission factor for milk cows and assuming the 50% reduction in ammonia, the cost of the ammonia reductions would be at least $41,067/ton to $61,601/ton. Information from Iowa State lists reduced costs of $129 - $193/cow-yr for only treating heavy use areas, such as feed bunks and water troughs. It is not clear how much manure is excreted in heavy use areas, but even if the resulting cost per ton of reduction was cut in half, the costs would still be significant. Given the insignificant PM2.5 reduction achieved per ton of ammonia reduction, this cost-effectiveness translates to a much higher relative cost-effectiveness when compared to other, more effective strategies, such as NOx reductions. Also, because flush dairies are common in the Valley, the heavy use areas will generally be paved, and the flushing of the freestall or corral lanes already significantly reduces ammonia emissions; therefore, application of SBS to only these areas would not benefit the Valley. It would be flushed to a lagoon or pond where the high buffering capacity would render it ineffective and possibly increase H2S emissions.

Due to the ineffectiveness during the peak PM2.5 season, feasibility issues with potential controls, potential environmental impacts, cost effectiveness issues, and the insignificant contribution of ammonia reductions to improvements in PM2.5 concentrations, ammonia control strategies will not further assist the Valley's PM2.5 attainment goals at this time. However, as previously mentioned, the District intends to continue ongoing efforts to evaluate additional potential strategies for reducing CAF-related emissions in the Valley. Therefore, the District commits to continue to analyze and support studies regarding confined animal facility ammonia emissions, for the purpose of evaluating the potential effectiveness of additional ammonia controls on confined animal facilities in reducing PM2.5 concentrations in the Valley.

SC 001 Lawn Care Equipment

The District's Governing Board approved funding for District-sponsored research to quantify Valley-specific lawn care activity levels. The survey results will allow review and improvement of the emissions inventory for this source category.

The District is also actively demonstrating zero-emission lawn-care equipment technology through the recent launch of the Zero-Emission Commercial Lawn and Garden Equipment Demonstration Program. This program is funded with State Air Quality Improvement Program funds and will provide eligible cordless zero-emission commercial lawn and garden equipment to commercial landscape professionals who conduct business within the Valley. The District will continue its work with commercial operators to address the concerns with commercial viability through the implementation of this program. Based on findings and feedback from program participants, the District commits to developing more incentive program options for commercial operators to assist in deploying zero-emissions lawn and garden technologies.

SC 005 Asphalt and Concrete Operations

Warm-mix asphalt shows promise for reducing emissions associated with the production of asphalt for paving projects, when compared to hot-mix asphalt, because lower temperatures result in lower levels of criteria pollutant emissions. The cost, unfamiliarity with potential implementation issues, and uncertainty in the exact percentages of potential emissions reductions are potential barriers to the technology's use in the Valley. District staff commits to further evaluate the cost, effectiveness, and feasibility of this technology for Valley sources in the future.

5.4 ADDITIONAL CONTROL STRATEGIES

Non-regulatory strategies help accelerate attainment and have been an important part of recent District plans. For example, through the District's Fast Track strategy, the District and its Fast Track task force have evaluated several innovative and collaborative emissions-reducing measures, complementing the more traditional measures included in the *2007 Ozone Plan* and *2008 PM2.5 Plan*. These Fast Track efforts have resulted in increased incentive funding being brought to the Valley, expanded public outreach through Healthy Air Living (see Chapter 8), and guidance documents and model policies, such as the District's "Green Contracting" guidance and policy. Along these lines, the following strategies are under close evaluation by District staff for potential PM2.5 benefits.

5.4.1 Energy Efficiency

California has been on the forefront of developing renewable energy sources, and has implemented regulations to ensure cleaner non-renewable energy. The District's involvement in energy efficiency and renewable energy is guided by its Regional Energy Efficiency Strategy (REES), which was adopted in January 2010.[7] This policy identifies the District's commitment to fostering energy efficiency and clean energy alternatives as opportunities for emissions reductions. Consistent with the District's 2012 Legislative Platform, the District continues to work with stakeholders and state agencies to expand net metering and feed-in tariffs for use of solar and other renewable energy sources, promote energy efficiency programs for energy end users that will result in lower emissions and a more stable electrical distribution system, and develop measures that incentivize and encourage low-emission technologies for use of waste gas as an alternative to waste-gas venting or flaring.

5.4.2 Eco-driving

Given that mobile source emissions now represent approximately 81% of the NOx emissions in the Valley, and that mobile sources are essentially outside the regulatory control of the District, finding ways through education and outreach to reduce such emissions in the Valley is critical to future attainment. One such program in development is Eco-Driving. Eco-Driving refers to everyday techniques that drivers can do to maximize the fuel economy of their vehicles. These include observing good operating maintenance, such as proper tire pressure, wheel alignment, and oil viscosity; improving aerodynamics; traveling at efficient speeds; choosing the appropriate gear for manual transmissions; driving defensively to avoid unnecessary braking; accelerating at a constant pace; and other simple, yet often forgotten, driving techniques. As with other informational activities conducted by the District, an Eco-Driving program could be encompassed under the Healthy Air Living umbrella.

[7] San Joaquin Valley Air Pollution Control District. (2010). *Approval of the District's Regional Energy Efficiency Strategy*. Memorandum to the SJVAPCD Governing Board. Public Hearing, January 21, 2010. http://www.valleyair.org/Board_meetings/GB/agenda_minutes/Agenda/2010/January/Agenda_Item_7_Jan_21_2010.pdf

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Chapter 6

Incentive Programs

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Chapter 6: Incentive Programs

Incentive programs are an integral part of the District's emissions reduction effort. These programs provide an effective way to accelerate emissions reductions and encourage technology advancements, particularly in the mobile source sector, a sector not directly under the District's regulatory jurisdiction. Given that 80% of the Valley's NO_X emissions come from mobile sources, these successful voluntary incentive grant programs help the Valley achieve highly cost-effective emissions reductions beyond the District's regulatory bounds that are surplus of the reductions required by regulations.

The District operates one of the largest and most well-respected voluntary incentive programs in the state. Through strong advocacy at the state and federal levels, the District has increased its incentive funding levels over the past five years to a proposed incentive program appropriation of $182 million in the 2012–2013 District Budget. Since the District's inception in 1992, considerable funding has been expended in support of clean-air projects in the Valley. These projects have achieved significant emissions reductions with corresponding air quality and health benefits. The District typically requires match funding of 30% to 70% from grant recipients. To date, grant recipients have provided $487,256,276 in matching funds, with a combined District and grant recipient funding investment of $919 million.

Over the past 10 years, the District has provided incentive funding to purchase, replace, or retrofit thousands of pieces of equipment, including the following:

- 4,584 agricultural irrigation pump engines
- 726 agricultural equipment replacements
- 945 off-road equipment repowers
- 2,434 heavy-duty trucks
- 1,879 school bus retrofits
- 432 school bus replacements
- 3,585 lawnmower replacements
- 2,318 fireplace change-outs
- 18,476 commuter subsidies
- 35 locomotive replacements
- 396 new alternative-fuel, light-duty vehicles
- 706 vehicle retirements (car crushing)
- 17 bicycle infrastructure projects (bike paths)

The District's incentive programs continue to be a model for other agencies throughout the state. Recent audits noted the District's efficient and effective use of incentive grant funds in reducing air pollution. The District has been collaborating with the U.S. Environmental Protection Agency (EPA) to establish criteria for quantifying incentive program emissions reductions for use in state implementation plans (SIP).

6.1 INCENTIVE FUNDING

The District is engaged at every level of state and federal government to craft policy and funding targets that account for the Valley's unique challenges and need to accelerate emissions reductions, particularly from sources not under the District's regulatory authority. Toward that end, the District is working closely with the Valley's legislative delegation to ensure that the Valley's needs are well represented in discussions of where to focus funding throughout the state and the region as a whole. In addition, the District is focused on how to effectively allocate the limited funding received for its incentive programs.

6.1.1 Funding Sources

The District continues to dedicate significant effort to ensure that the San Joaquin Valley receives its share of state and federal incentive funds through a variety of sources. In addition to aggressively pursuing funding from state funding sources such as the Carl Moyer Program and Lower-Emission School Bus Program, the District has been very successful in securing grants from the highly-competitive federal Diesel Emissions reductions Act (DERA) and the state AB 118 Air Quality Improvement Program (AQIP).

While demand for incentive programs continues to be strong, many of the funding sources for these programs are scheduled to sunset during the implementation time frame of this plan, unless funding is renewed. These programs include, but are not limited to, Proposition 1B, which provided $1 billion statewide to reduce goods-movement emissions; AB 923, which authorized a $2-per vehicle DMV fee and additional statewide funding for the Carl Moyer program; and AB 118, which provides $200 million statewide for alternative and renewable fuel projects, as well as vehicle technology projects.

The single largest source of funding for the District's incentive programs is the Proposition 1B program, which uses bond funds for a variety of state transportation priorities. The District aggressively pursued its share of Proposition 1B funding, and the Valley will receive approximately $250 million over the life of the program. The District will receive its last allocation of Proposition 1B funding in fiscal year 2013-2014.

The Carl Moyer program has been an on-going and reliable source of funding since 1998. The Carl Moyer program, as it operates today, was established in 2004 with the adoption of AB 923 and SB 1107; the latter provided increased and continued funding through 2014 and expanded the program to include light-duty vehicle projects and agricultural sources of air pollution. In total, the District receives approximately $14 million per year in Carl Moyer and other funding under AB 923. Without further action by the legislature, funds authorized by AB 923 will sunset on January 1, 2015.

In 2007, the California legislature approved AB 118: the California Alternative and Renewable Fuel, Vehicle Technology, Clean Air, and Carbon Reduction Act of 2007. AB 118 provides approximately $200 million annually through 2015 for three new programs to fund air quality improvement projects and develop and deploy technology and alternative and renewable fuels. The bill creates a dedicated revenue stream for the programs through increases to the smog abatement, vehicle registration, and vessel registration fees. AB 118 is designed to reduce emissions of criteria pollutants and greenhouse gas emissions and to deploy advanced technology. Most AB 118 programs are administered on a statewide basis. While the District has administered some of the AB 118 programs for the state, these programs have not been a significant portion of the District's incentive program revenue. However, in the future, these funds may be more important, particularly as the District becomes more involved in technology advancement projects. AB 118 funding will sunset on January 1, 2016.

6.1.2 Incentive Strategy

Each of the funding sources administered by the District includes different guidelines and statutory requirements for using the funds. Beyond the specific guidelines of each funding source, the District considers the following common factors when deciding how and where to spend incentive funds:

Cost-effectiveness – An important factor when considering where to invest District funds is determining which types of projects and programs will give the District the greatest return on its investment. This is typically represented in dollars per ton of emissions reduced. While cost-effectiveness is a primary factor, the District also considers projects that may not have the highest cost-effectiveness, but that provide other benefits, such as the advancement of new technology or community involvement (as described below).

Inventory of available projects – This factor is critical in all District incentive programs. To date, the District has been extremely successful in designing programs that have broad appeal and applicability across multiple industries. Over the past 10 years, this level of interest has resulted in a substantial backlog of eligible projects waiting for funding. Unfortunately, many of those on waiting lists have since moved into a regulated class, making them ineligible for funding, in most cases. As a result, the District must continue to not only work within the existing regulations to find cost-effective, surplus project categories, but also to focus future funding in areas where a significant inventory of eligible projects still exists.

Required expenditure timeframes – Each funding source that the District administers generally requires obligation and expenditure by certain deadlines. These deadlines greatly impact funding priorities and choice of projects. The District may prioritize a funding category over others because of the timeframe associated with a particular funding source. For instance, priority may be given to certain projects that can reasonably be expected finish prior to the deadline for that specific fund over other projects of equal relevance or cost-effectiveness, but with longer expected completion times. Again, the flexibility of this option works in concert with the dynamic nature of the incentive programs, projects, expenditure deadlines.

Upcoming regulatory deadlines – To ensure that incentive programs obtain the maximum SIP-creditable emissions reductions, the District performs a thorough analysis of all local, state, and federal regulations relating to the target categories. In addition, the District works proactively with the regulating agencies during the rule development process to understand the potential impacts of that rule on incentive projects and to ensure that opportunities for early incentive funding are maximized. These analyses determine which types of projects can be funded, for how long projects can be funded, which also impacts the potential cost-effectiveness of those projects.

Health benefits – In addition to emissions reductions needed to attain air quality standards, the District also seeks incentive projects that provide direct health benefits to Valley residents. For instance, the District's Lower-Emission School Bus Program reduces exposure to children from toxic diesel particulates, even though this source is not one of the largest sources of regional particulate pollution.

Promoting technology advancement – Funding projects that demonstrate and advance new emission reduction technologies will be essential for meeting increasingly stringent air quality standards given the Valley's existing challenges. The District's recent adoption of the Technology Advancement Program emphasizes the priority given to this area.

Environmental Justice – The District places a strong emphasis in providing funding in a manner that benefits environmental justice communities. The District has worked cooperatively with the Environmental Justice Advisory Group to understand the Valley's environmental justice issues and to craft programs that reduce emissions in these areas.

Community involvement/benefits – The District develops and administers programs with an emphasis on community involvement. Some examples of these are the Clean-Green-Yard-Machine program, Drive Clean! Rebate program, Burn Cleaner program, Transit Pass Subsidy program, and the Polluting-Automobile Scrap and Salvage program.

6.1.3 Statutory Constraints on Incentive Funding

The District's current incentive funding comes from a range of local, state, and federal funding sources. Each funding source places restrictions on the types of projects that may be funded, the funding limits, expenditure deadlines, and the administrative approach for distribution. These requirements vary significantly from one funding source to another, resulting in a complex matrix of funding categories and program requirements. Some key examples are listed below:

Proposition 1B Goods Movement – Funding for this program must be used on heavy duty trucks and locomotives. The program procedures require that a Request-for-Proposals (RFP) process is used and that the most cost-effective projects are funded first.

Lower-Emission School Bus – Funding for this program must be used on school bus replacements or retrofits. The program requires that all retrofits be prioritized and that the oldest buses are replaced first.

Carl Moyer – Funding is predominately used for heavy-duty diesel equipment projects. The program has strict funding caps and cost-effectiveness requirements.

DMV Funds – Funding must be used primarily for on-road and off-road mobile sources. Portions of funds must follow state Carl Moyer and Lower-Emission School Bus guidelines.

Advanced Emission Reduction Option Funds – Funding is for emission reduction incentive projects. The District's Governing Board has discretion as to where to apply these funds using the District's annual budget process to allocate this funding.

Indirect Source Review (ISR) Funds – Funding preference is given to emissions reductions opportunities near development projects.

6.2 SIP CREDITABILITY OF INCENTIVE PROGRAMS (RULE 9610)

Historically, states and local air agencies have not been able to obtain SIP credits for incentive-based reductions. When given SIP credit, incentive-based emissions reductions can be used alongside regulatory-based emissions reductions to meet federal Clean Air Act requirements, such as demonstrating attainment with air quality standards at a future date or demonstrating that emissions reductions meet reasonable further progress requirements. Given the heavy investment from the public and private sectors in replacing equipment under these voluntary incentives, establishing a general framework to receive SIP credit for these emissions reductions is critical for ensuring the continued success of these programs. The District, EPA, Air Resources Board (ARB), and United States Department of Agriculture – Natural Resources Conservation Service (USDA-NRCS) have recognized the importance of this issue, and signed a Statement of Principles in December 2010 that established a general framework for ensuring that reductions in air emissions resulting from voluntary incentives to replace off-road agricultural equipment received credit in the SIP. The MOU states that the District, NRCS, ARB and EPA will work collaboratively to develop a mechanism to provide SIP credit for emissions from incentive programs that are surplus, quantifiable, enforceable, and permanent. Additionally, in July 2012, EPA and USDA agreed to specifically implement this concept to ensure that emissions reductions from incentive programs were given their proper credit in the SIP context.

As with rules adopted by the District, EPA guidance requires that emissions reductions achieved through voluntary incentive programs be demonstrated to be surplus, quantifiable, and enforceable in order for those reductions to receive SIP credit. Additionally, EPA guidance requires extensive documentation of emissions reductions proposed for SIP credit with ongoing follow-up and tracking of the emissions reductions.

In order to be surplus, emissions reductions from voluntary incentive programs generally must not be required by any local, state, or federal regulations. Quantifiable emissions reductions are calculated using methodologies of state programs or other publically developed methodologies. To ensure enforceable emissions reductions, creditable programs require mechanisms such as legally binding agreements with program participants and physical inspections to verify the completion of projects. District incentive programs have been designed to meet the surplus-quantifiable-enforceable criteria. Additionally, all criteria and reporting mechanisms are transparent to the public.

The District has conferred with EPA regarding the process for documenting and submitting the information necessary to receive SIP credit for incentive-based emissions reductions. The framework for establishing this SIP credit will be in the form of a new District rule. District Rule 9610 will establish the documentation, reporting, and public review process for the District to take credit in the SIP for emissions reduced through incentives. Chapter 9 discusses how these SIP-creditable incentives reductions would be incorporated into the SIP for purposes of this PM2.5 plan.

6.3 CURRENT DISTRICT PROGRAMS

The District offers numerous incentives programs to reduce emissions from a variety of equipment types such as heavy duty engines, school buses, and lawn and garden equipment. The District places particular emphasis on providing incentives to environmental justice communities. To date, the District has awarded $432 million in incentive funding resulting in 93,349 tons of lifetime emissions reductions. District staff will continue to expand on the success of its current programs and craft new incentive programs for additional emissions reductions from Valley sources.

The following summarizes incentive programs the District currently implements:

6.3.1 Heavy-Duty Trucks

The District has administered numerous incentive programs targeted at on-road heavy-duty trucks, one of the biggest sources of NO_X emissions in the Valley. Through the state's Proposition 1B Goods Movement Emission Reduction Program, Carl Moyer Voucher Incentive Program (VIP), and other District-operated voucher incentive programs funded by grants from EPA and locally generated incentive funds, the District has replaced hundreds of older, high-polluting trucks with cleaner trucks certified to meet the latest ARB emissions standards.

The District's truck voucher programs have been designed to provide an alternative source of incentive funding for small businesses that do not qualify for funding under the Proposition 1B Program. The District contracts with Valley dealerships and makes the review and approval process efficient and streamlined to provide vouchers to truck operators.

6.3.2 Agricultural Pumping Engines

The District provides up to 85% funding for farmers looking to replace older, dirtier diesel engines with low-emission Tier 4 engines or zero-emission electric motors. Agriculture accounts for a majority of the local economy, and this program not only provides for significant emissions reductions from agricultural operations, but provides economic relief to Valley farmers, ranchers, and dairy operators. Eligible projects are funded with local, state, and federal sources, including but not limited to District Indirect Source Review (ISR) mitigation fees, Carl Moyer Program funding, AB 923 funding, Federal Designated Funding, and Federal Diesel Air Shed Grant funding. In the past, collaboration with the California Public Utilities Commission and local utilities has allowed for additional incentives on electric line extensions and special rate schedules, enhancing participation in the District's replacement program.

Over the past ten years, the District has funded the replacement of over 4,584 agricultural pump engines, with more projects currently in the queue. Over 2,000 of these replacements involved replacing older diesel engines with electric motors. The District has seen an increased demand for emissions-compliant diesel-engine repowers to electric motors in recent years. This option is ideal for both parties, since the District achieves the maximum emissions reductions with electric motor repowers and farmers lower their operating costs by switching to electricity, a more affordable fuel source. The District will consider pursuing a renewed public/private collaborative partnership similar to the previously mentioned partnership to provide further incentives for replacing remaining agricultural IC engines with electric motors, potentially including assistance for line extensions for remotely located wells.

For a typical irrigation pump project, District staff will verify that the old engine is operational and eligible. If so, the engine owner is offered the incentive and has the new engine or motor installed, making sure that the old engine is sufficiently disabled. District staff conducts a post-inspection prior to payment to document the new engine or motor's specifications and to ensure the emissions reductions are accurate. Ongoing monitoring and reporting ensures the projects meet contracted emissions reductions targets.

6.3.3 Agricultural Equipment

Off-road agricultural equipment replacements and repowers play a crucial role in reducing emissions. These equipment units, including tractors, backhoes, wheel loaders, and other off-road farming vehicles are widely used in the Valley, and are essentially uncontrolled and unregulated. Eligible projects are funded with local, state, and federal sources, including but not limited to ISR, Carl Moyer funding, AB923 funding, Federal Designated funding, and Federal Diesel Air-Shed Grant.

The District has funded the repower and replacement of over 1,017 off-road agricultural vehicles, with more projects currently in the queue. It is estimated that a large inventory of vehicles that qualify for repower or replacement still exists, and the program has the potential for significant and very cost-effective emissions reductions. Whether a farmer wishes to repower the current equipment with a cleaner engine or replace the equipment altogether, this program allows the District to achieve surplus emissions reductions while also facilitating the early equipment retirement and fleet turnover, both of which result in more efficient farming operations with less overall hours of operation.

An important component of the District's incentive efforts in this category has been its collaboration with the NRCS to replace agricultural tractors. Over the course of this collaborative tractor replacement program, the District has obligated $21.4 million in incentive funds, NRCS has obligated $72.2 million, and this has leveraged $89.9 million in applicant cost share for new tractors. This $183 million investment by the District, NRCS, and Valley farmers has resulted in significant emissions reductions, and work is underway with EPA to ensure the reductions from this investment can be credited to the SIP.

In both repower and replacement projects, the farmer enters into an agreement with the District to replace the old, dirty engine or vehicle with newer, cleaner technology. District staff first performs a pre-inspection to determine that the equipment and engine are operational. Then a final inspection is performed to verify the new equipment, as well as witness the old equipment and engine's destruction at a District-approved recycling or scrapping facility, ensuring the old equipment and engine will never be put back into service. Ongoing monitoring and reporting ensure the expected emissions reductions and operation of the equipment meet the grant agreement requirements.

6.3.4 Locomotives

The emissions from goods movement are a significant source of diesel particulate matter (PM) in the Valley and the state, and many of the larger cities in the Valley are home to locomotive rail yards. Locomotives, in particular, present a considerable health risk from diesel PM emissions. Residential areas located close to rail yards have shown a significant increase in cancer risk and can equal or exceed the regional background or regional health risk levels. The locomotive component of the Heavy-Duty Engine Program awards up to 85% grant funding for newer, cleaner diesel locomotive engines and locomotive replacements. Eligible projects are funded with local, state, and federal sources, including but not limited to the Carl Moyer Program, the Federal Diesel Air Shed Grant, and DERA funding.

The District has funded the repower or replacement of 11 locomotives, with more projects currently in the queue. One of the major benefits to the locomotive repower and replacement program is increased efficiency and longevity as a result of the revolutionary GenSet engine technology. The GenSet system uses multiple smaller off-road tier-4 emission level engines mounted on a single chassis. This system allows for each of the engines to be fired up individually so that in low-power demand situations only one of the engines can be used, helping to reduce unnecessary emissions. In addition, this system comes equipped with idle reduction technology that will shut down the engine during periods of inactivity.

The District funds locomotive repower or replacement projects through an RFP procurement process, and reviews and selects recipients based on established scoring criteria. During the pre-inspections, all necessary locomotive engine information is verified by District inspectors and documented in digital photographs. Upon verification of all information, District staff enters into an agreement with the recipient for the project. Once the replacement switcher locomotive engine has been purchased and the original engine has been dismantled, the recipient will complete and return the claim-for-payment packet, and a post-inspection is performed, prior to payment, to verify the new information. Monitoring and reporting continue for the duration of the agreement to ensure the emissions reductions expected from the project occur.

6.3.5 Forklifts

The District funds the replacement and retrofit of forklifts through its Large Spark-Ignited (LSI) forklift retrofit program and its Electric Forklift New-Purchase program. Because emission standards for new engines in this source category have only been in effect for the past few years, a significant number of high-emitting units are still in operation and available for retrofit. Operators can meet the proposed in-use fleet-average emission standards by purchasing low- and zero-emission equipment and by retrofitting uncontrolled equipment in their fleets. The use of new controlled engines and the retrofit of existing engines can reduce fuel use and improve engine life, thus creating cost savings that offset a portion of the additional equipment cost. Eligible projects are funded with federal, state, and local sources, including Carl Moyer Program funds and motor vehicle surcharge fees.

The District has funded 17 forklift projects. The installation of a LSI retrofit system will improve engine operation and reduce fuel use. Closed-loop fuel systems generally improve the engine's overall efficiency. There is an estimated 10% to 20% reduction in fuel consumption with engines using closed-loop systems. An electric forklift has as obvious advantage as an emission-free vehicle, but can typically cost $1,500 to $5,000 more than a comparable LSI forklift. However, since an electric forklift has a longer useful life and reduced fuel and maintenance costs, the electric forklift can reduce life-cycle costs compared to a LSI forklift.

The forklift program is an over-the-counter program, in that applications are continually accepted on a first-come-first-served basis. Contrary to many of the off-road or agricultural components in the Heavy-Duty Engine Program, a pre-inspection is not required for the new electric forklift component (LSI retrofits are pre-inspected to ensure emissions are real and quantifiable). After contracts are awarded and the new equipment is purchased and installed, post-inspections are performed to ensure emissions reductions are accurately recorded and ongoing monitoring and reporting are required to ensure the emissions reductions occur.

6.3.6 School Bus Replacement and Retrofit

School bus replacements and retrofits play a vital role in reducing school children's exposure to both cancer-causing and smog-forming pollution. The School Bus Replacement and Retrofit programs provide grant funding for new, safer school buses and air pollution control equipment (retrofit devices) on buses that are already on the road. Public school districts in California that own their buses are eligible to receive funding. Eligible projects are funded with local, state, and federal funds including the Lower-Emission School Bus Program (Proposition 1B), DERA funding, and the American Reinvestment and Recovery Act (ARRA).

The District has provided funding to retrofit 1,879 school buses and replace 432 school buses. New buses purchased to replace older buses may be fueled with diesel or an alternative fuel, such as compressed natural gas (CNG), provided that the required emissions standards specified in the current guidelines for the Lower-Emission School Bus Program are met. Funds are also available for replacing on-board CNG tanks on older school buses and for updating deteriorating natural gas fueling infrastructure. Commercially available hybrid-electric school buses may be eligible for partial funding.

Eligible school buses are selected based on specific program requirements, including replacing the oldest models first. After determining eligibility, school districts are awarded contracts that provide a reasonable time period for project completion. A claim-for-payment form must also be submitted before funds can be awarded.

6.3.7 Community Incentives

While all of the District’s incentive programs are open to residents of the Valley, there are a number of programs, such as the Heavy-Duty Engine Program and the Proposition 1B Goods Movement Emission Reduction Incentive Program, that are specifically designed for Valley businesses. These programs focus on replacing or retrofitting large diesel-powered equipment such as trucks, tractors, and agricultural irrigation pump engines. These programs are highly efficient and extremely cost-effective. Of equal importance, the District currently operates several incentive programs designed for the general public. These programs give the general public the opportunity contribute to the our goal of cleaner air for all Valley residents.

The District’s community incentives include a wide range of project types and source categories. Current community incentive programs include the following:

Burn Cleaner Program – The Burn Cleaner Program helps Valley residents upgrade their current wood-burning devices and open fireplaces to natural gas, propane gas, or clean pellet devices. The District offers a financial incentive to any interested resident and an additional incentive to low-income residents through a streamlined voucher program that involves partnering with interested retailers. The program has upgraded over 2,300 wood-burning devices, and continues to receive a steady stream of applicants.

Polluting Automobile Scrap and Salvage (PASS) – The PASS program offers cash incentives for participants who have retired their older vehicle; a voucher toward the replacement of an older high-emitting vehicle with a newer cleaner vehicle; and, recently added, a voucher for emissions-related repairs to high-emitting vehicles. The program has replaced 202 high-emitting vehicles with newer, cleaner vehicles, retired 504 additional vehicles for a lower cash incentive, screened nearly 5,000 vehicles for high emissions, and provided nearly 3,000 vouchers for emissions-related repairs. The program has been operated with locally generated incentive funds and will continue to retire and replace vehicles utilizing funding provided by the State's Enhanced Fleet Modernization Program. Vehicle repairs were conducted with grant funding from the Reformulated Gasoline Settlement Fund created as a result of an antitrust class action, and it will continue to be funded using locally generated incentive funds.

Clean-Green-Yard-Machine (CGYM) – The CGYM program helps clean the Valley's air through incentives for residents to retire their old gas mowers in favor of nonpolluting, electric mowers. The program has used locally generated incentive funds as well as funding from the State's AQIP. Over the past two years, the program has replaced over 3,500 gas lawn mowers with clean electric models.

Drive Clean! Rebate Program – During the 2011–2012 fiscal year, the District revamped its incentive program structure to encourage Valley residents to drive advanced, clean vehicles, including electric and other alternative-fueled vehicles. In addition to clean-vehicle rebates, the Drive Clean! Program includes incentives that cover a portion of the charging infrastructure cost associated with electric vehicles.

Alternatives to Professionally Managed Pyrotechnic Firework Displays – In 2012, the District provided incentive funding for a pilot program to demonstrate clean laser-light shows as an alternative to pyrotechnics for July 4th celebrations.

Public Benefit Grants Program – The Public Benefit Grant Program is another recent addition to the District's incentive programs that provides funding to Valley cities, counties, and other public agencies for a wide variety of clean-air, public-benefit projects. Eligible applicants are cities, counties, special districts (e.g. water districts and irrigation districts), and public educational institutions (e.g. school districts, community colleges, and state universities) located within the Valley.

REduce MOtor Vehicle Emissions (REMOVE) – The REMOVE program provides incentives for specific projects that will reduce the Valley's motor vehicle emissions, including e-mobility (video-telecommunications), bicycle infrastructure, alternative fuel vehicle mechanics training, and public transportation and commuter vanpool subsidies. The program allocates funds to cost-effective projects that have the greatest motor vehicle emissions reductions resulting in long-term impacts on air pollution problems in the Valley. All projects must have a direct air quality benefit in the Valley.

The current incentive priorities are reflected in the 2012-13 District Budget's incentive spending plan and include funding for the following incentives:

Community Incentives

Drive Clean! Rebate (passenger vehicles)
PASS Vehicle Repair
Burn Cleaner (residential woodburning)
Clean-Green-Yard-Machine (lawn mowers)
REMOVE (vanpools, bikepaths, etc.)

Goods Movement

Proposition 1B Heavy Duty Trucks
Proposition 1B Line-Haul Locomotives
Rail Yard Switcher Locomotives

Heavy Duty Equipment Programs

Agricultural Equipment Replacement
Agricultural Irrigation Pumps
Truck Voucher and Reuse
Construction Equipment Replacement
Refuse Fleet Replacement

Advanced Transportation/Vehicles

Public Benefit Grants
Electric Vehicle Strategic Plan

School Bus Replacement and Retrofit

School Bus Replacement/Retrofit
Statewide Retrofit Program

Regional Assistance

Energy Efficiency Partnership
Greenhouse Gas Mitigation Assistance

Technology Advancement

Technology Advancement Program
Zero-Emission Commercial Lawn and Garden

6.4 NEW POTENTIAL INCENTIVE PROGRAMS

The District has successfully launched and expanded incentive programs in the Valley while steadily increasing the scope, accessibility, and efficiency of those programs. The District's incentive programs have been models for other agencies to follow: the State used the District's successful PASS program as a model for its Enhanced Fleet Modernization Program, the South Coast AQMD implemented the District's augmentation of the State's Hybrid Truck and Bus Voucher Incentive Program (HVIP), and the U.S. Department of Agriculture's NRCS used the District's highly successful agricultural equipment replacement program as the model for their own complementary program. The District's commitment to developing new and innovative incentive programs will continue to serve as a shining example for other agencies nationwide.

In addition to funding the existing core incentive programs that have traditionally achieved highly cost-effective emissions reductions (heavy duty tractors, trucks, etc.), the District has evaluated some additional opportunities to expand the portfolio of programs available. As new funding sources and opportunities are identified, the District will continue to look for additional incentive programs and expansions to existing programs.

Table 6-1 Potential New Incentive Programs

Potential New Incentive Measures	Implementation Date
Ongoing Enhancements. Continue to seek additional funding to implement incentive programs and continue to support existing incentive programs for mobile sources, as appropriate.	Ongoing
Kern County Focused Incentives. The District will consider opportunities to target incentive reductions in Kern County to expedite attainment of the 24-hour federal PM2.5 standard.	Ongoing
Charbroilers. Continue to seek additional funding to implement incentive programs and continue to support existing incentive programs for stationary sources such as the ChIP and the Burn Cleaner programs, as appropriate.	Ongoing
Internal Combustion Engines. Consider funding new programs to further promote replacement of agricultural internal combustion engines with electric motors, including but not limited to providing additional incentives for the high cost associated with utility line extensions to remove irrigation pump installations.	Ongoing
Lawn Care. Continue to evaluate commercial lawn care technologies through the Cordless Zero-Emission Commercial Lawn and Garden Equipment Demonstration Program; once new technologies are verified as viable for the Valley develop on-going incentive programs to encourage use of these new technologies; consider expanding the Clean Green Yard Machine program to include other eligible types of yard care equipment, including low- or zero-emission equipment.	Ongoing
Energy Efficiency. Continue to foster and incentivize programs, as appropriate, consistent with the District Regional Energy Efficiency Strategy; including but not limited to continued support of the use of state Energy Efficiency and Conservation Block Grant funds, the funding of a pilot program to assess and	Ongoing

Potential New Incentive Measures	**Implementation Date**
analyze two manufacturing facilities to determine the potential to operate more efficiently, and funding outreach program showing government and service organizations the benefits of "going green".	
Fireworks. Continue the incentive program for municipal laser-light shows to replace fireworks displays and to seek partners and consider sponsoring shows combining a small amount of fireworks with an otherwise predominantly laser driven show.	Ongoing
Construction Equipment Replacement. Consider providing incentives for construction fleets to replace their heavy-duty off-road equipment sooner than required by the State's In-Use Off-Road Diesel Vehicle Regulation.	Ongoing
Refuse Vehicle Replacement Program. Consider providing incentives for the replacement of older refuse trucks, with a particular emphasis in Environmental Justice and other vulnerable communities.	Ongoing

Chapter 7

Technology Advancement

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Chapter 7: Technology Advancement

The District Governing Board approved creation of the Technology Advancement Program in March 2010 to accelerate development of technologies that can help reduce air pollutant emissions in the Valley. Meeting EPA's increasingly stringent ozone and PM2.5 air quality standards will require significant advancements in low-emissions technologies from mobile and stationary sources. The Technology Advancement Program provides a strategic and comprehensive means to identify, solicit, and support technology advancement opportunities. Ongoing refinement of the program's technology focus areas targets efforts to achieve the greatest impact on the Valley's attainment and other health-based goals under the *2012 PM2.5 Plan* and the District's other ozone and PM2.5 attainment plans.

The Valley's air quality challenges are not completely unique to the Valley, nor are they isolated within the boundaries of the air basin. Technology development can benefit regional and state air quality. Strategies for reducing emissions in the Valley can be enhanced through partnerships and collaborations with other air districts and state agencies. The District is currently collaborating with the California Air Resources Board (ARB) and the South Coast Air Quality Management District (SCAQMD) to prepare a document to outline a common vision for attainment of federal air quality standards, as well as greenhouse gas goals and reduced exposure to toxics. The market penetration of transformative technologies will be a critical component of realizing a common vision, and the Technology Advancement Program will help to identify and support upcoming technology opportunities.

7.1 TECHNOLOGY FOCUS AREAS

The District has structured the Technology Advancement Program to encourage participation within three focus areas:

I. **Renewable Energy**. Renewable energy projects are those that overcome the barriers to using renewable energy, such as remote solar energy/storage, vehicle-to-grid, wind energy, or peak-shaving systems with zero- or near-zero-emissions technologies.

II. **Waste Solutions**. Waste solutions focus on waste systems or technologies that minimize or eliminate emissions from existing waste management systems and processes, including waste-to-fuel systems, such as dairy digesters and other bio-fuel applications.

III. **Mobile Sources**. Mobile source projects include, but are not limited to, retrofit technologies for reducing particulate or NO_X emissions from heavy-duty trucks, zero- or near-zero-emissions goods movement solutions, clean alternative fuels (hydrogen, electric, etc.), vehicle hybridization, and efficiency improvements to on-road or off-road equipment.

These focus areas represent the current needs of the Valley; they also reflect the types of proposals previously received by the District within this and other programs. Throughout implementation of this PM2.5 plan and future air quality plans, the District will continue to evaluate and, if necessary, update these technology focus areas to address to the Valley's air quality challenges.

7.2 FUTURE DEMONSTRATION PROJECTS

For the fiscal year 2012–2013, the District has committed an additional $8 million of funding for new demonstration projects. In addition to directly funding demonstration projects, the District actively seeks opportunities to collaborate with technology innovators in seeking additional funding. An example of this type of funding is the District's administration of the Zero-Emission Commercial Lawn and Garden Technology Demonstration, funded with State Air Quality Improvement Program funds.

Moving forward, District staff will continue to search for opportunities to support projects that build the air quality technology research and demonstration capacity of colleges and universities in the Valley. This emphasis will improve the ability of local institutions to engage in future clean-technology projects that are specifically suited to the Valley's needs. To accomplish this, staff has adapted the Technology Advancement Program scoring criteria so that projects that incorporate local colleges and universities will score higher in that category than those that do not.

7.3 DEMONSTRATION PROJECTS IN PROCESS

The District's Technology Advancement Program has had two rounds of funding and received over 60 proposals for clean technology projects. In 2011, the District selected 18 of the proposed projects for funding, for over $3 million in support of clean technology demonstrations. The following 11 projects, out of the 18 selected, are in process and moving forward:

Engine, Fuel, and Emissions Engineering, Inc. (EF&EE)
Rancho Cordova, CA
Renewable Energy and Waste Solutions Technology Focus Areas
The EF&EE project will demonstrate a compact SCR device on a biogas-powered engine to be installed at Joseph Gallo Farms in Atwater, CA. This technology is expected to reduce emissions from biogas-powered generation systems to ultra-low NOx levels. The system will include advanced monitoring and reductant metering equipment to prevent ammonia slip and reduce or eliminate the need for an ammonia slip catalyst. The slip catalyst is the primary source of NO_X emissions in their current system, and the new system with advanced metering is expected to reduce NO_X emissions.

This new technology has a low cost relative to the anticipated emission reductions, resulting in good cost-effectiveness. Additionally, the large amount of resource leveraging in the form of capital and equipment investment made this project a good candidate for funding. The technology being demonstrated has the potential to impact a large number of biogas projects in the Valley, and with statewide efforts being made to increase the number of biogas projects, this project is highly relevant to our planning process and offers additional co-benefits in greenhouse gas reductions.

Solar Storage Company
Redwood City, CA
Renewable Energy Technology Focus Area

The Solar Storage Company project will demonstrate a renewable solar-power generation system as an alternative to diesel power for agricultural irrigation pumping systems, especially those systems in remote locations. The demonstration system uses a thermal-solar concentration system with two reciprocating steam engines and a pressurized steam storage system. This technology will provide an alternative to electrifying pumping systems, which is not cost-effective in situations where electricity is not close by or infrastructure is not in place. The project will be installed in parallel with a diesel backup-power system to operate the pump at times when there is a need for emergency freeze protection occurring with two cloudy days in a row. Meteorological conditions that prevent the solar use in such cases are rare and only accounts for 1% of the pumping time of a typical agricultural irrigation pump. As a result, the project will result in a 99% reduction in emissions including diesel particulates, NO_X, and greenhouse gasses.

This project has potential for reducing criteria pollutant emissions, as well as the potential to reduce greenhouse gases, while expanding renewable energy options. Successful demonstration of the technology may prove a low-cost thermal storage alternative for additional applications, thus reducing the barrier to adoption of solar thermal technology.

California Bioenergy
Dallas, TX
Renewable Energy and Waste Solutions Technology Focus Areas

The California Bioenergy project will optimize and expand the emissions control systems used at the Bidart Dairy digester in Bakersfield, California. The digester gas system currently uses a non-selective catalytic reduction (NSCR) system. The project will tune the NSCR system to achieve very low NO_X emissions and install a second after-treatment system that uses hydrogen selective catalytic reduction to reach near-zero NO_X emissions.

The District is interested in the success of clean bioenergy production through the use of biowaste, particularly in terms of developing ultra-low-NO_X technologies to mitigate the potential impact from the large-scale development of these types of projects. Projects such as this one, if successful, move the Valley closer to that goal. The ability of digester projects like this to reduce greenhouse gas emissions provides co-benefits important for program acceptance.

US Hybrid Corporation
Torrance, CA
Mobile Sources Technology Focus Area

US Hybrid, in collaboration with CALSTART, will to convert a Terex wheel loader to plug-in hybrid operation for fuel savings and emission reductions. Hybrid-electric technology, which is already available in the light-duty vehicle category, has only recently been applied to off-road vehicles. This project will advance the use of this technology for this off-road category and quantify the emission reductions associated with the system. The wheel loader will be tested at Maddox Farms, a dairy located in Fresno County. The hybridized vehicle includes electric-only operation, idle elimination, and power for electric attachments.

The outcome of this project has the potential to affect a large segment of the off-road vehicle emissions inventory and is very relevant to the attainment planning process. Additionally, the expected fuel savings will also reduce the long-term cost of ownership for the technology.

Electricore, Inc.
Valencia, CA
Mobile Sources Technology Focus Area

Electricore, Inc. will build and demonstrate a zero-emission, completely autonomous agricultural spray vehicle. Electricore will work with Trexa, LLC, who has developed a low-cost, commercial, electric off-road vehicle platform that will be combined with a commercial orchard pull-rig agricultural spray trailer. Electricore will oversee the demonstration at Tech Agricultrual’s farms outside of Buttonwillow, in Kern County. The vehicle will operate autonomously based on robotics developed by the Robotics Institute at Carnegie Mellon University.

Successful implementation of this technology could have an impact on the inventory of emissions from agricultural tractors, which are numerous in the Valley. Likewise, the reduced fuel use and the associated greenhouse gas reductions provide co-benefits beyond criteria pollutant emissions reductions.

Sun-Maid Growers of California
Kingsburg, CA
Waste Solutions Technology Focus Area
Sun-Maid Growers will modify and test a mobile prototype device called the Burn Boss® Air Curtain Burner. Successful use of this device will reduce emissions resulting from the burning of paper raisin trays used during the grape harvest. The technology has been shown to significantly reduce visible smoke and NO_X emissions compared to open burning. The grape harvest coincides with District's highest ozone levels; reductions of these emissions greatly benefit air quality.

US Hybrid Corporation
Torrance, CA
Mobile Sources Technology Focus Area
US Hybrid, in partnership with CALSTART and Roush, will demonstrate a plug-in electric-hybrid propane utility truck using a Ford F-250 truck base. US Hybrid will demonstrate and test the utility truck at Maddox Farms near Riverdale, California. The demonstration and testing will identify NO_X emission reductions, greenhouse gas reductions, and fuel savings.

The outcome of this project has the potential to affect a large segment of the on-road vehicle emissions inventory in light of the extensive use of utility trucks in agriculture and other industries. Likewise, the reduced fuel usage, use of propane, and the associated greenhouse gas reductions provides co-benefits beyond criteria pollutant emissions reductions. The expected fuel savings will also reduce the long-term cost of ownership for the technology.

Leva Energy, Inc.
Santa Clara, CA
Waste Solutions Technology Focus Area
Leva Energy, Inc. will install and test two systems that recover wasted energy from ultra-low NO_X burners (ULNB). The system (Power Burner) integrates a gas-fired microturbine with a new ULNB into a system that can replace a burner on any boiler larger than 5 MMBtu/hr. The Power Burner recoups the energy lost with other ULNBs to cogenerate 100 kW of electricity with the same amount of fuel.

This technology's ability to provide boiler owners a faster payback on their investment has the potential to accelerate the adoption of ultra-low NO_X boilers in the Valley and provide NOx emissions reductions in the short term. The use of waste heat to generate electricity provides co-benefits beyond emissions reductions.

City of Manteca
Manteca, CA
Mobile Sources Technology Focus Area

The City of Manteca will demonstrate two new Autocar Xpeditor E3 refuse vehicles fitted with Parker RunWise advanced series hybrid-drive technology to reduce diesel fuel consumption, associated NO_X, and other emissions, by up to 45%. The City will purchase the trucks from Autocar and subcontract with infoWedge to install monitoring equipment and collect data from the hybrid truck and a conventional diesel truck, for comparison purposes. infoWedge will characterize the drive cycle; monitor a 30-day demonstration of the hybrid truck; monitor and report emissions testing; and monitor long-term (6 months) demonstration to evaluate usage patterns, fuel consumptions, and maintenance needs.

Successful implementation of this project will show the ability to reduce emissions through reduced fuel use in the medium heavy-duty diesel truck off-road category. The reduced diesel fuel use also reduces greenhouse gas emissions and lowers overall, long-term operating costs for end users.

Association of Compost Producers
Julian, CA
Mobile Sources and Waste Solutions Technology Focus Area

The Association of Compost Producers will design and test an aerated static pile method of composting for a large-scale composting facility. The system consists of three components: substitution of diesel-powered loaders with electronic conveyor systems to build piles; the use of solar-powered electric blowers to replace diesel-powered windrow turners during the active phase of composting; and the use of finished compost biofilter covers, which reduce VOC emissions.

Pacific Gas and Electric Company
San Ramon, CA
Mobile Sources Technology Focus Area

Pacific Gas and Electric Company will develop and demonstrate an extended-range, electric-drive Class-6 bucket truck with electric worksite operation capability. The system will improve on-road fuel efficiency and allow crews to work on-site without running the diesel engine. Emission reductions will be achieved by reducing consumption of 4,895 gallons of diesel fuel per vehicle per year.

Because of the number of class-6 utility work trucks that operate in the Valley, this project has the potential to demonstrate significant emissions reductions in the on-road vehicle category. The reduced diesel fuel use also reduces greenhouse gas emissions and lowers overall, long-term operating costs for end users.

7.4 INTERAGENCY COLLABORATIVE DEMONSTRATION PROJECTS

In addition to projects selected through the request-for-proposals process, the District has partnered with other air quality agencies in the state to demonstrate new and emerging technologies.

Under-fired Charbroiler Emission Control Demonstration
South Coast Air Quality Management District (South Coast)
South Coast is currently conducting a demonstration project focused on control technology for under-fired charbroilers. South Coast released a program opportunity notice for this demonstration project in October 2011 to solicit of proposals from control device manufacturers. District staff assisted in reviewing the submitted proposals, making recommendations on which manufacturers should be allowed to submit their device to the testing protocol at the University of California, Riverside College of Engineering - Center for Environmental Research and Technology test kitchen facility.

This technology demonstration effort is testing promising prototype emission control devices, which will support future regulatory efforts at both South Coast and the District. As discussed in Chapter 4, reducing emissions from commercial cooking is critical for the Valley's attaining the 2006 PM2.5 standard, particularly in Kern County. In addition, as noted in Appendix D, reducing emissions from commercial charbroiling contributes to the District's Risk-based Strategy.

Zero-Emission Commercial Lawn and Garden Equipment Demonstration
California Air Resources Board
The Cordless Zero-Emission Commercial Lawn and Garden Equipment Demonstration Program will provide eligible cordless zero-emission commercial lawn and garden equipment to commercial landscape professionals (participants) who conduct business within the Valley. The cordless zero-emission lawn and garden equipment must be designated commercial-grade and used by commercial landscape professionals to complete multiple small to large gardening tasks over an eight-hour workday period. Eligible equipment may include, but is not limited to, lawn mowers, edgers, trimmers/brushcutters, hedge clippers, blowers/vacuums, sweepers, and chainsaws. The District opened a Request for Applications on August 20, 2012 and expects a program completion date of May 2013.

Participating equipment manufacturers/vendors (technology demonstrators) will be responsible for providing the equipment; training to participants on the safe and efficient operation of the equipment and maintenance; and providing materials necessary for daily operation. The participants will use the equipment in real-world settings to verify equipment durability and performance, battery capacity, and battery charge time. In addition, the participants will be responsible for providing monthly data and feedback to the District and technology demonstrators and may have the opportunity to keep the equipment upon submittal of all required data and information for the program. At the conclusion of the program, the District and the technology demonstrators will work together to complete a final report and submit the findings to ARB.

Natural Gas-Fired, Fan-Type Central Furnaces with Reduced NO_X Emissions
South Coast Air Quality Management District
South Coast is currently conducting a demonstration project focused on prototype natural gas-fired fan-type central furnaces with reduced NO_X emissions. South Coast released a program opportunity notice for this demonstration project in February 2010, which solicited a number of proposals from furnace manufacturers and gas industry technology developers in partnership with furnace manufacturers. This technology assessment of reduced NO_X central furnaces was initiated with the November 2009 amendment of South Coast Rule 1111. The District committed to financial support of the technology assessment in June 2010, and has provided $50,000 for the demonstration project.

The goal of this technology assessment is to demonstrate reduced NO_X furnaces capable of meeting an emissions goal of 14 nanograms NO_X per joule of useful heat. Based on the preliminary results of the South Coast furnace demonstration project, the technology required to meet new NOx standards will be available by 2015. The District has committed to amend Rule 4905 in 2014 to lower the NOx emission limits for residential furnaces and to examine the possibility of incorporating NOx limits for natural gas-fired, fan-type, commercial central furnaces into the rule, with an anticipated compliance date of 2015. This demonstration project will be an integral component of the District’s 2014 Rule 4905 amendment.

Vision for Clean Air: A Framework for Air Quality and Climate Planning
South Coast Air Quality Management District and California Air Resources Board
While the District’s air quality challenges are significant, many aspects of those challenges are not unique, and they are not isolated to the boundaries of the Valley air basin. Strategies for reducing emissions in the Valley are enhanced through partnerships and collaborations with other air districts and state agencies. The District seeks out opportunities for such collaborations to build strong relationships and even stronger attainment strategies.

In 2011, ARB, with the assistance of the District and South Coast AQMD, developed the *Vision for Clean Air: A Framework for Air Quality and Climate Planning*. The goal of this collaboration is to draft a common vision for mobile and stationary source strategies that integrate the need to meet federal air quality standards for PM2.5 and ozone, the need to reach California’s greenhouse gas goals, and the need to reduce public exposure to toxics (e.g. diesel particulates). This collaborative effort will take advantage of the efficiencies inherent in dealing with these three issues as inter-dependent problems with inter-dependent solutions.

Through the *Vision for Clean Air* effort, the three agencies have been evaluating pollutant reductions needed to meet overlapping air quality requirements for 2019, 2023, 2035, and 2050. These reductions will depend on the integration of transformative measures and emerging technologies (including zero- and near-zero emission goods movement) with long-range planning and control strategies. Critical to the attainment of targets will be the evaluation of the potential policies, legislation, infrastructure, and efficiencies that will ensure that South Coast, the Valley, and California are prepared to meet the long-term goals.

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Chapter 8

Legislative Strategy and Community Outreach

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Chapter 8: Legislative Strategy and Community Outreach

The extreme air quality challenges of the San Joaquin Valley (Valley) demand that the San Joaquin Valley Air Pollution Control District (District) and the community take extraordinary measures to improve air quality and public health. The District has developed the most stringent rules and regulations in the nation, and has already achieved such significant emissions reductions that the Valley is at the point of diminishing returns from new regulatory controls on stationary and area sources.

The District's legislative strategy and community outreach efforts are examples of the innovative multi-faceted approach that the District takes to reduce emissions in the Valley. These activities may not directly generate SIP-creditable emissions reductions, but they reinforce the District's and Valley's commitment in meeting National Ambient Air Quality Standards (NAAQS) as efficiently and expeditiously as possible.

8.1 LEGISLATIVE STRATEGY

Each year the District Governing Board adopts a legislative platform to guide District advocacy and policy efforts. Through state and federal lobbying efforts and delegation visits to Washington D.C., the District informs elected officials about Valley needs and concerns based on the priorities established in the legislative platform. With persistence, the District has secured support and additional incentive funding for programs critical to emissions reductions in the Valley.

Table 8-1 District 2012 Legislative Platform

SJVAPCD 2012 Legislative Platform Priorities Impacting PM2.5 Emissions[1]
• Support legislation that preserves and increases funding for air quality incentive programs. • Advance the District's Risk-based Strategy to provide for a more reasonable implementation of national ambient air quality standards by prioritizing public health. • Promote *clean cars* and urge the State of California and the California Air Resources Board (ARB) to continue to develop and adopt expanded Low-Emission Vehicle (LEV III) standards to reduce criteria air pollutants and greenhouse gasses and to strengthen the state's Zero-Emission Vehicle (ZEV) and Clean Fuels Outlet (CFO) infrastructure. • Support energy efficiency and alternative energy policies and initiatives that will result in emissions reductions and cost-effective alternatives to burning agricultural waste. • Support adequate resources and policies to reduce the impact of wildfires and their attendant public health impact.

[1] Partial list. Refer to http://www.valleyair.org/Board_meetings/GB/agenda_minutes/Agenda/2012/January/FinalGBItem15_LegPlatform_011912.pdf for complete SJVAPCD 2012 Legislative Platform.

8.1.1 Incentive Funding

While the District's incentive programs have been very successful, in part thanks to significant state and federal funding sources, continued success depends on continued funding. One of the top priorities in securing funding for air quality incentive programs is the extension, or re-authorization, of Carl Moyer program funding, as currently provided by Assembly Bill 923 (AB 923) and Senate Bill 1107 (SB 1107), and funding approved through AB 118 and creating the *California Alternative and Renewable Fuel, Vehicle Technology, Clean Air, and Carbon Reduction Act of 2007*. Currently, the District receives approximately $14 million per year in Carl Moyer and other funding under AB 923. Under its original legislation, this program will sunset on January 1, 2015.

Currently, AB 118 provides approximately $200 million annually (state wide) to fund air quality improvement projects, and to develop technology and alternative, renewable fuels. Similar to the Carl Moyer program, these funds will expire January 12, 2016 without re-authorization. AB 118 funds have not made up a significant portion of District incentive program revenue; however, the funds may become more important, particularly as the District becomes more involved in technology advancement projects.

The District is engaged as a stakeholder, along with other air districts, the California Air Resources Board (ARB), and the California Air Pollution Control Officers Association (CAPCOA) to develop a framework, legislative strategy, and policy language for re-authorizing these critical funding sources for California air districts in need of further emissions reductions.

8.1.2 Risk-based Strategy

The overall goal of the District's Risk-based Strategy is to minimize cumulative population exposure to air pollution and corresponding health risk in the region. This risk reduction goal is being pursued through the integration of emerging scientific knowledge into the District's control strategies, incentive programs, public communication, and enforcement actions. With this emphasis and prioritization on the health risks associated with PM2.5, the District will demonstrate how the Risk-based Strategy fits within and effectively supplements EPA's current regulatory framework. Chapter 2 details the District's approach using the Risk-based Strategy.

8.1.3 Lower Mobile Source Emissions

Since 1980, Valley stationary sources have reduced emissions by approximately 84%. Alternatively, vehicle miles traveled have increased by over 300%, and mobile source emissions now represent approximately 81% of NOx emissions in the Valley. The Valley's attainment progress depends on reductions in mobile source emissions, and through its legislative platform, the District supports the adoption of expanded low-emission vehicle standards (LEV III) and the strengthening of the state's zero-emission vehicle and clean-fuels outlet infrastructure programs. Tightening of these standards and expansion of programs will not only be necessary to reduce criteria air pollutant emissions, but will also help in reducing greenhouse gas emissions to meet state goals.

8.1.4 Energy Efficiency and Clean Energy Alternatives

In January 2010, the District adopted its Regional Energy Efficiency Strategy (REES). This policy document identifies the District's commitment to fostering energy efficiency and clean energy alternatives as opportunities for emissions reductions. As an alternative to open burning of agricultural waste—a high PM2.5 emission source—the District will continue to work with stakeholders and state agencies to develop additional biomass capacity to dispose of agricultural waste. Other efforts related to energy efficiency and clean energy alternatives include:

- Expansion of net metering and feed-in tariffs for use of solar and other renewable sources of energy;
- Promotion of energy efficiency programs for energy end users that will result in lower emissions and a more stable electrical distribution system; and
- Development of measures that incentivize and encourage low-emission technologies for use of waste gas as an alternative to waste-gas venting or flaring.

While the promotion and development of energy efficiency, renewable energy, and clean energy alternatives is central to many District policies and initiatives, quantifying emissions reductions related to energy efficiency and grid energy displaced by renewable energy and clean energy alternatives is complicated. Overall, electricity generation in California is relatively clean when compared to emission factors (GHG and criteria pollutant) from other states. California has been on the forefront of developing renewable energy sources, and has implemented regulations to ensure cleaner non-renewable energy. Whereas coal-fired electricity generation provides a significant percentage of electricity in other parts of the country, especially the eastern states, California relies more heavily on natural gas-fired power plants, which have lower emission rates for GHGs and criteria pollutants.

California imports 30% of its electricity from surrounding states.[2] The state's four major utility companies use this electricity, as well as resources from within the state, to supply continuous, reliable electricity to its customers. The inter-related nature of California's electricity transmission leads to a complex relationship between local energy efficiency programs and emissions reductions. Energy dispatch for needed demand is time and market dependent; the closest plant does not necessarily supply energy to the closest demand. In some cases, peak energy demand is met for areas outside the District, including Los Angeles and San Diego, with marginal (peaker) power plants within the Valley. Likewise, Valley demand may be met with electricity from marginal power plants

[2] California Energy Commission [CEC]:Total Electricity System Power, 2011 Total System Power in Gigawatt Hours. (2012). Retrieved August 21, 2012 from http://energyalmanac.ca.gov/electricity/total_system_power.html

outside the Valley. To complicate matters, the marginal plant used depends on the time of day, the minute-by-minute energy market, or other highly variable factors.

Using sophisticated dispatch modeling, Synapse Energy Economics Inc. was able to estimate NOx emissions reductions for renewable energy and energy efficiency projects within California and within each of the four major utility companies.[3] In preliminary model runs, Synapse showed that approximately 45 pounds of NOx could be reduced for each gigawatt of displaced base load electricity. Likewise, 76 pounds of NOx could be reduced for each gigawatt of displaced peak load electricity displaced by targeted energy efficiency efforts during peak demand hours.

To quantify emissions from projected energy efficiency programs, the District will engage in efforts to develop a detailed energy production and demand model for the Valley, likely in conjunction with upcoming ozone attainment planning. These efforts will include the use of dispatch and transmission modeling to quantify reductions not only in NOx and SOx, but greenhouse gas emissions. These efforts will be developed in coordination with a growing collaboration between state agencies and other air districts to integrate climate change planning, criteria pollutant attainment planning, and exposure planning with energy and efficiency planning.

8.1.5 Reduce Public Health Impacts from Wildfires

Air pollutant emissions from wildfires can exceed the total industrial and mobile source emissions in the Valley, resulting in adverse health effects in the region and throughout California. During the summer of 2008, California experienced a record number of wildfires, and the resulting emissions caused unprecedented levels of PM2.5 and ozone in the Valley, both with associated elevated health risks.

Reducing the threat of wildfires and the resulting air pollutants requires a sustained and multi-faceted approach that employs effective measures to reduce fuel supplies and adequate resources to manage fires when they occur. The District supports policies and initiatives that encourage rapid and efficient disposal of fuel through additional financial and staffing resources for public- and private-land prescribed burning. The District also supports funding for additional resources to manage wildfires once they occur. At the policy level, the District supports making environmental protection policies more consistent in their approach to fuel reduction measures, specifically with regards to using mechanized methods and prescribed burning to reduce fuel supply when other options are not feasible. Lastly, the District will continue to advocate for the incorporation of air quality concerns in prescribed burning and fire management techniques in federal policies. See Appendix D for additional discussion regarding this issue.

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[3] California Energy Commission. (2011, November). *Emission Reductions from Renewable Energy and Energy Efficiency in California Air Quality Management Districts: Final Project Report* (Draft). Synapse Energy Economics, Inc. for CEC Public Interest Energy Research (PIER) Program. CEC-500-2011-XXX. Available at http://uc-ciee.org/downloads/CAEmissionsReductions.pdf

8.2 COMMUNITY OUTREACH

The District's outreach programs are integral to the development, implementation, and success of the *2012 PM2.5 Plan*. In addition, engaging the public in efforts to reduce emissions is a key element of the District's attainment strategy. Education increases public support for new and controversial regulations.

The District's education and information program has expanded and evolved over the years. The following outreach programs are just some of the District's programs related to health-based PM2.5 control measures and strategies.

8.2.1 Real-Time Air Advisory Network (RAAN)

Pollution levels can vary greatly during the day. While the District issues a daily air quality forecast for each county in the air basin, localized air quality often deviates from these generalized, county-wide forecasts. Access to real-time data compensates for such deviations and helps ensure that outdoor activity can be limited to periods of the day when air quality is acceptable and healthier.

The District launched the Real-time Air Advisory Network (RAAN) in 2010. This program is the first communication network in the nation to provide automated notification of poor or changing local air quality to the public throughout the air basin. While the District initially developed the program for schools as a tool to determine appropriate levels of outdoor activity for their students, the District expanded the program in 2011, and it is now available to all Valley residents.

The District combines local air quality information with specific, concentration-based health recommendations that allow RAAN subscribers to make informed decisions about when and for whom outdoor activities should be limited. The knowledge that exercise magnifies the health risks of PM2.5 exposure motivated the District to develop the RAAN program. Heavy breathing, as during exercise, allows air pollutants, especially the smallest particles (those less than 0.1 microns (PM0.1), also referred to as ultrafine particles), to more easily penetrate the alveolar region of the lungs. Particles that make it to this region are absorbed directly into the body's bloodstream. A 2003 study[4] found that during moderate exercise, 80% of inhaled PM0.1 were deposited in the lungs, compared to 60% lung retention while a person is at rest. However, because the volume of air exchanged per minute increased substantially during exercise, overall PM0.1 deposition increases by as much as 450%.

Anyone can subscribe to RAAN at no charge through the District's website (www.valleyair.org); all that is required is the subscriber's email address. Once subscribed, the District will send email notifications with a link to the real-time data of the closest monitoring station within the District's extensive monitoring network. The

[4] Daigle, C.C., Chalupa, D.C., Gibb, F.R., Morrow, P.E., Oberdörster, G., Utell, M.J., and Frampton, M.W. (2003). Ultrafine Particle Deposition in Humans During Rest and Exercise. *Inhalation Toxicology*, 15, 539–552. DOI:10.1080/08958370390205065

District sends automated notifications on an hourly basis when air quality deteriorates or improves.

8.2.2 Real-Time Outdoor Activity Risk (ROAR)

To support the expanded RAAN program, the District developed the Real-time Outdoor Activity Risk (ROAR) scale. The levels of this scale provide specific recommendations and limitations for increasing levels of activity, from recess through competitive athletic events. This scale is based on the Air Quality Index system that is used for the daily air quality forecasts, but provides more detailed activity recommendations based on the latest health science. The ROAR system, when used in conjunction with the Air Quality Flag Program and daily air quality forecasts, is part of a comprehensive set of tools available to schools and the public for effective health protection.

8.2.3 Air Quality Flag Program

The Air Quality Flag Program is provided free of charge to hundreds of elementary and secondary schools throughout the Valley. The District provides to each school a set of colored flags mirroring the levels of the Air Quality Index (AQI), which are used to convey the daily air quality forecast. These flags represent a visual cue for students, faculty, and staff as to the daily air quality and potential risks associated with the expected air quality. School site training is a critical component of the flag program, providing school staff with the background and knowledge to effectively execute this program.

8.2.4 Check Before You Burn

The Check-Before-You-Burn outreach program is critical to the implementation of District Rule 4901—Wood Burning Fireplaces and Wood Burning Heaters. Rule 4901 was adopted in 2003 and, along with the Check-Before-You-Burn program, is credited with reducing levels of PM2.5 emissions during the winter season to historically low levels. The rule and outreach program was amended in 2008 to reflect more stringent federal health-based standards, and together they have achieved the highest level of public recognition and compliance of any District program, with 83% of Valley residents professing awareness of it based on a 2010 public survey.[5] According to the same survey, half the respondents (Valley-wide) with wood-burning devices never used them. These statistics are a testament to heightened public awareness resulting from the District's multilingual, multimedia, targeted public outreach campaigns.

Annual Check-Before-You-Burn outreach campaigns feature District Governing Board members in outdoor, radio, and video media speaking to the public about how to get involved in clean air activities. The District also uses extensive social media posts

[5] San Joaquin Valley Air Pollution Control District: Memorandum to SJVUAPCD Governing Board, District's Comprehensive Public Outreach and Education Program. Fresno, CA: Public Governing Board Study Session, September 29–30, 2010. Available at http://www.valleyair.org/Board_meetings/GB/agenda_minutes/Agenda/2010/Study_Session/Agenda_Item_13_Sep_29_2010.pdf

(Facebook and Twitter) to reach even more segments of the Valley's population. In addition, the District's toll-free information line and website receives hundreds of "hits" during the wood-burning season, specifically to access wood-burning forecast information.

8.2.5 Healthy Air Living

Most of the District's outreach activities and programs are covered by the Health Air Living umbrella. As a year-round message, the Healthy Air Living idea of "make one change" promotes and encourages Valley residents and businesses to implement voluntary measures to reduced emissions and improved air quality. Many of the emission-reduction recommendations address PM2.5 emissions, either directly emitted or as byproducts of other pollutants (e.g. reducing the number of miles traveled in a car reduces NOx and, therefore, particulates).

Components of the Health Air Living message include the *For Reel Video Contest*, aimed at middle-school, high-school, and college-aged students; the *Healthy Air Living Kids Calendar* for kindergarteners through high-school students; and *Healthy Air Living Pledge Cards*, which are customized for residents, businesses, schools, and faith-based organizations. In addition to these specific programs and others, the Healthy Air Living logo and message are incorporated into the District's communications, collateral, incentive materials, and outreach efforts.

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Chapter 9

Attainment Demonstration, RACM, RFP, and Contingency Measures

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Chapter 9: Attainment Demonstration, RACM, RFP, and Contingency Measures

The District's multi-faceted control strategy will achieve expeditious attainment Valley-wide. Kern County is expected to be the last portion of the San Joaquin Valley air basin (Valley) to attain the 24-hour PM2.5 standard, with attainment in 2019. This chapter shows that this plan satisfies federal PM2.5 plan requirements for attainment, reasonably available control measures (RACM), reasonable further progress (RFP), and contingency measures.

9.1 ATTAINMENT OUTLOOK

Initial attainment deadlines for PM2.5 are five years from the effective date of the nonattainment designation, though up to a five year extension is available. This sets the initial attainment date for the federal 24-hour PM2.5 standard (National Ambient Air Quality Standard, or NAAQS) at December 14, 2014, with an extension up to December 14, 2019, if needed. EPA has clarified that for an attainment date of December 14, 2014, air monitoring data collected in calendar years 2012 through 2014 would be used to determine whether the area has reached attainment.[1] December 14, 2019 attainment would then be based on air monitoring data collected in calendar years 2017 through 2019. To be granted an extension, an area must show that it cannot attain by 2014, but will attain as expeditiously as possible, no later than 2019.

Photochemical modeling and other technical analyses for this plan establish an emissions level at which the Valley would attain the federal 24-hour PM2.5 standard. Attaining the federal PM2.5 standard is extremely challenging, particularly in the southern Valley, and will require tremendous reductions in emissions. Given the significant contribution of ammonium nitrate to the Valley's PM2.5 concentrations, reductions in NOx emissions are particularly important. To achieve the NOx reductions critical for reaching attainment in the Valley, ARB has adopted regulations that will significantly reduce NOx emissions from various mobile sources. Achieving this level of emissions reductions requires adequate time and carries a tremendous cost. These reductions are ultimately achieved in time to bring most of the Valley into attainment well before 2019, with the exception of Bakersfield.

All areas of the Valley will attain the standard in 2019 with the regulatory controls in this plan (see Chapter 5). In particular, Kern County is projected to be the last portion of the Valley to attain, and is thus the area with the most need for additional emissions reductions through this plan. Table 9-1 shows that the 2019 emissions target would not be achieved in Kern County prior to 2019. In order for Bakersfield to attain a year earlier by 2018, an additional 2.1 tons per day of NOx reductions would be needed in

[1] U.S. Environmental Protection Agency (2012, March 2). Memorandum from the Office of Air Quality Planning and Standards: Implementation Guidance for the 2006 24-Hour Fine Particle (PM2.5) National Ambient Air Quality Standards (NAAQS). Pages 14-15. Retrieved from http://www.epa.gov/ttn/naaqs/pm/pdfs/20120302_implement_guidance_24-hr_pm2.5_naaqs.pdf

Kern County. To put this in perspective, achieving this level of emissions reductions is equivalent to virtually eliminating all passenger vehicles in Kern County in 2018.

The District's "no stone unturned" evaluation of emissions sources and emissions controls did not reveal any additional reasonably available emissions reductions opportunities that could expedite attainment, with all new control strategies scheduled for implementation by 2017. There are no unused control strategies available that could achieve the reductions necessary to accelerate attainment, because every reasonable control measure is already included in the plan (discussed further in Section 9.5). Thus, the modeled emissions targets cannot be achieved before 2019, and 2019 is the most expeditious attainment year available.

This *2012 PM2.5 Plan* demonstrates that the Valley will attain the federal 24-hour PM2.5 standard as expeditiously as possible, with all feasible measures and strategies being implemented to accomplish this goal. The non-regulatory control measures not credited in the attainment demonstration are achieving actual emissions reductions in the Valley. The District will continue to reduce emissions wherever possible to expedite air quality improvements Valley-wide.

Table 9-1 Kern County Attainment Outlook

Ref#		**2007 base year**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
1	Winter PM2.5 emissions inventory, reflecting adopted control measures	15.4	11.8	11.5	11.4	11.4	11.4	11.4
2	New control measure commitments (Table 9-1)		0	0	0.1	0.3	0.3	0.3
3	**Winter PM2.5 emissions inventory reflecting full plan control strategy (Line 1 – Line 2)**		11.8	11.5	11.3	11.1	11.1	11.1
4	**Direct PM2.5 Attainment Target**		**11.1**					
5	Winter NOx emissions inventory, reflecting full plan control strategy	115.4	63.8	58.6	54.5	51.5	48.9	46.8
6	**NOx Attainment Target**		**46.8**					
7	Winter SOx emissions inventory, reflecting full plan control strategy	3.6	1.8	1.8	1.8	1.8	1.8	1.8
8	**SOx Attainment Target**		**1.8**					
Attainment?			No	No	No	No	No	Yes
Projected attainment year			**2019**					

9.2 REASONABLY AVAILABLE CONTROL MEASURES (RACM)

Table 9-1 shows that sufficient emissions reductions will be achieved for the Valley to reach attainment in 2019. A PM2.5 attainment plan must also demonstrate implementation of RACM (reasonably available control measures): the collection of reasonable emissions reductions that, taken as a group, advance attainment of an air quality standard by at least one year. Put another way, the total of all potential emissions reductions opportunities that are *not* included as plan commitments must not advance attainment by one year. Measures that are not necessary to satisfy Reasonable Further Progress (RFP) or expeditious attainment are also not required RACM for the area.

To advance attainment by at least one year, the collective emissions reductions that could be achieved through unused but reasonably available controls would have to achieve the 2019 emissions levels by 2018 in Kern County. Per the District's Risk-based Strategy, through which the District prioritizes public health benefits in its attainment control strategy, the District is adopting its new rule amendments to reduce directly-emitted PM2.5 to achieve the necessary PM2.5 reductions by 2017, in advance of the 2019 attainment year. Similarly, the SOx emissions level needed for attainment is being achieved by 2014.

Advancing attainment by one year would thus depend on expediting NOx reductions. However, many NOx emissions are being reduced as adopted regulations are fully implemented through fleet turn-over and normal equipment replacement. In fact, as demonstrated in Appendix B, 92% of NOx reductions from the 2007 base emission inventory to attainment in 2019 come from mobile sources. These reductions cannot be expedited through additional stationary and area source regulations, for which the District has regulatory authority. Based on the difference between 2018 and 2019 NOx emissions levels shown in Table 9-2, unused control measures would have to achieve 2.1 tons per day (tpd) of NOx reductions in Kern County to advance attainment by one year. However, as previously discussed, there are no unused control measures in this plan because every reasonable control measure is used in this plan.

RACM are, by definition, reasonable. Although an air quality attainment plan must include a thorough analysis of reasonably available measures, it need not analyze every conceivable measure; reasonability must drive the analysis. Any measure that is absurd, unenforceable, impractical, or would cause severely disruptive socioeconomic impacts is unreasonable.

This analysis must consider all agencies' opportunities together, but the starting point is the separate analyses of each agency:

- **District:** as discussed in Appendix D, and Chapter 5, all reasonable control measures under the District's jurisdiction are being implemented. The District has adopted many of the toughest stationary and area sources rules in the nation. 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.

- **ARB:** as discussed in Appendix C, all reasonable control measures under ARB's jurisdiction for mobile sources are being implemented. Given the significant emission reductions needed for attainment in California, ARB has adopted some of the most stringent control measures nationwide for on-road and off-road mobile sources and the fuels that power them. 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.

- **Metropolitan Planning Organizations (MPOs):** as discussed in Appendix C, all reasonable control measures under MPO jurisdiction are being implemented. 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.

There are no reasonable regulatory control measures from any agency's jurisdiction that have been excluded from use in this plan; therefore, there are no emissions reductions associated with unused regulatory control measures. The District also considered whether ammonia emissions reductions could expedite attainment. Based on 2018 emissions and analysis conducted for this plan, the District estimates the 2018 design value for Bakersfield-California is at least 1 $\mu g/m^3$ higher than the attainment level. It would therefore take at least 125 tons of additional ammonia emissions reductions to advance attainment by one year. As discussed in Chapter 5, this is an infeasible amount of emissions reductions for ammonia, since there are no control strategies that exist or have been identified which could achieve such large reductions.

9.3 REASONABLE FURTHER PROGRESS (RFP)

Clean Air Act (Act) Section 171(1) defines reasonable further progress (RFP) as incremental emission reductions leading to the attainment date. EPA's interpretation of the RFP requirement for federal PM2.5 standards is "generally linear progress" from the base year to the attainment year, demonstrated at RFP milestone years.[2] "Generally linear progress" is calculated in an exactly linear fashion.

This plan identifies 2019 as the most expeditious attainment date practicable in the San Joaquin Valley, with a baseline year of 2007. For the federal 24-hour PM2.5 standard, the RFP milestone years are 2014 and 2017.[3] RFP is demonstrated for the

[2] 72 FR 20633, codified at 40 CFR 51 Subpart Z Section 51.1000 (Definitions)

[3] U.S. Environmental Protection Agency (2012, March 2). Memorandum from the Office of Air Quality Planning and Standards: Implementation Guidance for the 2006 24-Hour Fine Particle (PM2.5) National Ambient Air Quality Standards (NAAQS). Page 16. Retrieved from http://www.epa.gov/ttn/naaqs/pm/pdfs/20120302_implement_guidance_24-hr_pm2.5_naaqs.pdf

nonattainment area as a whole. RFP requirement targets and attainment demonstrations are as follows:

1. Determine the Emissions Inventory of the Valley with the Plan control strategy for the baseline year, the RFP years, and the attainment year.

Table 9-2 Emissions Inventory with Plan Control Strategy (tpd)

Description	2007	2014	2017	2019
Direct PM2.5				
Emission Inventory (Table B-1)	87.1	64.4	63.5	64.0
Subtract Additional CM Reductions (Table 10-1)	0.0	0.0	0.3	0.3
Projected Direct Emissions Inventory, reflecting full plan control strategy	87.1	64.4	63.2	63.7
NOx				
Projected Emissions Inventory, reflecting full plan control strategy (Table B-2)	465.1	275.7	226.9	208.5
SOx				
Projected Emissions Inventory, reflecting full plan control strategy (Table B-3)	12.8	8.6	8.8	9.0

2. Determine the total reductions from the 2007 baseline emission inventory that must be achieved to reach attainment.

Table 9-3 Total Reductions Necessary to Reach Attainment (tpd)

Pollutant	2007 Baseline Emissions Inventory	Attainment Emissions Level	Reductions Needed
Direct PM2.5	87.1	63.7	23.4
NOx	465.1	208.5	256.6
SOx	12.8	9	3.8

3. Determine the fraction of reductions that are achieved in each RFP milestone year. The base year of 2007 and attainment year of 2019 span a 12-year period.
   - 2014 occurs at year seven of twelve (7/12), so **58.3%** of the needed emissions reductions must occur by 2014.
   - 2017 occurs at year ten of twelve (10/12), so **83.3%** of the needed emissions reductions must occur by 2017.

4. Determine the RFP target emissions levels using reduction fractions.

Table 9-4 Target Emissions Levels for RFP Milestone Years (tpd)

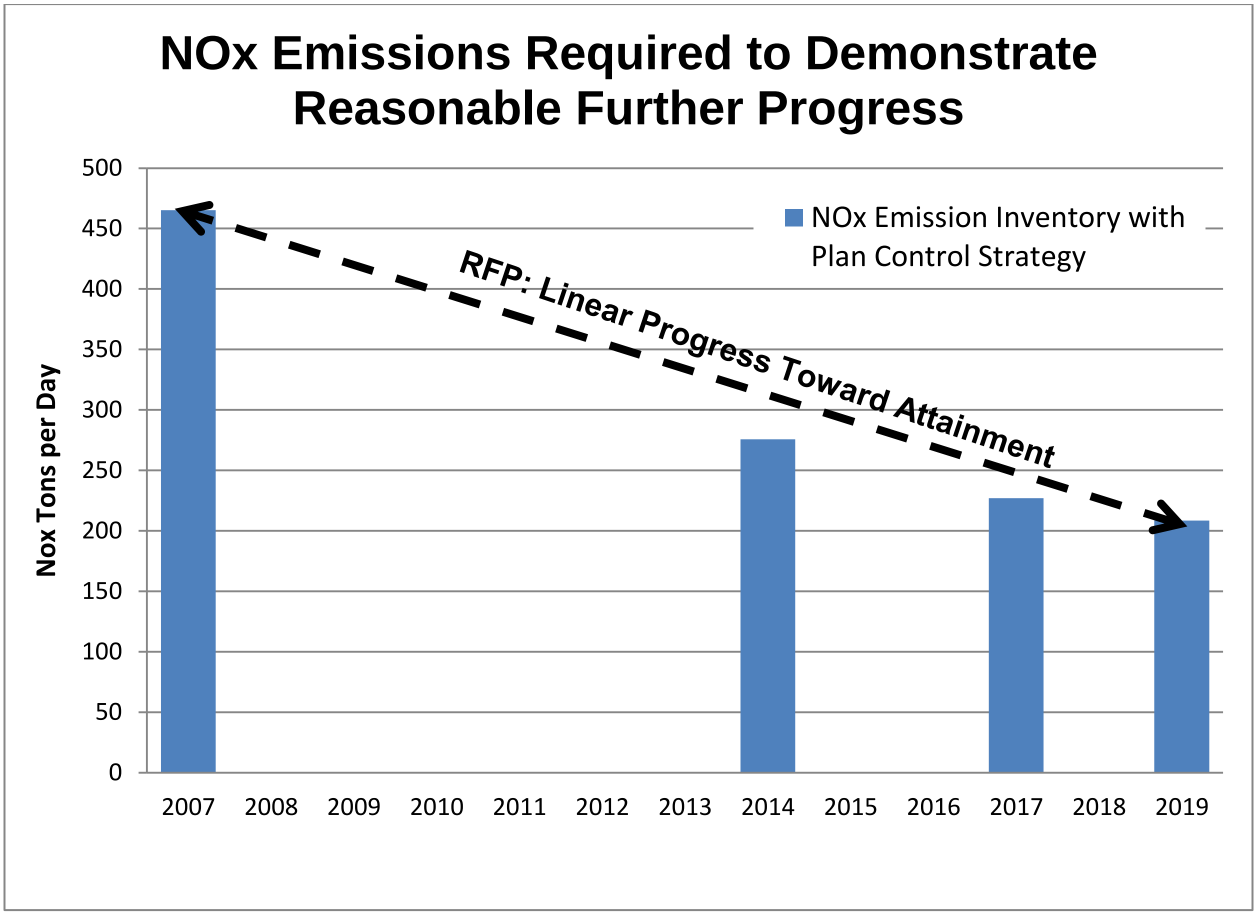
Pollutant	2007 Emissions Inventory	Reductions Needed	2014		2017	
			Tons to be reduced *(B x 58.3%)*	RFP target emissions level *(A-C)*	Tons to be reduced *(B x 83.3%)*	RFP target emissions level *(A-E)*
	A	*B*	*C*	*D*	*E*	*F*
Direct PM2.5	87.1	23.4	13.6	73.5	19.5	67.6
NOx	465.1	256.6	149.6	315.5	213.7	251.4
SOx	12.8	3.8	2.2	10.6	3.2	9.6

5. Compare RFP target emissions level (Table 9-4) to the projected emissions inventory (Table 9-2) to determine compliance with RFP targets.

Table 9-5 RFP Target Demonstration (2014 and 2017)

	2014			2017		
	RFP target emissions level	Projected emissions inventory	RFP target met?	RFP target emissions level	Projected emissions inventory	RFP target met?
Direct PM2.5	73.5	64.4	Yes	67.6	63.2	Yes
NOx	315.5	275.7	Yes	251.4	226.9	Yes
SOx	10.6	8.6	Yes	9.6	8.8	Yes

Figure 9-1 NOx RFP Demonstration



9.4 CONTINGENCY MEASURES

Contingency measures are extra emissions reductions that go into effect without further regulatory action. In an attainment plan, the measures must be "extra" in the sense that the reductions are not accounted for in RFP or in the attainment demonstration. Contingency reductions must start occurring automatically, without any further regulatory action, in the following scenarios:

- **RFP contingencies:** Used if planned emissions controls fail to reach the emissions targets specified in the attainment plan for RFP. The need to implement RFP contingencies is based on the emissions inventory in the RFP milestone years.
- **Attainment contingencies:** Used if a region fails to attain a federal standard by the final attainment date. The need to implement attainment contingencies is based on ambient air quality data as of the end of the attainment year. If EPA finds that an area fails to attain a standard on time, contingency reductions must be implemented automatically. An area often must adopt a new attainment plan, and sometimes other penalties apply as well, depending on the requirements associated with the standard in question.

The contingency years for this plan are the RFP milestone years (2014 and 2017) and the attainment year (2019). The total emissions reductions available from contingency measures should be equivalent to about one year of reductions needed for RFP[4]. This is based on the overall level of reductions needed to demonstrate attainment (see Table 9-3) divided by the number of years between the base year and the attainment year (12 years). Table 9-6 shows the resulting contingency need for each pollutant.

Table 9-6 Contingency Emissions Reductions Target (in tons per day, or tpd)

	Contingency Need = "One year's worth of RFP"
PM2.5	2.0
NOx	21.4
SOx	0.3

Interpollutant trading can be used to demonstrate equivalent emissions reductions levels between PM2.5, NOx, and SOx reductions strategies. Appendix G (Weight of Evidence Analysis) documents the methodology used to develop the relative efficacy of emission reductions from the different PM2.5 precursors based on photochemical modeling sensitivity runs. The current modeling using Valley-wide emissions reductions demonstrates that the greatest benefits are achieved from reductions in directly emitted PM2.5, followed by NOx (based on EPA's relative response factor procedures). Kern County specific model sensitivity runs were also conducted to evaluate the benefits of

[4] Clean Air Fine Particle Implementation Rule [PM2.5 Implementation Rule]. 72 Fed. Reg. 79, pp. 20586–20667. At 20642-43. (2007, April 25). Retrieved from http://www.gpo.gov/fdsys/pkg/FR-2007-04-25/pdf/E7-6347.pdf#page=1

emission reductions focused on the Bakersfield area. These runs show that directly emitted PM2.5 emission reductions are approximately eight times more effective than NOx reductions. Refer to Appendix G Section 10.c. (Evaluation of precursor sensitivity) and Section 11 (Summary) for the complete analysis and discussion). Additionally, due to the photochemistry of ammonium sulfate formation, one ton of SOx reductions is equivalent to one ton of PM2.5 reductions; therefore, for contingency purposes, SOx is equivalent to directly emitted PM2.5.

9.4.1 What Qualifies as a Contingency Measure?

Contingency measures must be fully adopted rules or control measures that are ready to be implemented quickly without significant additional action by the state or local agency or by EPA[5]. The plan should contain trigger mechanisms and a schedule for the contingency measure implementation. Contingency measures can include measures already adopted and scheduled for implementation, as long as these measures are not relied on to provide emissions reductions needed to provide for RFP or expeditious attainment.

Based on these general contingency requirements, the District is utilizing three types of contingency measures:

A. Surplus reductions from implementation of traditional regulations
B. Regulations with a contingency trigger
C. SIP-creditable incentive-based emissions reductions

9.4.1.1 Surplus Reductions from Implementation of Traditional Regulations

Although contingency measures must be surplus to RFP and attainment calculations, areas are not required to wait until there is an RFP or attainment failure to implement the measures. In fact, designing an effective adopted-but-not-implemented approach with an appropriate implementation trigger is only an option in very limited circumstances (see 9.4.1.2). Both already-adopted regulations and new or amended regulations to be pursued under this plan

As shown in the RFP demonstration in this chapter, significant regulatory emissions reductions are being achieved by 2014 and 2017 – more than the minimum needed to demonstrate RFP in those years. As such, the difference between the RFP target emissions level and the actual projected emissions level can serve as contingency reductions in 2014 and 2017. Using the data in Table 9-5, Table 9-7 shows amount of reductions available in 2014 and 2017.

[5] Clean Air Act Section 172(c)9, 40 CFR 51.1012.

Table 9-7 Reductions Surplus to RFP for Contingency (tpd)

Year	2014			2017		
	RFP target emissions level	Projected emissions inventory	Contingency	RFP target emissions level	Projected emissions inventory	Contingency
PM2.5	73.5	64.4	9.1	67.6	63.2	4.4
NOx	315.5	275.7	39.8	251.4	226.9	24.5
SOx	10.6	8.6	2.0	9.6	8.8	0.8

As the 2019 attainment contingency need would not occur until 2020 (since attainment would be based on air quality data collected through the end of 2019), the additional PM2.5 and NOx reductions occurring between 2019 and 2020 can serve as attainment contingencies (Table 9-8). SOx will not be further reduced between 2019 and 2020 and is thus omitted from Table 9-8.

Table 9-8 Attainment Contingencies from Traditional Regulatory Reductions (tpd)

		2019 emissions	**2020 emissions**	**Attainment Contingency**
PM2.5	Adopted measures	*62.0*	*61.9*	*0.1*
	Rule 4692 reduction for contingency accounting (Appendix D)			*0.3*
	Rule 4901 reduction for contingency accounting (Appendix D)			*1.3*
	Total			**1.7**
NOx (adopted measures only)		*208.5*	*196.2*	**12.3**

The control measures achieving the contingency reductions in Tables 9-7 and 9-8 are as follows:

- **Rule 4692 PM2.5 contingency:** The modeling conducted for this plan shows that reducing emissions from under-fired charbroiling by 20% in Kern County is necessary for attainment; thus, only the reductions achieved in Kern County are accounted for in the attainment demonstration. By reducing emissions from under-fired charbroiling 20% Valley-wide, the District achieves significant health benefits Valley-wide per the District's Risk-based Strategy, and the emissions reductions achieved in the Valley's other seven counties can be counted as contingency reductions, as reflected in Table 9-9. This contingency reduction approach would be valid for 2017 as well, but is not needed to show sufficient contingency reductions as shown in Table 9-10 at the end of this chapter.
- **Rule 4901 PM2.5 contingency:** Similarly, the modeling conducted for this plan shows that lowering the Rule 4901 wood burning curtailment level from 30 µg/m³ to 20 µg/m³ is necessary for attainment in both Kern County and Kings County; thus, only the reductions achieved in Kern and Kings Counties are accounted for in the attainment demonstration. By lowering the wood burning curtailment

Valley-wide, the District achieves significant health benefits Valley-wide per the District's Risk-based Strategy, and the Rule 4901 emissions reductions achieved in the Valley's other six counties can be counted as contingency reductions, as reflected in Table 9-9. This contingency reduction approach would be valid for 2017 as well, but is not needed to show sufficient contingency reductions as shown in Table 9-9 at the end of this chapter.

- **Adopted mobile source measures for NOx contingency:** Most of the total NOx contingency reductions (12.2 tpd of the total 12.3 tpd NOx reduction need in 2019, for example) are from adopted mobile source control measures for the following sources:
    - Passenger cars, light-duty vehicles, and medium-duty vehicles
    - Heavy-duty trucks
    - Buses
    - Aircraft
    - Trains
    - Commercial harbor craft
    - Motor homes
    - Off-road equipment
    - Farm equipment
- **Adopted stationary and area source measures for NOx contingency**: Some of the total NOx contingency reductions (0.1 tpd of the total NOx reduction need in 2019, for example) are from adopted District rules:
    - Rule 4307 (Boilers, Steam Generators, and Process Heaters- 2.0 MMBtu/hr to 5.0 MMBtu/hr)
    - Rule 4308 (Boilers, Steam Generators, and Process Heaters- 0.075 MMBtu/hr to less than 2.0 MMBtu/hr)
    - Rule 4320 (Advanced Emission Reduction Options for Boilers, Steam Generators, and Process Heaters Greater than 5.0 MMBtu/hr)
    - Rule 4702 (Internal Combustion Engines)
    - Rule 4103 (Open Burning)

9.4.1.2 Regulations with Contingency Trigger

The District's 2008 Amendment to Rule 4901 (Wood Burning Fireplaces and Wood Burning Heaters) included a contingency provision (Section 5.6.5 of Rule 4901) that would lower the mandatory wood burning curtailment threshold if the Valley fails to attain the 1997 PM2.5 standard by April 2015. The contingency, if implemented, would lower the curtailment level from a forecast 24-hour level PM2.5 level of 30 µg/m³ to 20 µg/m³, which would result in more "No Burn" days and more emissions reductions from residential wood combustion. The trigger for this measure is that the lower threshold would become effective 60 days after final EPA rulemaking that the Valley failed to attain the federal annual PM2.5 standard set in 1997 by the applicable attainment deadline (April 2015). Since the wood burning curtailments are effective from November through February, the earliest the contingency level would take effect would be November 1, 2015, pending EPA finding that the Valley failed to attain.

If, as projected in the *2008 PM2.5 Plan*, the Valley reaches the PM2.5 standard by the deadline, then this contingency measure would not be used. The Governing Board directed District staff to report on the likely necessity of this existing contingency measure or the potential for substitute measures. However, this *2012 PM2.5 Plan* contains a commitment to lower the curtailment level 20 µg/m³ officially before for the current contingency trigger could occur. As such, the need to evaluate the likely necessity of this existing contingency measure is now moot, with the contingency level being implemented regardless of a failure to attain the 1997 PM2.5 standard. The contingency reductions still apply to the *2008 PM2.5 Plan*, since that plan did not rely on those reductions.

Given EPA's acceptance of the previous Rule 4901 contingency measure, though, the District commits to include a contingency threshold in the next Rule 4901 amendment. Since the curtailment level in rule would be 20 µg/m³, the District proposes a new contingency level of 15 µg/m³, to be implemented if EPA finds that the Valley fails to attain the federal 24-hour PM2.5 standard set in 2006 by 2019. The emissions reductions that would be achieved by this contingency measure are based on the increased number of "No Burn" days resulting from the curtailment threshold decreasing from 20 µg/m³ down to 15 µg/m³: **1.5 tpd of PM2.5,** as an average day during the wood burning season (November - February). However, average winter reductions greatly understate the full impact of Rule 4901 "No burn" days, which reduce some of the most harmful species of particulates in the times and places where air quality is forecast to reach unhealthy levels. A Valley-wide no-burn day achieves a direct PM2.5 emission reduction of 16.7 tons. No other single regulation achieves this level of effectiveness. This Rule 4901 Contingency-Trigger reduction is in addition to the contingency reductions quantified in section 9.4.1.1 above.

9.4.1.3 SIP-Creditable Incentive-Based Emissions Reductions

As discussed in Chapter 6 of this plan, voluntary incentive programs achieve emissions reductions beyond those achieved by regulations alone. Incentive programs accelerate the adoption of cleaner technologies and encourage the use of cleaner technologies by those not yet subject to air quality regulations. Incentives allow the District to reduce emissions from source categories outside of the District's traditional regulatory authority, as well as source categories where financial hardship would otherwise prevent traditional control strategies from being implemented. As discussed in Chapter 6, and reflected in Table 10-1, the District will be developing a new rule (Rule 9610) allowing for SIP-credit of incentive based emissions reductions.

The District will continue to seek opportunities for additional incentive reductions Valley-wide to achieve emissions reductions for contingency and expedite public health benefits Valley-wide. However, as this plan's modeling and analysis shows the particular effectiveness of localized controls, replacing of on- and off-road engines that are likely to operate in Kern County would be especially effective in accelerating Bakersfield's attainment of the 24-hour PM2.5 standard. The District will consider opportunities to target mobile source incentive reductions, per this PM2.5 standard as well as the Valley's other attainment and public health considerations.

Both ARB and the District are committed to pursuing the needed funding and to target incentive programs to provide for expeditious attainment. Some source categories that are good candidates for such targeted incentive reductions, due to their associated post-2019 regulatory deadlines, include, but are not limited to:

- Further emissions reductions from construction equipment to accelerate conversion of older construction equipment to Tier 4. Upon targeting construction fleet turnover in the Kern County area, the District could work to encourage use of the cleanest equipment (and discourage the use of other equipment) during episodes generating poor air quality.
- Accelerated retirement of older light- and medium-duty vehicles
- Accelerated retirement of older on- and off-road diesel vehicles and equipment, including on-road diesel, off-road, and agricultural equipment
- Further emission reductions from freight locomotives, including the introduction of Tier 4 locomotives in the South Coast air basin that then travel through the Valley

At this time, the District proposes to achieve **1.9 tpd of NOx reductions** through Rule 9610 and related incentive programs to use as contingency for 2019. Beginning in 2017, the District will evaluate the Valley's progress towards attainment of the 2006 federal PM2.5 standard. If needed, the District will explore any other legally feasible corrective actions that may be suitable, such as additional reductions from ARB, and amend the SIP if appropriate before the Rule 9610 contingency reductions are needed.

9.4.2 Sufficient Contingency Reductions

Areas like the Valley that have significant nonattainment challenges have developed several generations of aggressive and far-reaching emission reduction measures to meet various Clean Air Act requirements. The result of this "no stone left unturned" policy is that when viable emission reductions are identified, they are implemented to contribute to expeditious attainment. Reductions are not usually held in reserve to be used only if an area fails to meet a milestone. As a result, contingency measure demonstrations in the Valley have been a challenge, historically.

However, this chapter has outlined three types of contingency measures being used to meet the contingency reductions required for this plan:

- Surplus from traditional regulations (see Section 9.4.1.1)
- Regulations with contingency trigger (see Section 9.4.1.2)
- SIP-creditable incentives (see Section 9.4.1.3)

Table 9-9 shows how these approaches together generate enough emissions reductions to meet the contingency reductions required for this plan.

Table 9-9 Demonstration of Sufficient Contingency Reductions

	2014	2017	2019	Data reference
PM2.5				
Surplus from traditional regulations	*9.1*	*4.4*	*1.7*	Tables 9-7 and 9-8
Regulations with contingency trigger	*0*	*0*	*1.5*	Section 9.4.1.2
SIP-creditable incentives	*0*	*0*	*0*	Section 9.4.1.3
Subtract PM2.5 reductions, trade for SOx	*0*	*0*	*-0.3**	1:1 trading ratio*
Subtract PM2.5 reductions, trade for NOx			*-0.9**	1:8 trading ratio*
Total contingency reductions achieved	9.1	4.4	2.0	
Contingency reductions required	2.0			Table 9-6
Contingency need met?	*Yes*	*Yes*	*Yes*	
NOx				
Surplus from traditional regulations	*39.7*	*24.4*	*12.3*	Tables 9-7 and 9-8
Regulations with contingency trigger	*0*	*0*	*0*	Section 9.4.1.2
SIP-creditable incentives	*0*	*0*	*1.9*	Section 9.4.1.3
Substitute PM2.5 reductions			7.2*	Above, with 1:8 trading ratio*
Total contingency reductions achieved	39.7	24.4	21.4	
Contingency reductions required	21.4			Table 9-6
Contingency need met?	*Yes*	*Yes*	*Yes*	
SOx				
Surplus from traditional regulations	*2.0*	*0.8*	*0*	Tables 9-7 and 9-8
Regulations with contingency trigger	*0*	*0*	*0*	Section 9.4.1.2
SIP-creditable incentives	*0*	*0*	*0*	Section 9.4.1.3
Substitute PM2.5 reductions			*0.3**	Above, with 1:1 trading ratio*
Total contingency reductions achieved	2.0	0.8	0.3	
Contingency reductions required	0.3			Table 9-6
Contingency need met?	*Yes*	*Yes*	*Yes*	

* 1 ton of direct PM2.5 emissions reductions is equivalent to 1 ton of SOx reductions or 8 tons of NOx reductions as demonstrated in the Weight of Evidence (Appendix G). These ratios are conservative estimates summarizing the plan as a whole, not reflecting ratios appropriate for New Source Review (NSR)

Chapter 10

Summary of Attainment Strategy

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Chapter 10: Summary of Attainment Strategy

This *2012 PM2.5 Plan* presents sound science and extensive analysis to determine which strategies would help the Valley to expeditiously attain EPA's 2006 PM2.5 standard. This *2012 PM2.5 Plan* also presents the District's comprehensive evaluation of opportunities to reduce emissions of PM2.5 and its precursors in the Valley. This chapter summarizes the District's resulting multi-faceted control strategy, which will generate continuous air quality improvements Valley-wide and attainment of EPA's 2006 PM2.5 standard in all areas of the Valley in 2019.

Public health has been the number one priority throughout this effort. Toward that end, this chapter also discusses the public health benefits that will be achieved through implementation of this plan's attainment strategy.

10.1 SUMMARY OF *2012 PM2.5 PLAN* CONTROL STRATEGY

The District's multi-faceted control strategy includes traditional regulatory control measures as well as innovative incentive programs, technology demonstration projects, further study measures, outreach, policy initiatives and more. This plan's strategy is presented in Chapters 5 through 8 and summarized in Tables 10-1 through 10-4.

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Table 10-1 District Regulations Contributing to Continued PM2.5 Improvement

Adopted District Regulatory Control Measures	*Date Adopted/ Last Amended*
Rule 4103 Open Burning	04/15/2010
Rule 4106 Prescribed Burning and Hazard Reduction Burning	1/21/2001
Rule 4204 Cotton Gins	2/17/2005
Rule 4307 Boilers, Steam Generators, and Process Heaters 2 to 5 MMBtu/hr	05/19/2011
Rule 4308 Boilers, Steam Generators, and Process Heaters 0.075 to <2 MMBtu/hr	12/17/2009
Rule 4309 Dryers, Dehydrators, and Ovens	12/15/2005
Rule 4311 Flares	06/18/2009
Rules 4306 & 4320 Boilers, Steam Generators, and Process Heaters >5 MMBtu/hr	10/16/2008
Rule 4352 Solid Fuel Fired Boilers, Steam Generators and Process Heaters	12/15/2011
Rule 4354 Glass Melting Furnaces	05/19/2011
Rule 4550 Conservation Management Practices	08/19/2004
Rule 4692 Commercial Charbroiling	09/17/2009
Rule 4702 Internal Combustion Engines	08/18/2011
Rule 4703 Stationary Gas Turbines	09/20/2007
Rule 4901 Wood Burning Fireplaces and Wood Burning Heaters	10/16/2008
Rule 4902 Residential Water Heaters	03/19/2009
Rule 4905 Natural Gas-Fired, Fan-Type Residential Central Furnaces	10/20/2005
Regulation VIII Rules Fugitive PM10 Prohibitions	08/19/2004
Rule 9310 School Bus Fleets	09/21/2006
Rule 9410 Employer-based Trip Reduction	12/17/2009
Rule 9510 Indirect Source Review	12/12/2005

Table 10-2 ARB Regulations Contributing to Continued PM2.5 Improvement

Adopted ARB Regulations	*Date Adopted*
Advanced Clean Car Program	1/27/2012
Expanded Off-Road Recreational Vehicle Emission Standards	12/16/2011
Cleaner In-Use Off-Road Equipment	12/17/2010
Port Truck Modernization	12/17/2010
Cleaner In-Use Heavy-Duty Trucks	12/16/2010
Accelerated Introduction of Cleaner Line-Haul Locomotives	06/24/2010
Enhanced Fleet Modernization Program (formerly called the Expanded Vehicle Retirement Program)	06/24/2010

Adopted ARB Regulations	Date Adopted
Smog Check Improvements	08/31/2009
Portable Outboard Marine Tanks	09/25/2008
Clean Up Existing Harbor Craft	11/15/2007
Voluntary Accelerated Retirement Regulation	12/07/2006
Emergency Regulation for Portable Equipment Registration Program, Airborne Toxic Control Measures and Portable and Stationary diesel-Fueled Engines	12/06/2006
Airborne Toxic Control Measure for Stationary Compression Ignition Engines (Agricultural Eng. Exemption removal)	11/16/2006
Distributed Generation Guidelines and Regulations	10/19/2006
Zero Emission Bus Regulation	10/19/2006
Heavy-Duty In-Use Compliance Regulation	09/28/2006
On-Board Diagnostic II	09/28/2006
Off-Highway Recreational Vehicles and Engines	07/20/2006
California Motor Vehicle Service Information Rule	06/22/2006
Portable Equipment Registration Program	06/22/2006
Fork Lifts and Other Industrial Equipment (Large Off-Road Spark Ignition Engines > 1 liter)	05/26/2006
Technical Amendments to Evaporative Exhaust and Evaporative Emissions Test Procedures	05/25/2006
Diesel Verification Procedure, Warranty & In-Use	03/23/2006
AB1009 Heavy-Duty Vehicle Smoke Inspection Program	01/26/2006
Diesel Particulate Matter Control Measure for On-Road Heavy-Duty Diesel-Fueled Vehicles Owned or Operated by Public Agencies and Utilities	12/08/2005
Mobile Cargo Handling Equipment at Ports and Intermodal Rail Yards	12/08/2005
Marine Inboard Sterndrive Engines	11/17/2005
Requirements to Reduce Idling Emissions from New and In-Use Trucks, Beginning in 2008	10/20/2005
2007-2009 Model-Year Heavy Duty Urban Bus Engines and the Fleet Rule for Transit Agencies	09/15/2005
Portable Fuel Containers (PFC) [Part 1 of 2]	09/15/2005
Portable Fuel Containers (PFC) [Part 2 of 2]	09/15/2005
On-Board Diagnostic System Requirements for 2010 and Subsequent Model-Year Heavy-Duty Engines (HD OBD)	07/21/2005
Airborne Toxic Control Measure for Stationary Compression Ignition Engines amendments	05/26/2005
Transit Fleet Rule	02/24/2005
Off-Road Compression Ignition Engines	12/09/2004
Emergency Regulation for Temporary Delay of Diesel Fuel Lubricity Standard	11/24/2004
Diesel Fuel Standards for Harbor Craft & Locomotives	11/18/2004
Greenhouse Gas	09/23/2004

Adopted ARB Regulations	Date Adopted
Airborne Toxic Control Measure for Diesel Particulate from Diesel Fueled Commercial Vehicle Idling	07/22/2004
Urban Bus Engines/Fleet Rule for Transit Agencies	06/24/2004
Engine Manufacturer Diagnostic System Requirements for 2007 and Subsequent Model Heavy Duty Engines	05/20/2004
Heavy Duty Diesel Engine-Chip Reflash	03/27/2004
Airborne Toxic Control Measure for Diesel-Fueled Portable Engines	02/26/2004
Modifications to the Statewide Portable Equipment Registration Program (PERP) Regulations	02/26/2004
CA Motor Vehicle Service Information Rule	01/22/2004
Airborne Toxic Control Measure for Diesel Particulate for Transport Refrigeration Units	12/11/2003
Airborne Toxic Control Measure for Stationary Compression Ignition Engines	12/11/2003
Diesel Retrofit Verification Procedure, Warranty and In-Use Compliance Requirements Amendments	12/11/2003
Small Off-Road Engines (SORE)	09/25/2003
Solid Waste Collection Vehicles	09/24/2003
Off-Highway Recreation Vehicles	07/24/2003
Specifications for Motor Vehicle Diesel Fuel	07/24/2003
Zero Emission Vehicle Amendments for 2003	03/25/2003
Airborne Toxic Control Measure for Diesel Particulate from School Bus Idling	12/12/2002
Low Emission Vehicles II. Align Heavy Duty Gas Engine Standards with Federal Standards; minor administrative changes	12/12/2002
Revision to Transit Bus Regulations Amendments	10/24/2002
Diesel Retrofit Verification Procedure, Warranty and In-Use Compliance Requirements	05/16/2002
On-Board Diagnostic II Review Amendments	04/25/2002
Airborne Toxic Control Measure for Outdoor Residential Waste Burning	02/21/2002
Voluntary Accelerated Light Duty Vehicle Retirement Regulations	02/21/2002
California Motor Vehicle Service Information Rule	12/13/2001
Distributed Generation Guidelines and Regulations	11/15/2001
Low Emission Vehicle Regulations	11/15/2001
Heavy Duty Diesel Engine Standards for 2007 and Later	10/25/2001
Marine Inboard Engines	7/26/2001
Zero Emission Vehicle Infrastructure and Standardization of Electric Vehicle Charging Equipment	06/28/2001
Zero Emission Vehicle Regulation Update	01/25/2001
Heavy Duty Diesel Engines "Not-to-Exceed (NTE)" Test Procedures	12/07/2000
Light-and Medium Duty Low Emission Vehicle Alignment with Federal Standards. Exhaust Emission Standards for Heavy Duty Gas Engines	12/07/2000

Adopted ARB Regulations	*Date Adopted*
Air Toxic Control Measure for Chlorinated Toxic Air Contaminants from Automotive Maintenance and Repair Facilities	04/27/2000
Transit Bus Standards	02/24/2000
Off-Road Compression Ignition Engines	01/27/2000

Table 10-3 New District Regulatory Control Measures

New District Regulatory Control Measures	*Implementation Date*
Adopt new Rule 9610 (SIP-Creditability of Incentives): This will provide the District with a mechanism to claim SIP credit for emissions reductions through certain incentive programs.	2013
Amend Rule 4308 (Boilers, Steam Generators, and Process Heaters 0.075 to <2 MMBtu/hr)	2015
Amend Rule 4905 (Natural Gas-fired, Fan-type Residential Central Furnaces)	2015
Amend Rule 4901 (Wood Burning Fireplaces and Wood Burning Heaters) to lower the burning curtailment level to prevent PM2.5 buildup that may lead to a potential exceedance day.	2016/2017
Amend Rule 4692 (Commercial Charbroiling) to reduce under-fired charbroiler emissions.	2017

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Table 10-4 District Non-Regulatory Control Measure Strategy Summary

Further Study Measures and Research	***Study Completion Date***
Rule 4103 (Open Burning): Evaluate the feasibility of postponed burning activities every 5 years, as outlined in current rule.	2015
Rule 4106 (Prescribed Burning): Examine feasibility of a biomass removal program.	2013
Rule 4311 (Flares): Review flare minimization plans and annual reports for further emissions reductions opportunities.	2013
Rule 4550 (Conservation Management Plans): Analyze existing studies and support new studies to establish a more accurate inventory of PM2.5 emissions and identify potential additional emission reduction opportunities.	2014
Rule 4570 (Confined Animal Facilities): Analyze existing studies on ammonia at confined animal facilities and evaluate potential ammonia controls for their effectiveness in reducing PM2.5 concentrations in the Valley.	2017
SC 001 (Lawn Care Equipment): Emissions inventory evaluation and technology demonstration.	2013
SC 005 (Asphalt/Concrete Operations): Examine feasibility of warm mix asphalt.	2013
Ongoing Study and Research. Conduct and support going research that continues to enhance the District's understanding of PM2.5 concentrations and formation, including further health research in support of the District's Risk-Based Strategy.	Ongoing
Potential New Incentive Measures	**Implementation Date**
Ongoing Enhancements. Continue to seek additional funding to implement incentive programs and continue to support existing incentive programs for mobile sources, as appropriate.	Ongoing
Kern County Focused Incentives. The District will consider opportunities to target incentive reductions in Kern County to expedite attainment of the 24-hour federal PM2.5 standard.	Ongoing
Charbroilers. Develop new incentive program to assist in the deployment of new technologies upon their development and commercial availability.	Ongoing
Internal Combustion Engines. Consider funding new programs to further promote replacement of agricultural internal combustion engines with electric motors, including but not limited to providing additional incentives for the high cost associated with utility line extensions to remove irrigation pump installations.	Ongoing
Lawn Care. Continue to evaluate commercial lawn care technologies through the Cordless Zero-Emission Commercial Lawn and Garden Equipment Demonstration Program; once new technologies are verified as viable for the Valley, develop on-going incentive programs to encourage use of these new technologies; consider expanding the Clean Green Yard Machine program to include other eligible types of yard care equipment, including low- or zero-emission equipment.	Ongoing
Energy Efficiency. Continue to foster and incentivize programs, as appropriate, consistent with the District Regional Energy Efficiency Strategy; including but not limited to continued support of the use of state Energy Efficiency and Conservation Block Grant funds, the funding of pilot programs to assess and analyze sources to determine the potential to operate more efficiently, and funding outreach program showing government and service organizations the benefits of "going green".	Ongoing
Fireworks. Continue the incentive program for municipal laser-light shows to replace fireworks displays and to seek partners and consider sponsoring shows combining a small amount of fireworks with an otherwise predominantly laser driven show.	Ongoing

Construction Equipment Replacement. Consider providing incentives for construction fleets to replace their heavy-duty off-road equipment sooner than required by the State's In-Use Off-Road Diesel Vehicle Regulation.	Ongoing
Refuse Vehicle Replacement Program. Consider providing incentives for the replacement of older refuse trucks, with a particular emphasis in Environmental Justice and other vulnerable communities.	Ongoing
Technology Advancement	**Implementation Date**
Technology Advancement Program. Continue to seek additional funding and potential feasible and low-cost technologies that may provide for additional emission reduction opportunities in the Valley.	Ongoing
Kern County Focused Demonstration. The District will consider opportunities to target technology demonstration efforts in Kern County to expedite attainment of the 24-hour federal PM2.5 standard.	Ongoing
Conservation Management Practices. Commit to continue to look for opportunities to develop better CMPs through the current TAP and AgTech.	Ongoing
Charbroiling. Continue to offer funding and seek parties to participate in the District ChIP program.	Ongoing
Lawn Care. Continue the current Cordless Zero-Emission Commercial Lawn and Garden Equipment Demonstration Program.	Ongoing
Energy Efficiency. Continue to pursue technology advancement projects that may result in further emission reductions through energy efficiency.	Ongoing
Legislative Strategy	**Implementation Date**
Legislative Platform. Continued support for the following: viability of biomass facilities as an alternative to open burning, cleaner burning alternative fuels, the removal of contradictory environmental protection policies, additional resources to manage wildfires, and legislative measures to provide reliable water supplies to the Valley, and additional state and federal funding for incentive programs.	Ongoing
Fireworks. Take a policy stance opposing any expansion of fireworks use in the Valley, particularly if it occurs in winter months.	Ongoing
Community Outreach/Assistance	**Implementation Date**
Public Outreach and Education. Continue existing public outreach and education efforts and expand these efforts as opportunities become available.	Ongoing
Compliance Assistance. The District currently provides a robust education and outreach program for regulated sources through the Small Business Assistance program, Permit Stakeholder Meetings, Compliance Assistance Bulletins, and public notices for public workshops and public hearings. The District will continue to work closely with affected sources to ensure successful compliance.	Ongoing
Conservation Management Practices. Incorporate new information from research studies into education and outreach efforts as appropriate.	Ongoing
Energy Efficiency. Continue existing education and outreach efforts for energy efficiency programs in the Valley and expand these efforts when appropriate.	Ongoing
Fireworks. Continue current education and outreach efforts regarding safety hazards of fireworks. Partner with local fire and police departments for outreach efforts when appropriate, and consider sponsoring a technology demonstration of lasers at a pre-July 4th public event to showcase the laser technology and improve public acceptance of reducing use of fireworks in the Valley.	Ongoing

10.2 Population in Attainment through Implementation of Strategy

Attaining EPA's health-based standards is an important milestone for improving public health. Through the strategy outlined in this plan, the Valley as a whole, based on Kern County, will attain the federal 24-hour PM2.5 standard in 2019. However, while ultimate attainment under the federal Clean Air Act is determined through a worst-case approach that considers the last portion of the Valley that reaches attainment, it is important to also evaluate progress made towards attaining the standard throughout the Valley regions and population. As discussed in Appendix A, there are a variety of metrics for evaluating air quality progress. Even where areas have not yet attained the standard, there will be continuous air quality improvements.

To take a closer look at the Valley's journey to attaining the federal standard, the District has projected air quality progress throughout the Valley as the *2012 PM2.5 Plan* is implemented. Using projected 2019 emissions and modeled design values; 2007 emissions and actual design values; and emissions inventory trends between 2007 and 2019,. As illustrated by Figure 10-1, the majority of the Valley will reach attainment earlier than 2019, with 53% of the Valley's population experiencing PM2.5 concentrations below the federal standard by 2014, and 94% of the population by 2017. Figure 10-2 further illustrates the significant progress made throughout the Valley in achieving PM2.5 concentrations below the standard by mapping Valley monitoring sites, and showing their expected attainment status and progress toward attainment in 2011, 2014, 2017, and 2019.

Figure 10-1 Valley Residents with PM2.5 Concentrations below the Federal 24-hour PM2.5 standard

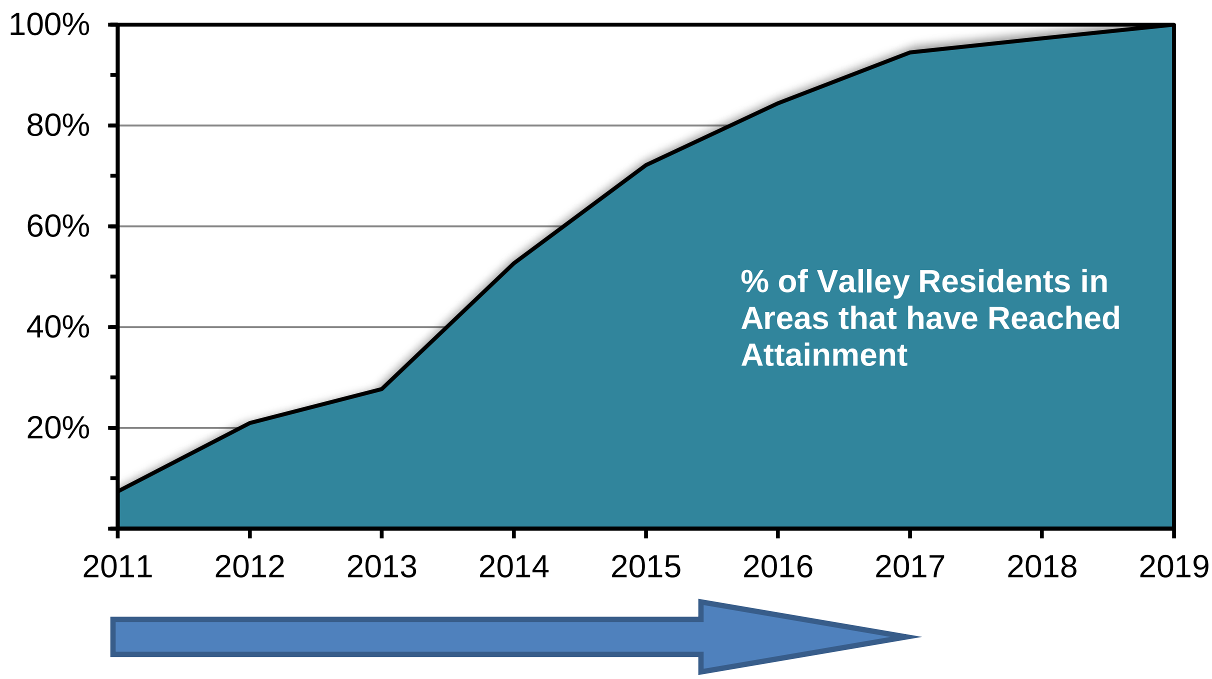
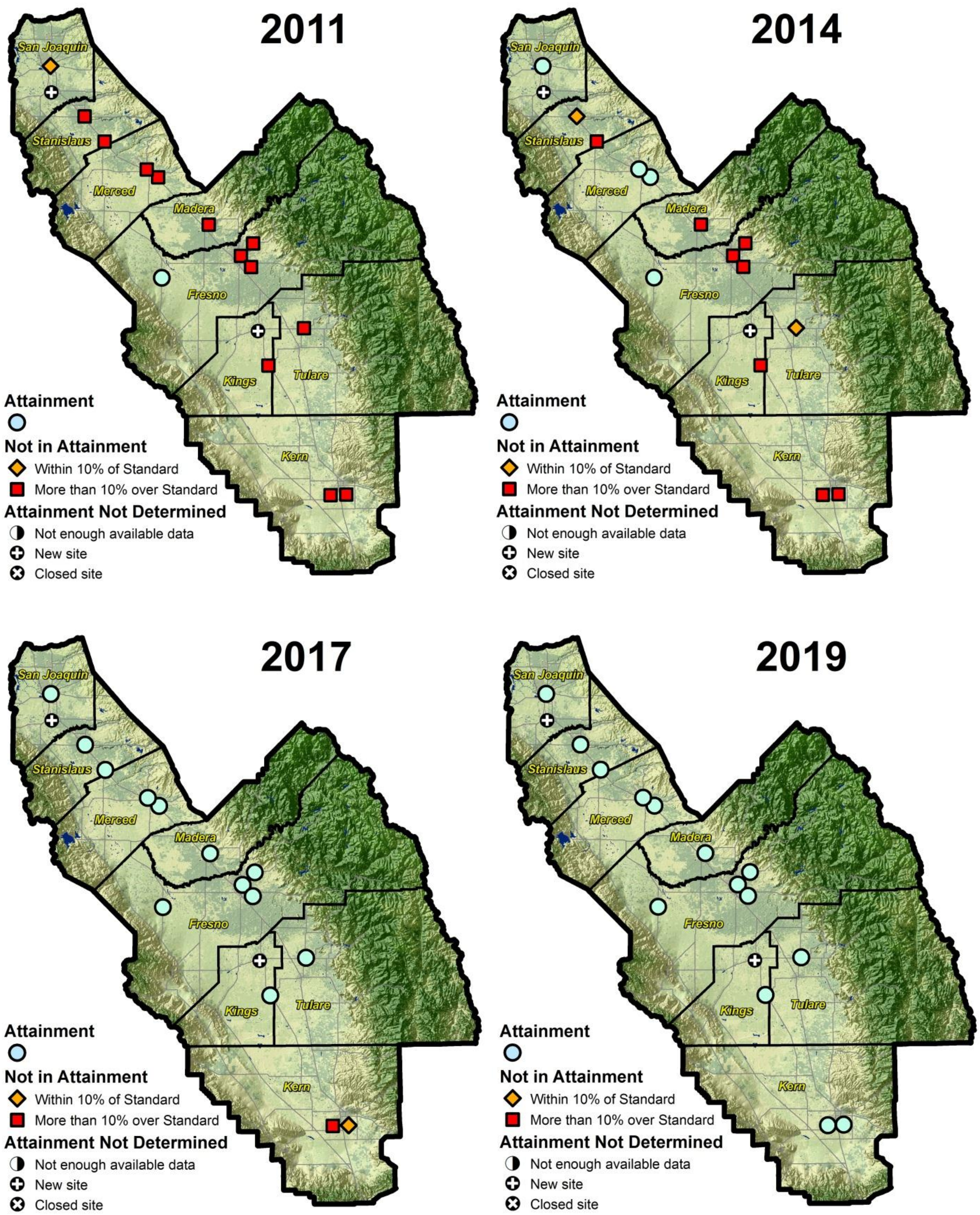


Figure 10-2: Modeled PM2.5 Attainment Status by Monitoring Site



10.3 HEALTH BENEFITS OF ATTAINMENT UNDER THE PLAN

Attaining the PM2.5 standard will improve public health by lowering the number of cases of certain diseases and other health impairments. The District used an EPA model (BenMAP) to estimate the number of avoided cases of various health endpoints expected to result due to reduced PM2.5 exposure resulting from plan implementation and attainment in 2019 (as described in Chapter 2 (section 2.5) and Appendix E). The results of this analysis are summarized in Table 10-5. Through the associated economic analysis, the District estimates that plan implementation will achieve an annual Valley-wide savings of $102 million in health costs starting in 2019 (not including the costs or social value of premature death). See Appendix E for more information.

Table 10-5 Health Benefits Achieved Through Implementation of the Plan

Health Impact	Health Benefit (reduction in health impact)
Premature Death	**671**
Acute Myocardial Infarction, Hospital Admissions	**93**
Asthma Age 0-19, Hospital Admissions	**131**
Cardiovascular, Hospital Admissions	**175**
Asthma Age 20-99, Hospital Admissions	**246**
Asthma Age 20-99, Emergency Room Visits	**407**
Asthma Age 0-19, Emergency Room Visits	**699**
Acute Bronchitis	**1,498**
Upper Respiratory Symptoms	**15,523**
Lower Respiratory Symptoms	**19,011**
Asthma Exacerbation	**114,376**
Work Loss Days	**125,138**

Appendix A

Ambient PM2.5 Data Analysis

2012 PM2.5 Plan
SJVUAPCD

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Contents

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Appendix A: Ambient PM2.5 Data Analysis

The concentration of ambient PM2.5 at any given location in the San Joaquin Valley (Valley) is a function of meteorology, the natural environment, atmospheric chemistry, and PM2.5 emissions from regulated and unregulated sources. The San Joaquin Valley Air Pollution Control District (District), the California Air Resources Board (ARB), and other agencies[1] monitor PM2.5 concentrations throughout the Valley, as detailed in the 2011 Air Monitoring Network Plan,[2] using filter-based monitoring (starting in 1999) and real-time concentration monitoring (starting in 2002). The U.S. Environmental Protection Agency (EPA) serves as the official repository of ambient PM2.5 data and analysis.[3]

The District uses the collected data to show air quality improvement through the standardized design value calculations, using EPA protocols to document basin-wide improvement and attainment of the National Ambient Air Quality Standards (NAAQS). As shown in this appendix, the design value data show steady, long-term air quality improvement that will lead to the attainment of the 2006 PM2.5 NAAQS.

The District also uses the data to evaluate the impact of changing daily, quarterly, and annual PM2.5 concentrations on public health. These trend analyses provide the District with critical information about how to develop control measures and incentive programs that provide the most impact to public health improvements.

This appendix provides the technical details used to evaluate and analyze the District's PM2.5 concentration data as summarized in Chapters 3 and 4 of the *2012 PM2.5 Plan*. It also shows the multiple factors that affect ambient PM2.5 concentrations in the Valley (e.g. meteorology, exceptional events) and the evidence for air quality improvement through District regulatory actions, including the District's highly successful Rule 4901 (Wood Burning Fireplaces and Wood Burning Heaters).

A.1 PM2.5 CONCENTRATIONS—MEASUREMENT AND INFLUENCES

The District, ARB, and other agencies manage an extensive air monitoring network throughout the Valley. The information obtained from the PM2.5 monitors within this network provide the District with necessary information for demonstrating attainment of the NAAQS and valuable information for protecting public health throughout the year. The monitoring network captures the spatial, seasonal, daily, weekly, and annual variations in PM2.5 concentrations throughout the Valley that result from changing meteorology, the occurrence of exceptional events (e.g. high winds and wild fires), and PM2.5 emissions from regulated and unregulated sources.

[1] Other agencies include the Tachi Yokut Tribe and the National Park Service.
[2] San Joaquin Valley Air Pollution Control District [SJVAPCD]. (2011). *2011 Air Monitoring Network Plan.* Fresno, CA: June 30, 2011 submittal to EPA. Available at http://www.valleyair.org/aqinfo/Docs/2011/1_2011AirMonitoringNetworkPlanandAppendixA_Final2.pdf
[3] U.S. Environmental Protection Agency: Technology Transfer Network (TTN), Air Quality System (AQS): *AQS Web Application.* (2010). Available at http://www.epa.gov/ttn/airs/airsaqs/aqsweb/

A.1.1 PM2.5 Monitor Types

The District and ARB use three types of PM2.5 monitors in the Valley:

- Filter-based Federal Reference Method (FRM) monitors, defined as the standard for data collection;
- Real-time beta-attenuation method (BAM) monitors designated as federal equivalent method (FEM) monitors, and hereafter referred to as BAM/FEM monitors;
- Ordinary BAMs, not designated FEM, and hereafter referred to as BAM; and
- Filter-based speciation monitors, similar to FRM monitors.

Only FRM and BAM/FEM monitors produce data that is suitable for comparison with the NAAQS, and are therefore used for design value calculations. Real-time monitors (BAM/FEM and BAM) produce hourly measurements that the District uses every day to produce daily air quality forecasts, wood burning declarations, public health notifications, and Real-time Air Advisory Network (RAAN) notifications for schools.

The filter-based speciation monitors operate similarly to the standard FRM monitors; however, because of the specific analysis requirements for the different PM2.5 species (e.g. metals, silicon, chlorine, organics) multiple filter media are required, hence a multi-filter collection system. The evaluation and analysis of multiple PM2.5 species is critical to the development of an effective attainment strategy.

A.1.2 Meteorological Influences on PM2.5 Concentrations

Particulates in the atmosphere are dispersed by horizontal and vertical mixing within an air mass. Wind flow (horizontal mixing) and temperature instability (decreasing temperature with height leading to vertical mixing) provides the strongest mechanisms for dispersing pollutants. Wind speed can greatly influence the pollutant concentrations by horizontally mixing and dispersing pollutants over a large area. Generally, the higher the wind speed the lower the PM2.5 concentrations; however, in some cases, excessive winds may cause elevated PM2.5 levels as high winds entrain PM10 as well as PM2.5.

Vertical mixing of the air mass can result from atmospheric instability. A temperature inversion, or increasing temperature with increasing height, can shut down the vertical mixing of an air mass, thus creating a situation in which pollutants are trapped near the surface. Prolonged periods of high pressure and stable conditions with low-wind speeds can cause stagnant conditions that trap pollutants near the surface. PM2.5 concentrations increase during these poor dispersion periods. During low-pressure events, unstable conditions and stronger wind speeds occur. PM2.5 concentrations can decrease or increase depending on the strength and characteristics of the low pressure system.

Hemispheric weather patterns affect Valley meteorology and PM2.5 concentrations. As an example, during the 2011–12 wood-burning season (November 2011 through February 2012), the Valley experienced a strong stagnation episode from December 2011 to January 2012 that resulted in many days above the PM2.5 24-hour NAAQS of 35 µg/m^3. Unusual climate conditions caused by the La Niña weather pattern resulted in historically dry and poor air quality conditions in the San Joaquin Valley and throughout the state of California. During this event the District issued an unprecedented number of wood-burning prohibitions.

A La Niña is caused by a buildup of cooler-than-normal subsurface waters in the tropical Pacific. Eastward-moving atmospheric and oceanic waves help bring the cold water to the surface resulting in drier-than-normal precipitation and stagnant weather conditions not only in the Valley, but throughout most of California. December 2011 tied December 1989 (another strong La Niña year) as the driest December on record for the Valley. For the Valley, unusually cold overnight temperatures and warm air aloft during the 2011–2012 wood-burning season created strong surface-based temperature inversions (ranging from 500 feet to 2,500 feet) that trapped particulate pollution within a very small volume of air. Because of the La Niña weather pattern, the Valley experienced four times as many days at or below freezing during the 2011–2012 winter season compared to the previous winter. Combined with clear skies and afternoon sunlight, secondary particulate aerosol formation occurred, contributing to higher PM2.5 levels.

Such extreme, prolonged poor dispersion conditions have not occurred since the 1999–2000 and 2000–2001 La Niña years. Figures A-1 and A-2 show the PM2.5 concentration comparison between the three La Niña years for the Fresno-First and Bakersfield-California air monitoring sites, respectively.[4] The 1999–2000 and 2000–2001 PM2.5 concentrations reflect filter-based data, whereas, 2011–2012 PM2.5 (preliminary) concentrations reflect measurements from real-time monitors. The duration of the PM2.5 events were similar amongst the three seasons, however PM2.5 concentrations were lower during the 2011–2012 season. This reduction in PM2.5 concentrations under very similar stagnant weather patterns suggests that efforts related to District Rule 4901 (Wood Burning Fireplaces and Wood Burning Heaters) and other controls that have been implemented have resulted in a reduction in winter-time emissions.

[4] Note: In 2012, the Fresno-First site was moved from the cross streets of First and Shields to First and Garland. The data from both Fresno site locations are shown together in Figure A-1.

Figure A-1 Stagnation Episodes Comparison at Fresno-First

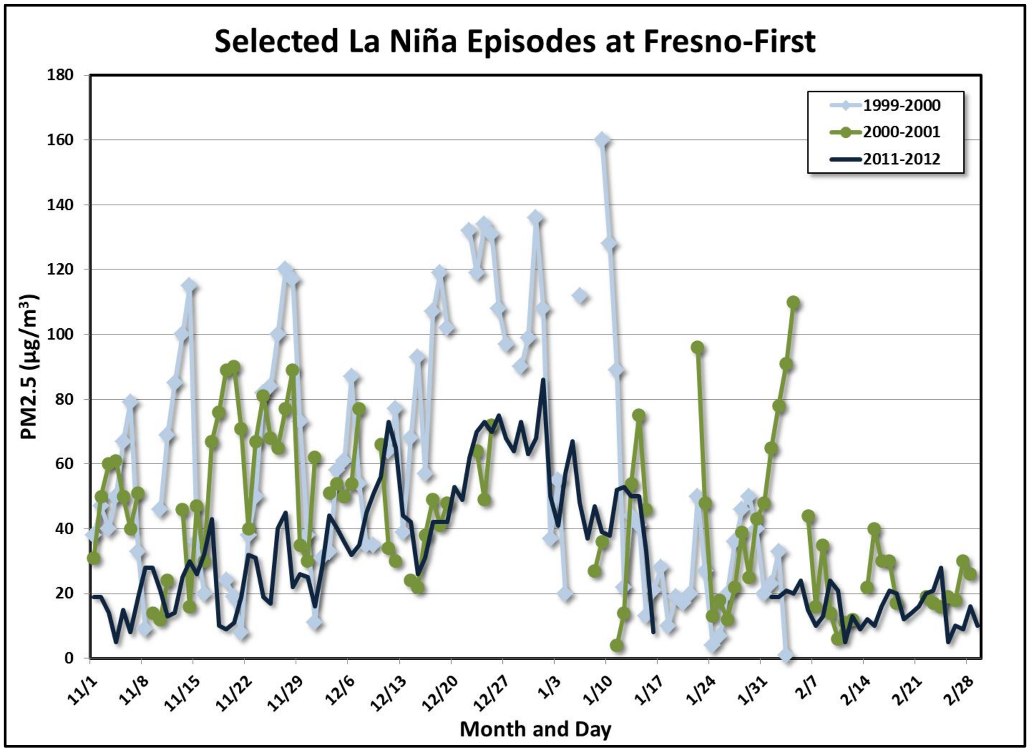
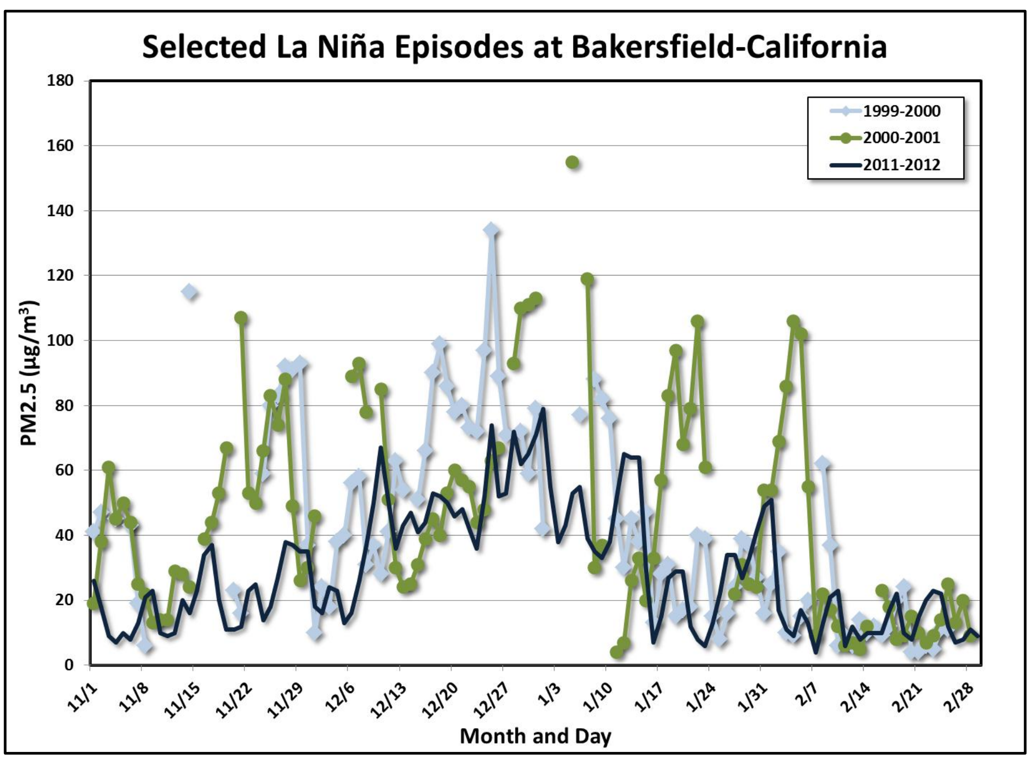


Figure A-2 Stagnation Episodes Comparison at Bakersfield-California



A.1.3 Exceptional Events Influences on PM2.5 Concentrations

In addition to local, regional, and hemispheric weather patterns, Valley PM2.5 concentrations are also affected by exceptional events such as wildfires, high winds events, and fireworks. These unforeseen events (with the exception of fireworks), can result in PM2.5 concentration peaks or even extended high-concentration episodes (in the case of summertime wildfires).

With proper documentation and EPA concurrence, data influenced by exceptional events can be excluded from official attainment demonstration calculations. Such documentation is extensive and requires significant District resources.[5] But since exceptional events are not reasonably preventable or controllable, it is inappropriate to use data influenced by these events without recognition of these circumstances.

EPA generally reviews only those requests that will directly affect an area’s attainment status. Although not every event results in a formal submittal to EPA, the District tracks these events and their impact on attainment as part of its ongoing air quality analysis. These ongoing efforts help the District to more accurately characterize ambient PM2.5 concentrations and attainment progress.

A.1.3.1 PM2.5 Exceptional Event Documentation Submitted to EPA

The District submitted documentation for the July 4 and 5, 2007 fireworks exceptional event and ARB submitted documentation for the summer 2008 wildfires exceptional event. If EPA approves this documentation, data from these events will be excluded from official attainment demonstration calculations.

On July 4th and 5th, 2007, elevated hourly PM2.5 concentrations at Fresno-First and Bakersfield-California coincided with fireworks activity. Table A-1 summarizes the effects of removing this data from the annual mean and 24-hour mean concentration calculations. The main effect of removing the data was lowering the PM2.5 annual mean values at Fresno-First and Bakersfield-California by 0.4 and 0.2 µg/m^3, respectively.

In the summer of 2008, just months after adoption of the *2008 PM2.5 Plan*, California experienced a record number of wildfires, burning more than one million acres. The resulting emissions, mostly from outside of the Valley, caused serious public health impacts and unprecedented levels of summertime PM2.5 and ozone in the Valley and throughout the state. Valley PM2.5 and ozone concentrations were elevated for a number of days during this period.

These exceptional events caused the Valley’s PM2.5 design values to be higher than normal. Table A-1 also summarizes the effects of removing this data from official attainment demonstration calculations. The prolonged 2008 wildfire event had a

[5] Treatment of Air Quality Monitoring Data Influenced by Exceptional Events, 72 Fed. Reg. 55, pp. 13560–13581. (2007, March 22). (to be codified in 40 C.F.R. pts. 50 and 51)

noticeable impact, especially for monitoring sites closest to the wildfires in the northern portion of the Valley. The largest difference occurred at the Stockton air monitoring site, where the 24-hour value was 61.6 µg/m³, with the exceptional event data included, and 48.2 µg/m³, with that data removed. Excluding days that were impacted by smoke reduces the PM2.5 annual mean value by 1.5 µg/m³.

The EPA has a policy of acting only upon those exceptional event documents that have a direct impact on an area's attainment status. As such, the EPA reviews and makes decisions on the concurrence or non-concurrence of the District's PM10 exceptional event documents, but has not yet made a decision on the submitted PM2.5 documents mentioned above since that decision would not change the District's attainment status of the PM2.5 NAAQS.

Since the timeframe discussed in the above analysis is outside of the 2009–2011 period, these exceptional events would not affect the 2011 attainment demonstration calculations. However, this analysis is illustrative of how these events can influence such calculations, and possibly whether an area is able to achieve attainment of the PM2.5 NAAQS.

Subsequent fireworks and wildland fire use exceptional events have occurred since the 2007 and 2008 documentation that was submitted to EPA. On July 4th, 2010, elevated PM2.5 concentrations at Bakersfield-Planz, Fresno-First, and Bakersfield-California coincided with fireworks activity. On September 25–30, 2010, Corcoran and Madera-City experienced smoke impacts and elevated PM2.5 levels from a wildland fire in the Sierra Nevadas. Since the District has not submitted official documentation of these events to EPA, the impact on the 24-hour and annual mean PM2.5 values are not shown.

Table A-1 2007 and 2008 Exceptional Events Impact on 24-hour and Annual PM2.5 Values

Year	Site	Annual Mean Before EE Concurrence	Annual Mean with EPA EE Concurrence	Difference µg/m³	24-hour Mean Before EE Concurrence	24-hour Mean with EPA EE Concurrence	Difference µg/m³
2008	Stockton	14.4	12.9	-1.5	61.6	48.2	-13.4
	Modesto	16.0	14.7	-1.3	53.3	49.5	-3.8
	Merced	14.9	13.9	-1.0	51.1	45.2	-5.9
	Clovis	16.0	14.8	-1.2	49.0	49.0	0.0
	Fresno-First	17.4	16.1	-1.3	57.4	54.4	-3.0
	Fresno-Winery	16.5	15.6	-0.9	44.5	44.5	0.0
	Visalia	21.0	19.5	-1.5	62.1	55.5	-6.6
	BAK-CA	21.9	20.0	-1.9	64.5	63.4	-1.1
	BAK-Planz	23.5	22.8	-0.7	72.3	72.3	0.0
2007	Fresno - First	18.8	18.4	-0.4	67.0	66.0	-1.0
	BAK-CA	22.0	21.8	-0.2	73.0	73.0	0.0

A.1.3.2 High-Wind Events Effects on PM2.5 Data

Valley high-wind events can result in significant increases in PM10 concentrations. Geologic particulates are the primary component of PM10 measured during these events. The District routinely submits formal PM10 exceptional event documentation for such events.

The District has observed similarities in hourly increases in PM10 and PM2.5 during certain high-wind events. High-wind events were recorded at the Bakerfield-Planz monitoring site on January 4, 2008 and October 13, 2009, and corresponding PM2.5 measurements were unusually high—100.3 µg/m^3 and 167.7 µg/m^3, respectively. Table A-2 summarizes an example of the impact of the 2008 and 2009 high-wind events on Bakersfield-Planz attainment calculations (design values represent a three-year average of mean 24-hour and annual pollutant concentrations and are discussed fully in Section A.2). The District has not submitted PM2.5 exceptional event documentation for either of these events.

Although not included in Table A-2, another high-wind event occurred on April 11, 2010. The Bakersfield Planz monitor recorded a PM2.5 concentration of 107.8 µg/m^3. Similarly, the District submitted documentation to EPA in regards to a PM10 exceptional event affecting Bakersfield-Planz that occurred on April 11, 2010, but has not submitted PM2.5 documentation

Table A-2 Example of High-Wind Event Influence on Bakersfield–Planz Design Value

	High-Wind Events			
	24-hour Design Values (µg/m^3)		**Annual Design Values (µg/m^3)**	
Year	*Included*	*Excluded*	*Included*	*Excluded*
2007*	72.2	72.2	21.8	21.8
2008	72.3	61.0	23.5	22.6
2009	65.5	65.4	22.5	21.4
2007-09 DV	**70**	**66**	**22.6**	**21.9**
Difference		**4**		**0.7**

***** - No high-wind events were captured in the 2007 data set.

A.2 ATTAINMENT DEMONSTRATION—DESIGN VALUES

Design values represent the official metric for assessing air quality improvements and attainment of the NAAQS per the Federal Clean Air Act and EPA regulations. Design value calculations are three-year averages that follow EPA protocols for rounding, averaging conventions, data completeness, sampling frequency, data substitutions, and data validity. The results provide consistency and transparency to determine basin-wide attainment for both components of the 2006 PM2.5 NAAQS, including the 24-hour PM2.5 standard of 35 µg/m³ and the annual PM2.5 standard of 15.0 µg/m³. If any monitoring site within the air basin has either a 24-hour or annual PM2.5 design value higher than the respective standard, then the entire air basin is designated nonattainment.

Table A-3 provides the generalized descriptions of how the 24-hour average and annual average design values are calculated for PM2.5. EPA provides detailed guidelines and standards for the calculation[6] and data handling[7] methodologies.

Table A-3 General PM2.5 Design Value Calculation Methods

Averaging Period	Level	Calculation Method
24-hour	35 µg/m³	**Step 1:** *Determine the 98th percentile value for each year over a consecutive three year period.* **Step 2:** *Average the three 98th percentile values.* **Step 3:** *Round the resulting value to the nearest 1.0 µg/m³.* **Step 4:** *Compare the result to the standard.*
Annual	15.0 µg/m³	**Step 1:** *Calculate the average of each quarter of each year over a three year period.* **Step 2:** *Average the four quarters in a calendar year to determine the average for each year.* **Step 3:** *Average the three annual values.* **Step 4:** *Round the resulting value to the nearest 0.1 µg/m³.* **Step 5:** *Compare the result to the standard.*

Tables A-4 through A-7 show the trend of the 24-hour average and annual average values for each PM2.5 monitoring site in the Valley by year as well as the three-year average design values for these metrics through the year 2011.

Table A-4 shows 24-hour single-year 98th-percentile averages, which are used to generate the three-year average 24-hour design values in Table A-5. Table A-6 shows single-year average PM2.5 concentrations, which are used to generate the three-year average annual design values in Table A-7. These data are also shown graphically in Figures A-3.1 through A-3.20 for a number of monitoring sites in the Valley. Monitoring

[6] Interpretation of the National Ambient Air Quality Standards for PM2.5, 40 C.F.R. Pt. 50 Appendix N (2012). Available at http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&sid=9bdb7a34dcb75892aef9ee60b74da642&rgn=div9&view=text&node=40:2.0.1.1.1.0.1.18.15&idno=40

[7] Environmental Protection Agency [EPA]: Office of Air Quality Planning and Standards. (1999, April). *Guideline on Data Handling Conventions for the PM NAAQS* (EPA-454/R-99-008). Retrieved from http://www.epa.gov/ttn/oarpg/t1/memoranda/pmfinal.pdf

sites with a brief PM2.5 monitoring history do not have line charts displayed. Note that the sites at Manteca, Madera-City, Tranquillity, and Hanford have limited PM2.5 data available; therefore, there is no three-year average. Design values for these sites will be able to be calculated in the future as their PM2.5 data records continue. The Bakersfield-Golden site was closed in early 2010, and the Corcoran site has been unavailable since the middle of 2011.

Average ambient PM2.5 concentrations vary by monitoring site within the Valley. In general, monitoring sites in the northern part of the Valley record the lowest ambient PM2.5 concentrations. Currently more Valley air monitoring sites meet the 1997 24-hour average standard of 65 $\mu g/m^3$ than the annual average standard of 15.0 $\mu g/m^3$. Although the single-year 98th-percentile and annual average values were higher in 2011 compared to the last few years, the 2009–2011 design values for some of the sites are showing a downward trend, including the peak Valley design value, while others have shown an increase. A downward trend will need to occur for all of the sites in the region as the Valley progresses towards attainment of the federal standard.

Table A-4 Single Year 24-hour Average PM2.5 98th Percentile Values (μg/m³)

SJV Monitoring Site	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Stockton	79.0	55.0	58.0	50.0	41.0	36.0	44.0	42.0	48.0	61.6	40.4	29.7	44.8
Manteca													38.9
Modesto	100.0	71.0	69.0	69.0	47.0	45.0	55.0	52.0	57.4	53.9	54.5	37.3	54.7
Turlock											53.1	43.5	57.4
Merced-Coffee												39.9	47.4
Merced-M	91.9	60.0	49.3	55.1	44.2	43.0	48.3	43.8	52.7	54.0	45.2	35.5	35.4
Madera-City													59.1
Fresno-1st	120.0	90.0	75.0	75.0	56.0	52.0	71.0	51.0	67.0	57.4	55.8	48.8	69.5
Fresno-Winery		64.8	61.5	71.9	49.7	49.4	71.2	55.0	57.4	44.5	48.2	37.0	59.6
Clovis	59.2	72.5	71.5	53.2	48.1	52.4	63.0	51.3	60.9	49.0	49.0	44.3	68.5
Tranquillity												27.7	27.5
Corcoran	53.0	55.1	89.5	65.1	42.2	49.4	74.5	50.1	57.9	47.9	53.4	46.8	
Hanford													64.6
Visalia	114.0	103.0	96.0	70.0	47.0	54.0	65.0	50.0	59.7	62.1	53.9	36.3	50.7
Bakersfield-Golden	95.3	93.9	95.9	80.4	51.9	53.9	74.9	64.4	67.7	60.8	68.6		
Bakersfield-California	97.4	92.7	94.9	73.0	48.3	61.5	63.2	60.5	73.0	64.5	66.7	53.3	65.5
Bakersfield-Planz		76.5	90.6	66.8	47.5	47.6	66.4	64.7	72.2	72.3	65.5	56.2	43.2

Table A-5 24-hour Average PM2.5 Design Values (Three-Year Averages, μg/m³)

SJV Monitoring Site	1999-2001	2000-2002	2001-2003	2002-2004	2003-2005	2004-2006	2005-2007	2006-2008	2007-2009	2008-2010	2009-2011
Stockton	64	54	50	42	40	41	45	51	50	44	38
Manteca											^
Modesto	80	70	62	54	49	51	55	54	55	49	49
Turlock									53	48	51
Merced-Coffee											44**
Merced-M	67	55	50	47	45	45	48	50	51	45	39
Madera-City											^
Fresno-1st	95	80	69	61	60	58	63	58	60	54	58
Fresno-Winery	63	66	61	57	57	59	61	52	50	43	48
Clovis	68	66	58	51	55	56	58	54	53	47	54
Tranquillity											28**
Corcoran	66	70	66	52	55	58	61	52	53	49	
Hanford											^
Visalia	104	90	71	57	55	56	58	57	59	51	47
Bakersfield-Golden	95	90	76	62	60	64	69	64	66		
Bakersfield-California	95	87	72	61	58	62	66	66	68	62	62
Bakersfield-Planz	84	78	68	54	54	60	68	70	70	65	55

Notes for Tables A-2 and A-3
- Empty cell: No data or insufficient data
- Asterisk (*): Values do not meet completeness criteria
- Double asterisk (**): Value based on 2-year average of 2010-2011, 2009 had minimal sampling
- ^ : Site does not have enough data to calculate a 3-year average, see text for details.

Table A-6 Single Year Annual Mean PM2.5 Concentrations (µg/m^3)

SJV Monitoring Site	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Stockton	19.7	15.5	13.9	16.7	13.6	13.2	12.5	13.1	12.9	14.4	11.3	10.6	11.3
Manteca													10.7
Modesto	24.9	18.7	15.6	18.7	14.5	13.6	13.9	14.8	15.0	16.0	13.0	12.1	14.7
Turlock											16.1	12.7^^	17.1
Merced-Coffee												16.3	15.6
Merced-M	22.6	16.7	14.5*	18.7	15.7	15.2	14.1	14.8	15.2	14.9*	13.6	11.2	10.4
Madera-City													20.4
Fresno-1st	27.6	24.5	19.8	21.5	17.8	16.3	16.7	16.8	18.8	17.4	15.1	13.0	15.5
Fresno-Winery		18.4	18.6	21.3	17.8	17.0	16.9	17.6	16.8	16.5	14.6	13.4	15.4
Clovis	19.8	16.3	18.0	16.2	18.5*	16.4	16.3	16.4	16.4	16.2	18.3	14.7	17.9
Tranquillity												8.8	8.2
Corcoran	14.3*	16.4	19.2	21.5	16.2	17.4	17.5	16.9	18.4	15.8	17.7	17.9	
Hanford													18.0
Visalia	27.6	23.9	22.5	23.2	18.2	17.0	18.8	18.8	20.4	19.8	16.0	13.6	16.1
Bakersfield-Golden	26.2	22.6	21.8	24.1	19.6	18.2	19.1	18.6	19.9	17.9	20.0		
Bakersfield-California	23.8	22.5	21.2	22.7	17.1	18.9	18.0	18.7	22.0	21.9	19.0	14.2	16.2
Bakersfield-Planz		20.3	20.8	23.5	17.8	17.4	19.8	19.3	21.8	23.5	22.5	17.6	14.5

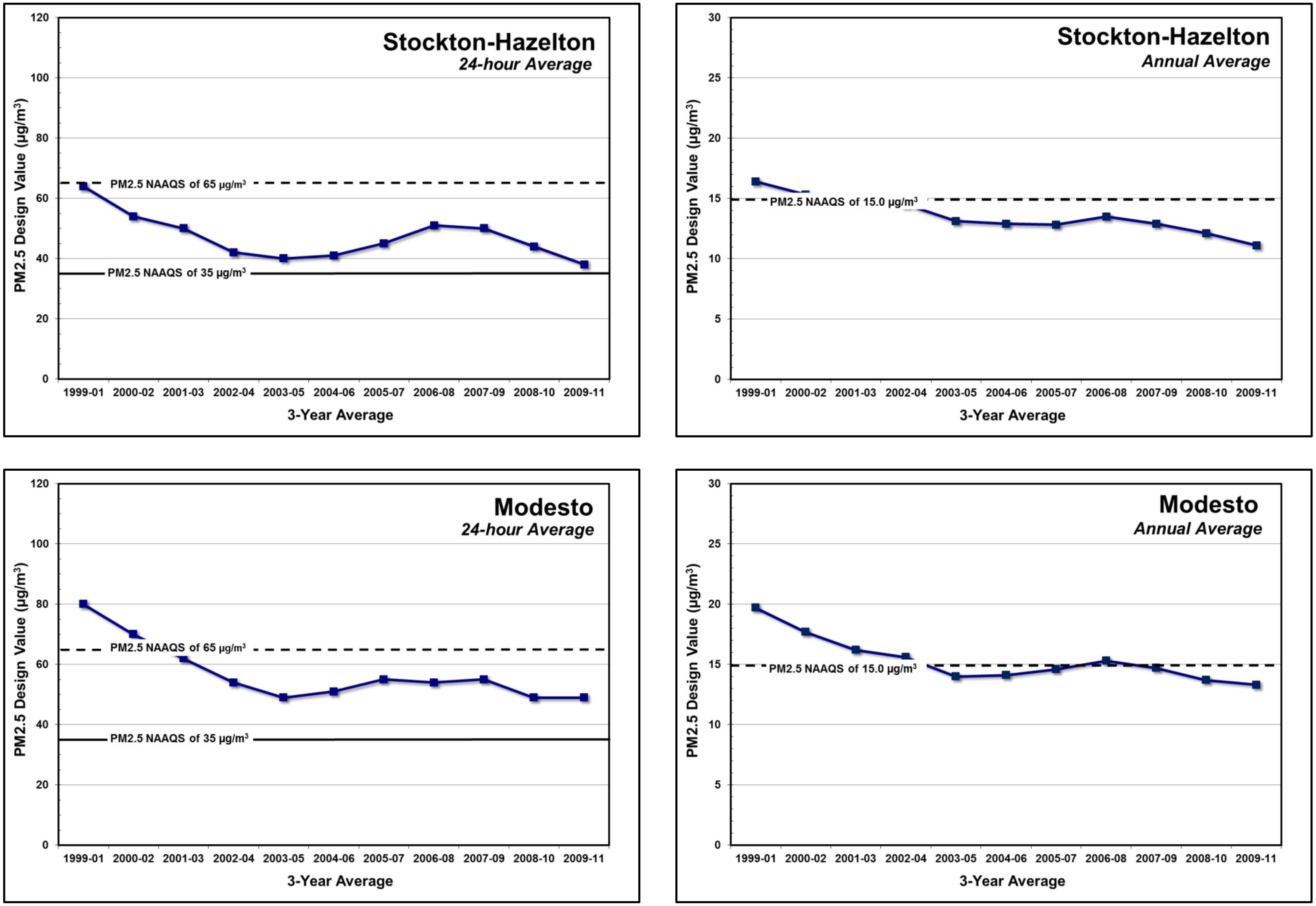
Table A-7 Annual PM2.5 Design Values (Three-Year Averages, µg/m^3)

SJV Monitoring Site	1999-2001	2000-2002	2001-2003	2002-2004	2003-2005	2004-2006	2005-2007	2006-2008	2007-2009	2008-2010	2009-2011
Stockton	16.4	15.3	14.7	14.5	13.1	12.9	12.8	13.5	12.9	12.1	11.1
Manteca											^
Modesto	19.7	17.7	16.2	15.6	14.0	14.1	14.6	15.3	14.7	13.7	13.3
Turlock											15.3^^
Merced-Coffee											16.0**
Merced-M	17.9	16.6	16.3	16.5	15.0	14.7	14.7	15.0	14.6	13.2	11.7
Madera-City											^
Fresno-1st	24.0	21.9	19.7	18.6	16.9	16.6	17.4	17.7	17.1	15.2	14.5
Fresno-Winery	18.5	19.4	19.2	18.7	17.2	17.2	17.1	17.0	16.0	14.8	14.5
Clovis	18.0	16.8	17.6	17.0	17.1	16.4	16.4	16.3	17.0	16.4	17.0
Tranquillity											8.5**
Corcoran		19.0	19.0	18.4	17.0	17.2	17.6	17.0	17.3	17.1	
Hanford											^
Visalia	24.7	23.2	21.3	19.5	18.0	18.2	19.3	19.7	18.8	16.5	15.2
Bakersfield-Golden	23.6	22.8	21.8	20.6	19.0	18.6	19.2	18.8	19.3		
Bakersfield-California	22.5	22.1	20.3	19.6	18.0	18.5	19.6	20.9	21.0	18.4	16.5
Bakersfield-Planz		21.5	20.7	19.6	18.4	18.9	20.3	21.5	22.6	21.2	18.2

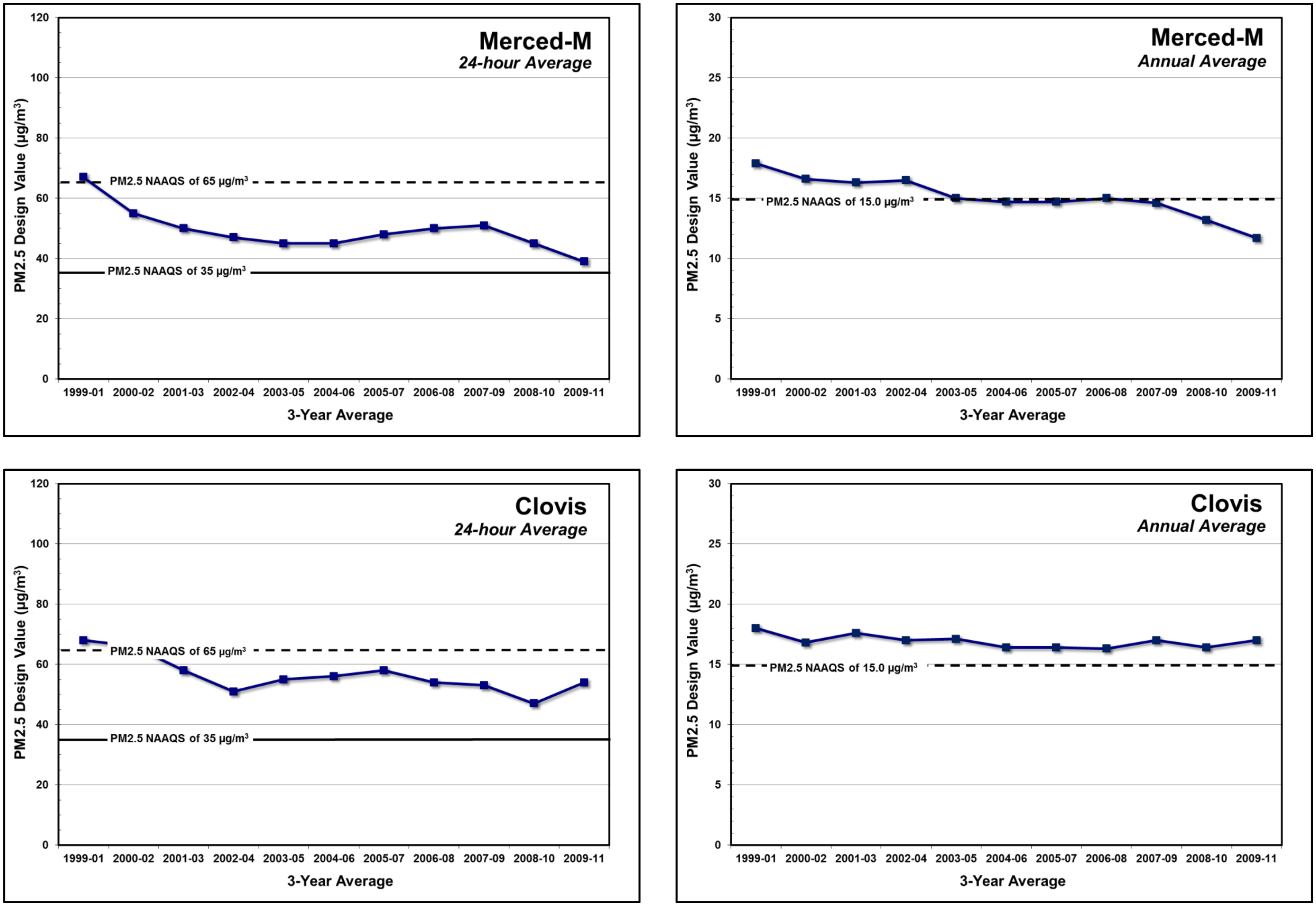
Notes for Tables A-4 and A-5

- Empty cell: No data or insufficient data
- Asterisk (*): Values do not meet completeness criteria
- Double asterisk (**): Value based on 2-year average of 2010-2011, 2009 had minimal sampling
- ^ : Site does not have enough data to calculate a 3-year average, see text for details.
- ^^ : Data incomplete in 2010, however high PM2.5 season was still captured.

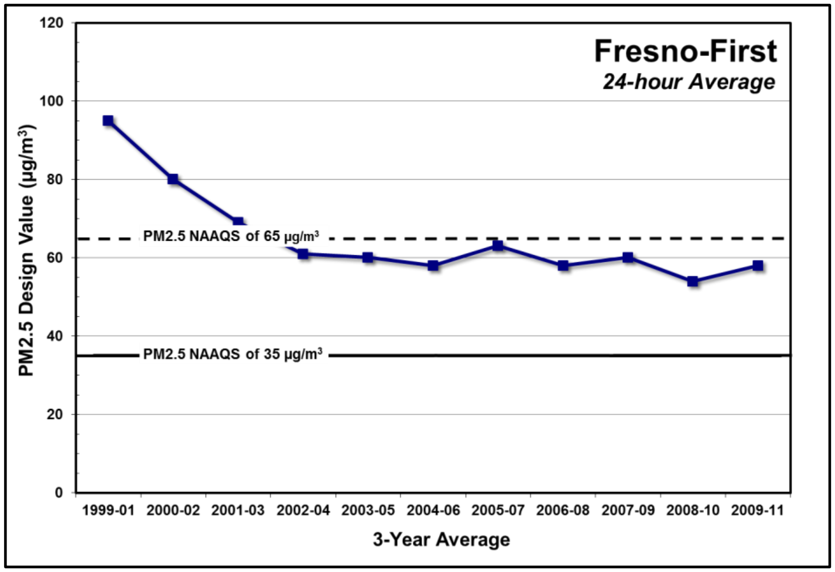
Figures A-3.1 through A-3.4 24-hour and Annual Design Value Trends at Stockton-Hazelton and Modesto

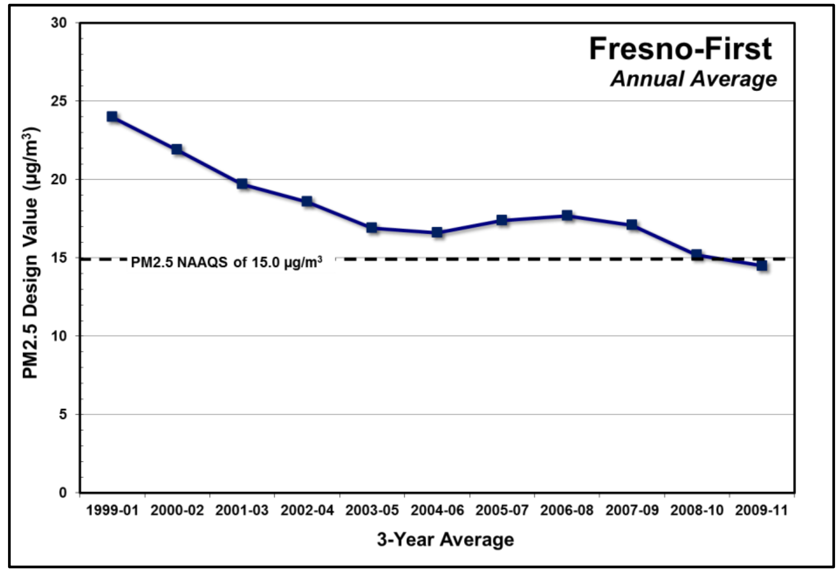


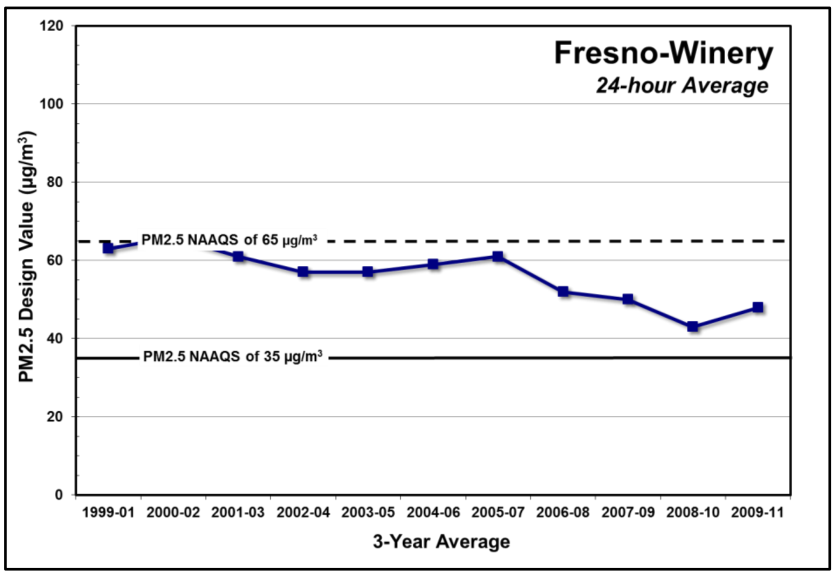
Figures A-3.5 through A-3.8 24-hour and Annual Design Value Trends at Merced-M and Clovis

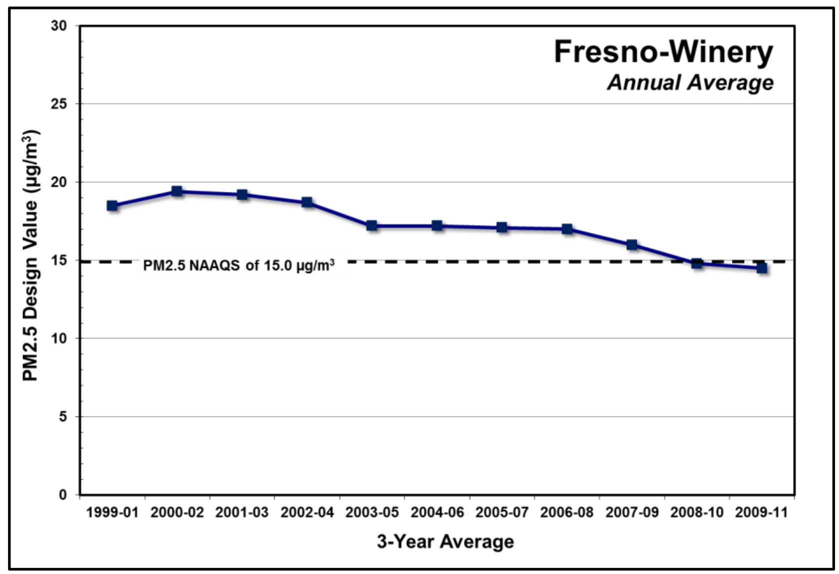


Figures A-3.9 through A-3.12 24-hour and Annual Design Value Trends at Fresno-First and Fresno-Winery

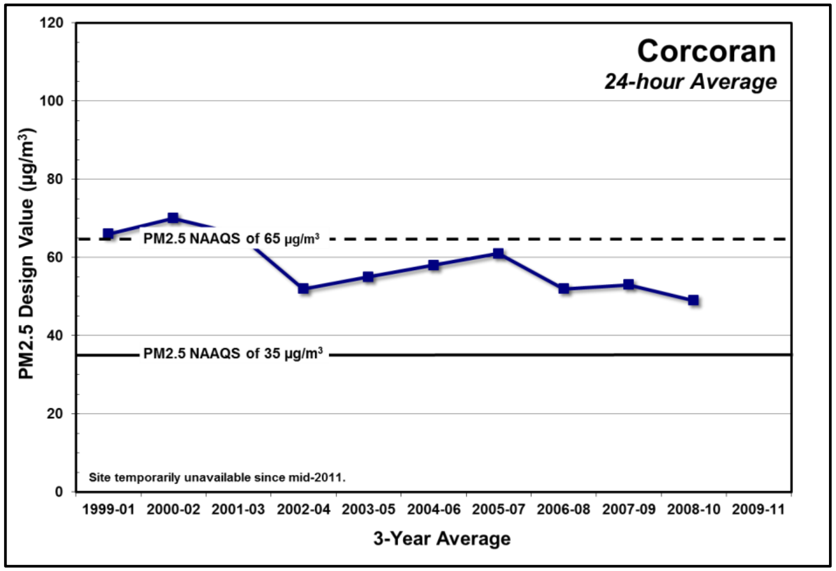


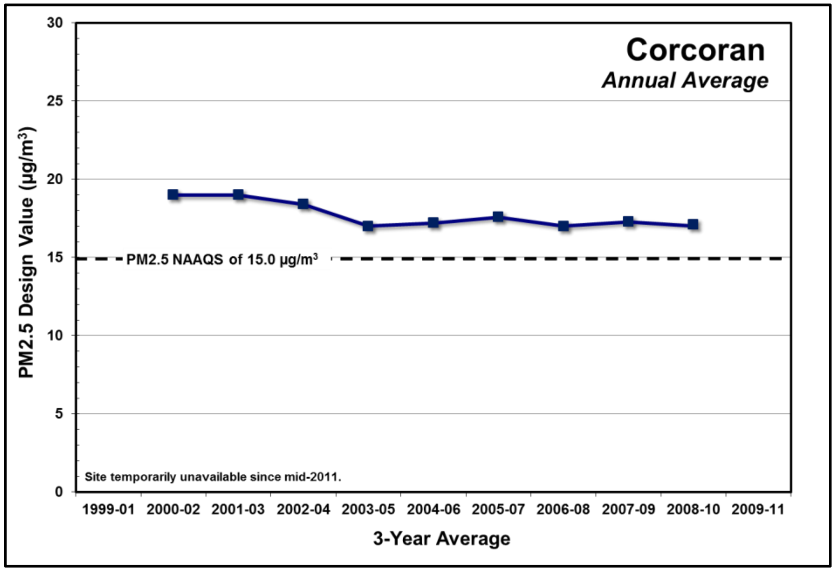


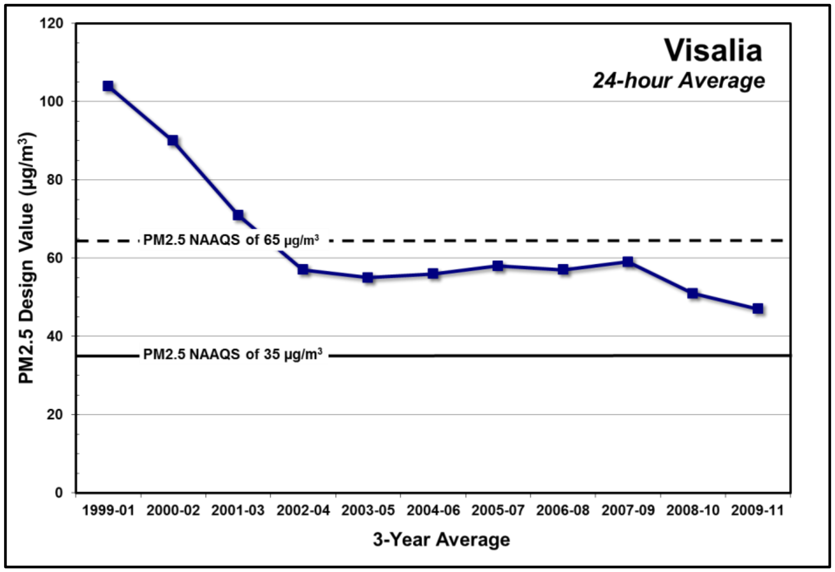


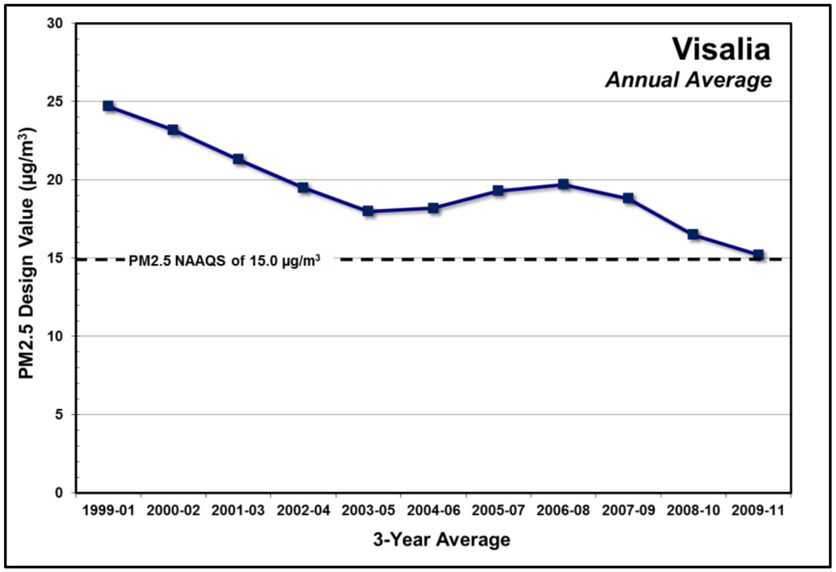


Figures A-3.13 through A-3.16 24-hour and Annual Design Value Trends at Corcoran and Visalia

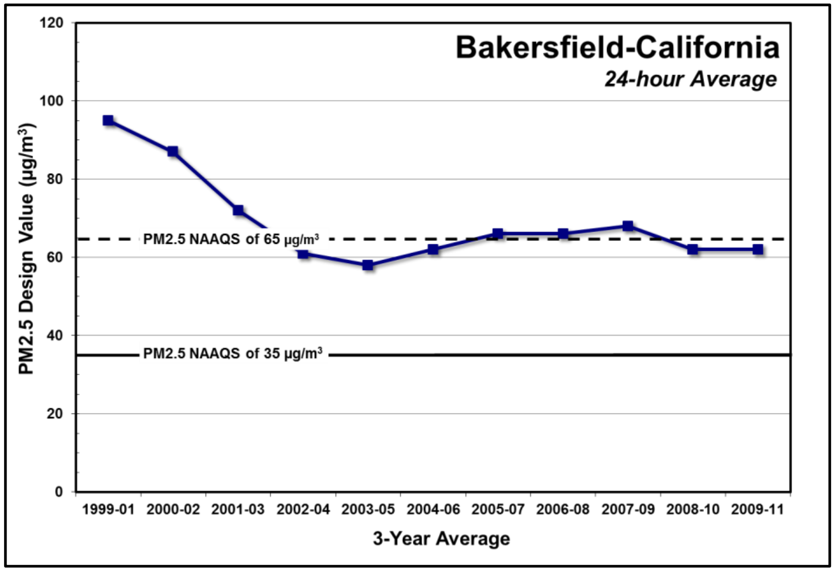


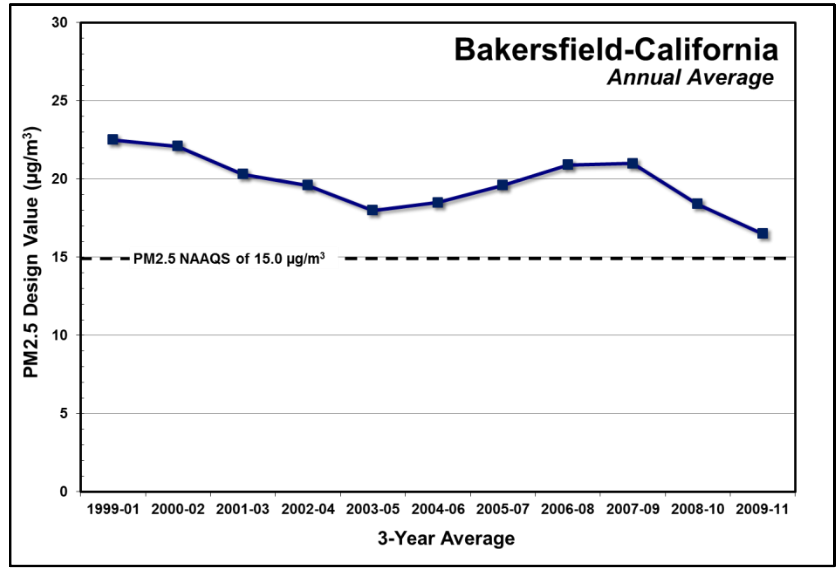


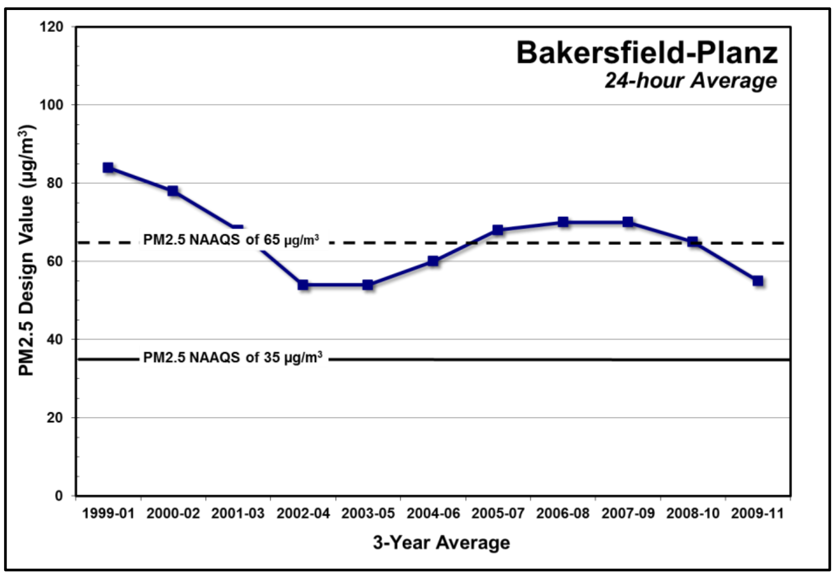


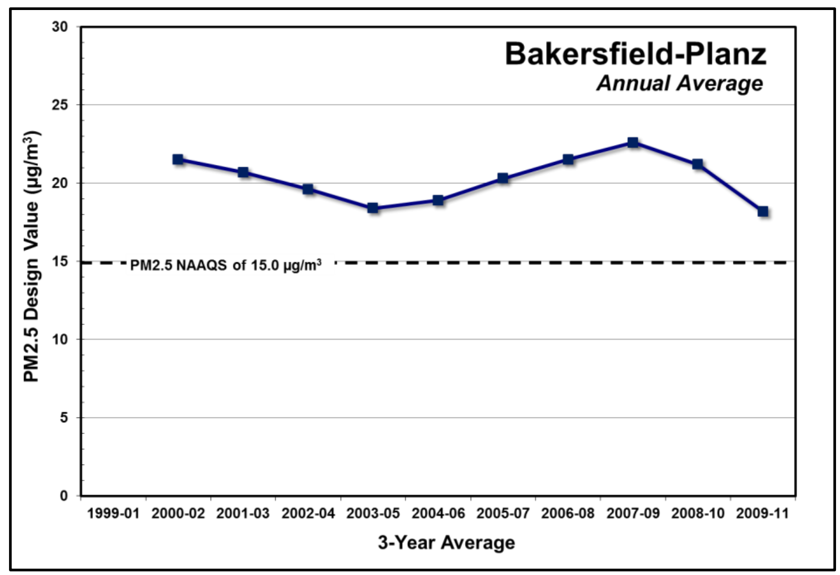


Figures A-3.17 through A-3.20 24-hour and Annual Design Value Trends at Bakersfield-CA and Bakersfield-Planz









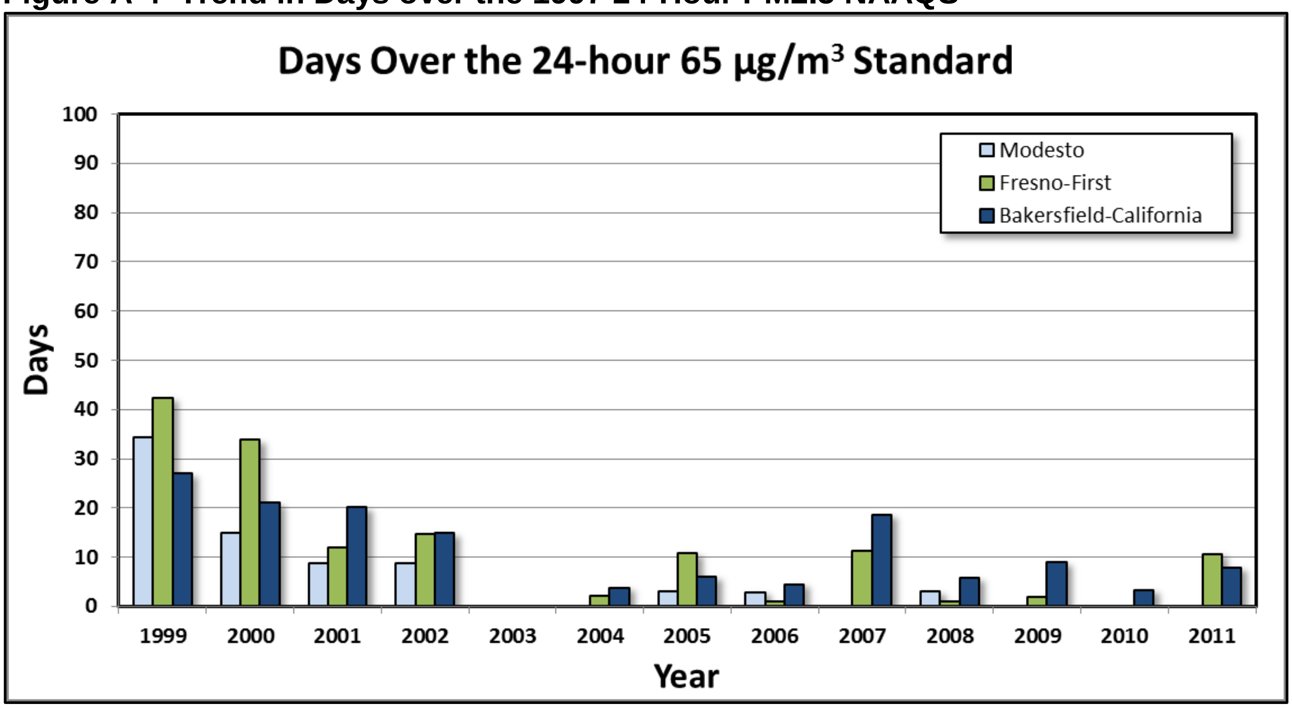
A.3 AMBIENT PM2.5 CONCENTRATION DATA TRENDS

Design values summarize data from a monitoring site with just two concentration values representing a three-year time period: an annual average and a value representing 24-hour peaks. These parameters are required for attainment demonstrations, but design values alone do not reveal the hourly, daily, weekly, seasonal, and regional PM2.5 effects on public health, nor do they track air quality improvements within such parameters. The District uses data from air monitoring sites to analyze air quality trends to provide a deeper understanding of changes in ambient PM2.5 concentrations as they relate to the implementation of District programs and to inform the attainment planning process and Risk-based Strategy.

A.3.1 Days Over the 24-Hour PM2.5 NAAQS

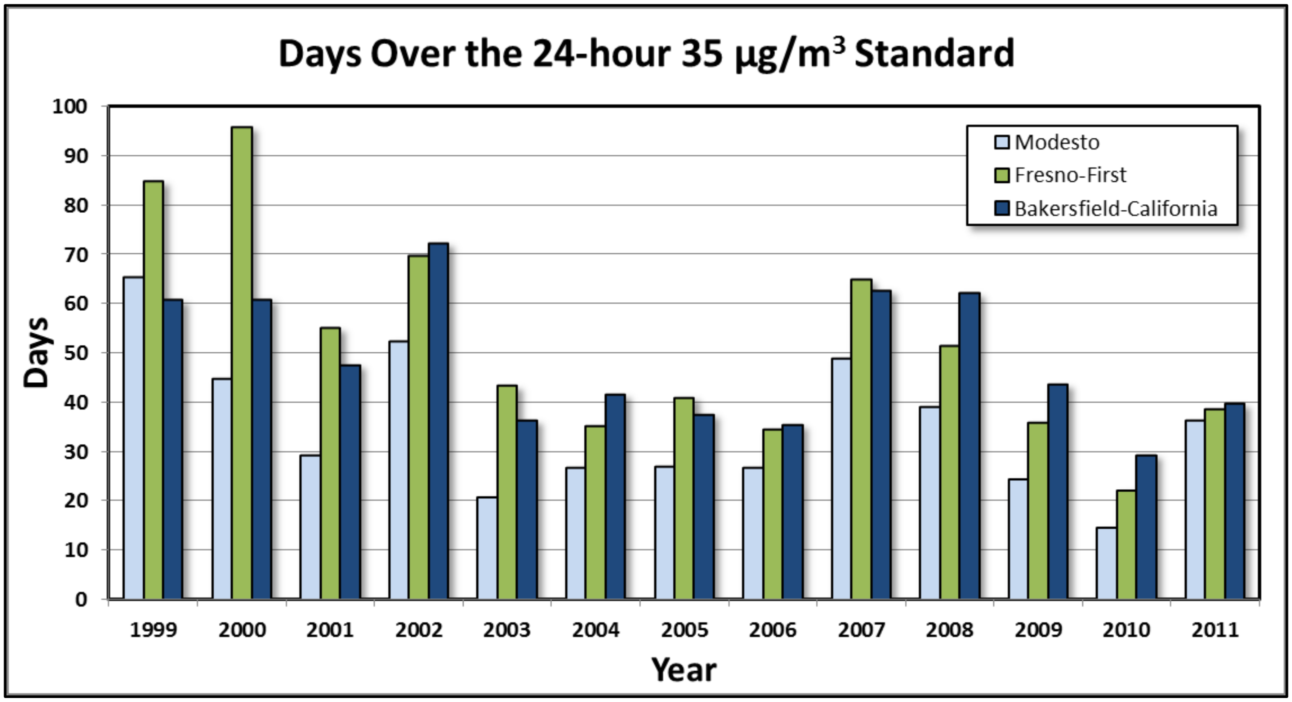
The number of days over the PM2.5 NAAQS is another indicator of air quality progress. Focusing on historical air monitoring sites from the northern, central, and southern portions of the Valley, Figures A-4 and A-5 show the trend of the number of days above both the 1997 and 2006 24-hour PM2.5 NAAQS (65 µg/m³ and 35 µg/m³, respectively) at the Modesto, Fresno-First, and Bakersfield-California monitoring sites. These counts have been estimated and normalized to account for the varying sampling schedules of the Valley's 1-in-6-day, 1-in-3-day, and daily PM2.5 monitors. Design value calculations for the 24-hour NAAQS use the 98th-percentile concentration value from each monitoring site (higher values in the 99th and 100th percentiles are not used to account for extreme outliers). Because of this, a region may experience a limited number of days over the standard, but still be considered in attainment.

Figure A-4 Trend in Days over the 1997 24-Hour PM2.5 NAAQS



Note: Years and sites with no data (colored bars) represent zero exceedances.

Figure A-5 Trend in Days over the 2006 24-Hour PM2.5 NAAQS



As shown in Figure A-4, the District has experienced a significant drop in the number of exceedances of the 65 µg/m³ standard. In 1999, approximately 103 exceedances of this standard occurred between the sites of Modesto, Fresno-First, and Bakersfield-California. Comparing this to the 17 exceedances that occurred in 2011, this represents an 83% decrease in the number of violations among these sites.

Figure A-5 shows that significant progress has been made towards the 35 µg/m³ standard despite the fact that sites recorded 35 to 40 exceedances in 2011. The number of exceedances of the 2006 PM2.5 NAAQS has decreased by 46%. The District's emissions reduction strategy, the investment from the regulated industry in control technology, and the public's willingness to make a change for cleaner air have all played key roles in the reduction of concentrations over this time period.

Despite this notable progress, the Valley still experiences many exceedance days over the 2006 24-hour PM2.5 NAAQS (35 µg/m³) during the winter months. During the winter, with unfavorable meteorology, as experienced during the 2011–2012 winter season, the number of exceedances spiked relative to seasons with favorable meteorology under identical regulatory controls. The values for 2011 in Figure A-5 show this resulting spike as compared to the years 2009 and 2010, when meteorology was more favorable. Similar poor dispersion conditions were experienced during the winter of 1999–2000; however, under those similar conditions, the number of exceedances in 2011 was markedly less than the number of exceedances in 1999, which strongly suggest a real reduction in emissions.

A.3.2 Seasonal Trends—First- and Fourth-Quarter Averages

The Valley experiences the highest PM2.5 concentrations during the fall and winter months, when residential wood burning is at its highest. The District evaluates ambient concentration trends during this time period (October through March) to document changes and patterns in seasonal PM2.5 peak concentrations.

A review of historical 24-hour PM2.5 filter data shows a general trend of ambient concentration reductions in both the average concentration and the magnitude of the concentration. Specifically, the District looked at PM2.5 filter data from 1999 through 2011, focusing on the first and fourth quarters at six sites in the Valley that tend to have the highest concentrations, including Clovis, Fresno-First, Corcoran, Visalia, Bakersfield-California, and Bakersfield-Planz.

The Bakersfield-California site is typical of the trend in improvement for these six sites: first quarter (January through March) ambient PM2.5 concentrations show greater reduction rates than fourth quarter (October through December) measurements. At the Bakersfield-California site the average PM2.5 concentration showed a downward trend of 0.74 µg/m³ per year for the first quarter and 1.15 µg/m³ per year for the fourth quarter, as shown in Figures A-6 and A-7, respectively.

Figure A-6 1st Quarter Average Trend at Bakersfield-California

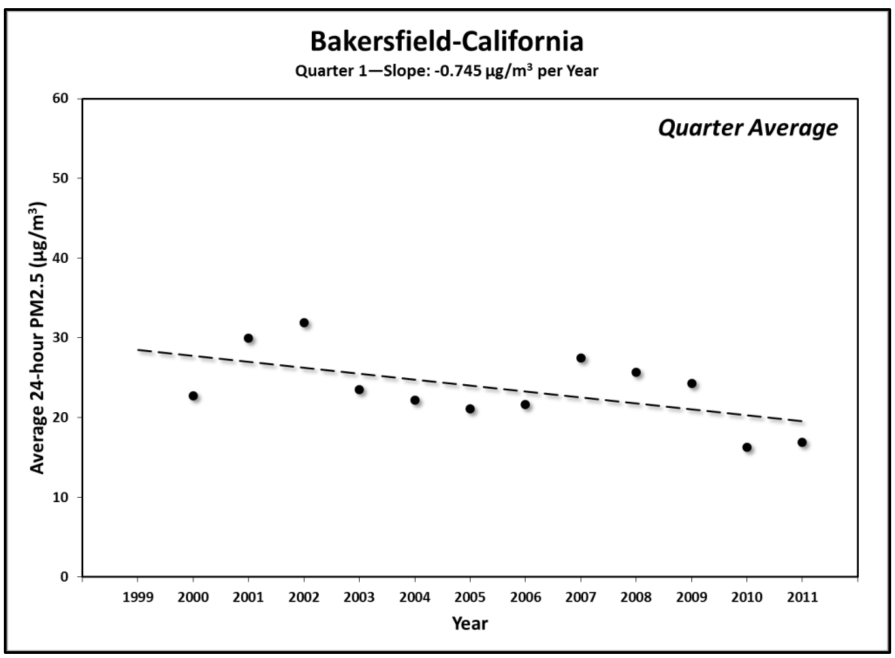
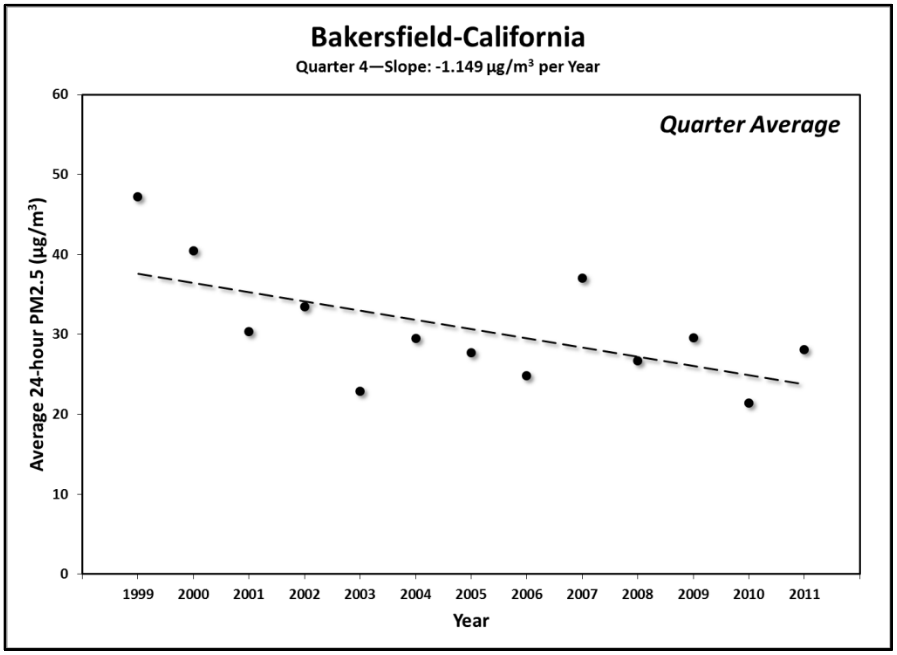


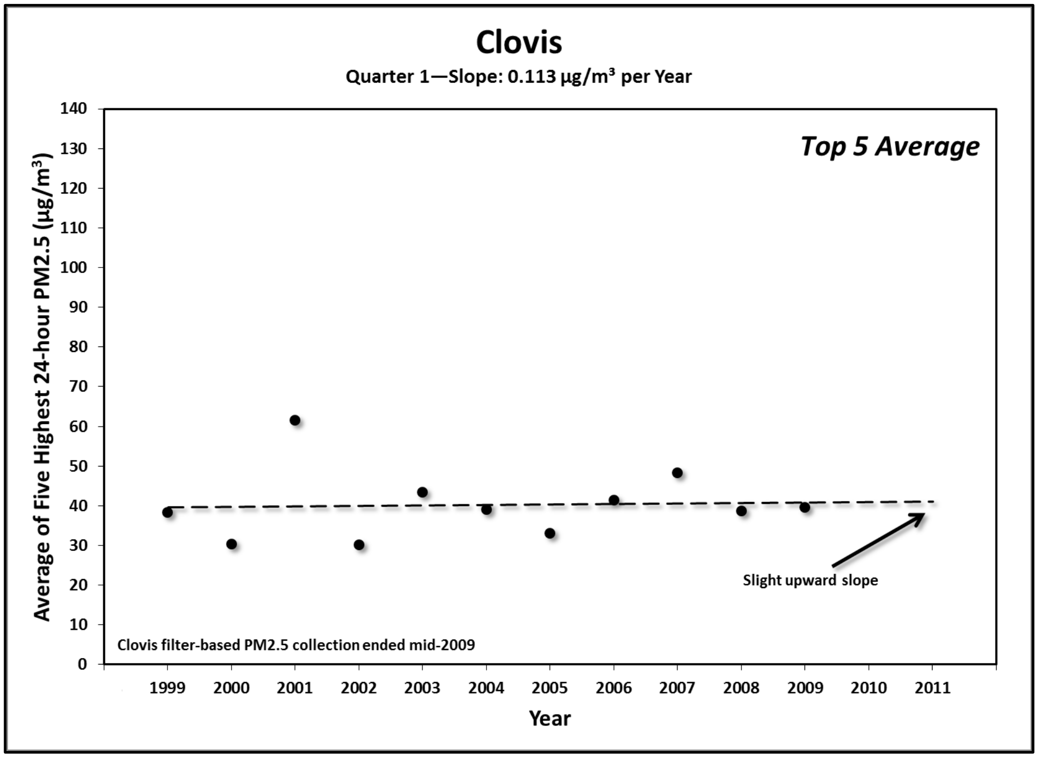
Figure A-7 4th Quarter Average Trend at Bakersfield-California



Using the same data, but focusing only on the five worst days of each quarter, the District was able to determine that not only are the average concentrations decreasing in each quarter, but the severity of the worst days (highest concentrations) are decreasing at a more rapid rate. Using the five worst days from the Visalia air monitoring site data (Figures A-9.13 through A-9.16), over the same time period as above, shows a 3.30 µg/m³ per year reduction rate for the first quarter compared to a 1.22 µg/m³ per year reduction rate for the same quarter when considering the average of all the first-quarter data. This data gives indication that the severity of PM2.5 episodes is decreasing over time, and supports the effectiveness of District wood-burning controls, controls that reduce public exposure to extremely high concentrations of PM2.5.

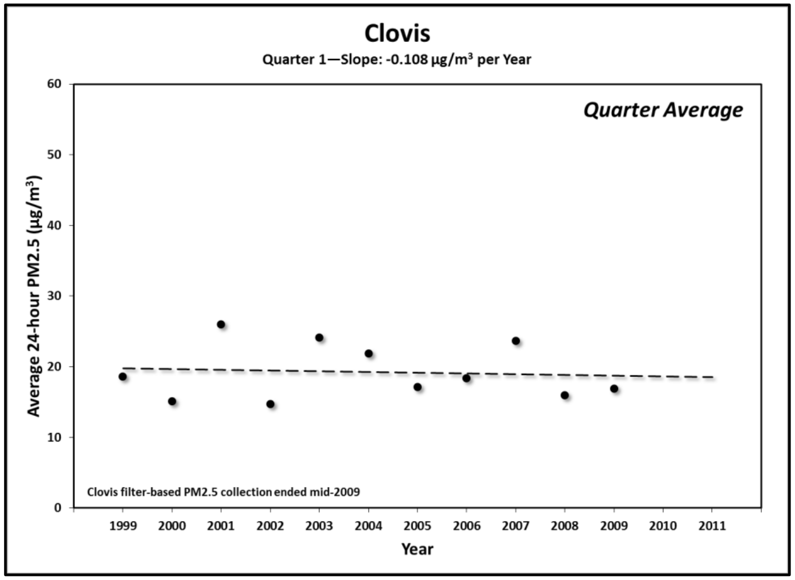
While most Valley air monitoring sites showed a similar pattern of peak reductions as with the Visalia site, evaluation of the Clovis site did not show the same pattern. As shown in Figure A-8, evaluation of the five worst days indicates a slight increase in the peak ambient concentration. However, such an increase may reflect random variation in the data and does not conclusively indicate an overall increase in the average PM2.5 concentration. While this anomaly occurs in the first-quarter data for the Clovis site, the fourth-quarter data is consistent with the overall decreasing trend in ambient PM2.5 concentrations.

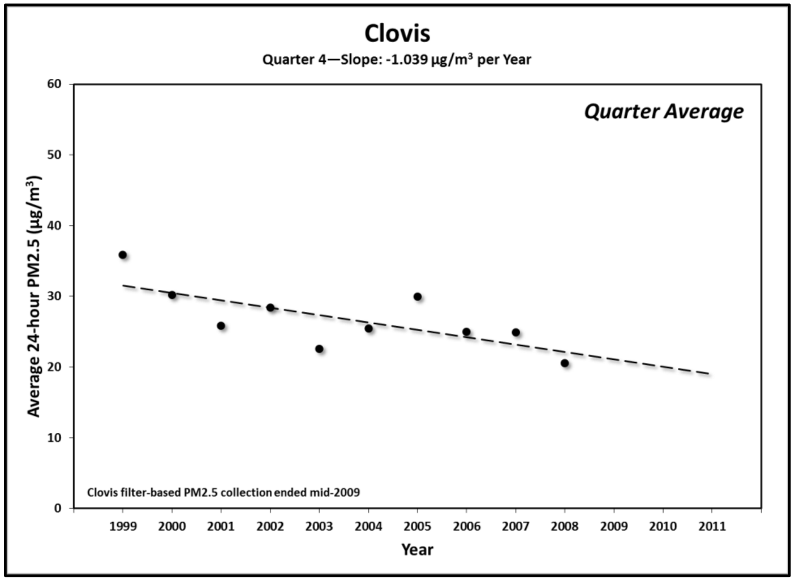
Figure A-8 1st Quarter Average Trend at Clovis

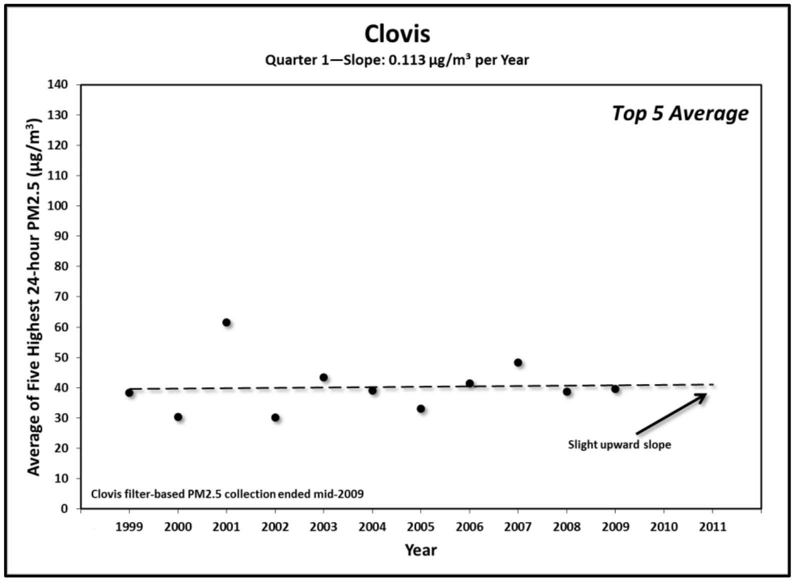


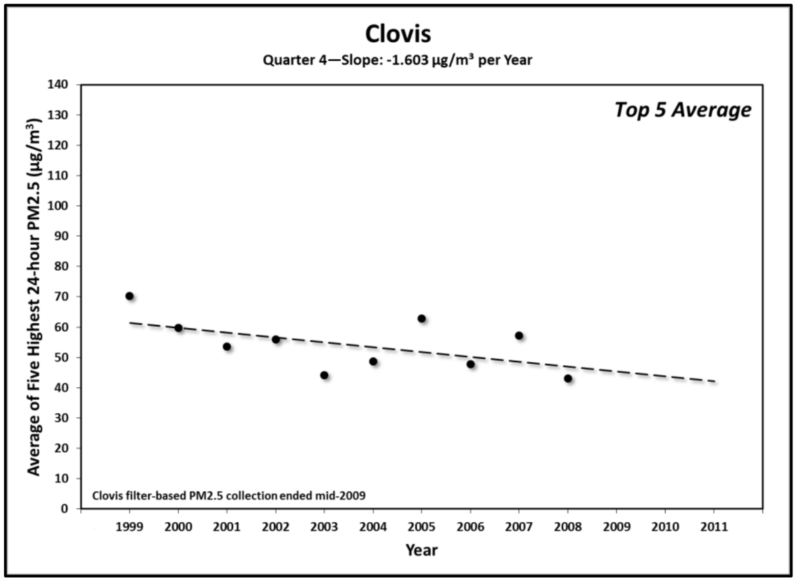
The following graphs, Figures A-9.1 through A-9.24, show the first- and fourth-quarter 24-hour PM2.5 averages, along with the average of the top five values within each of these quarters for the six monitoring sites included in this analysis.

Figures A-9.1 through A-9.4 1st and 4th Quarter PM2.5 Average Trends at Clovis

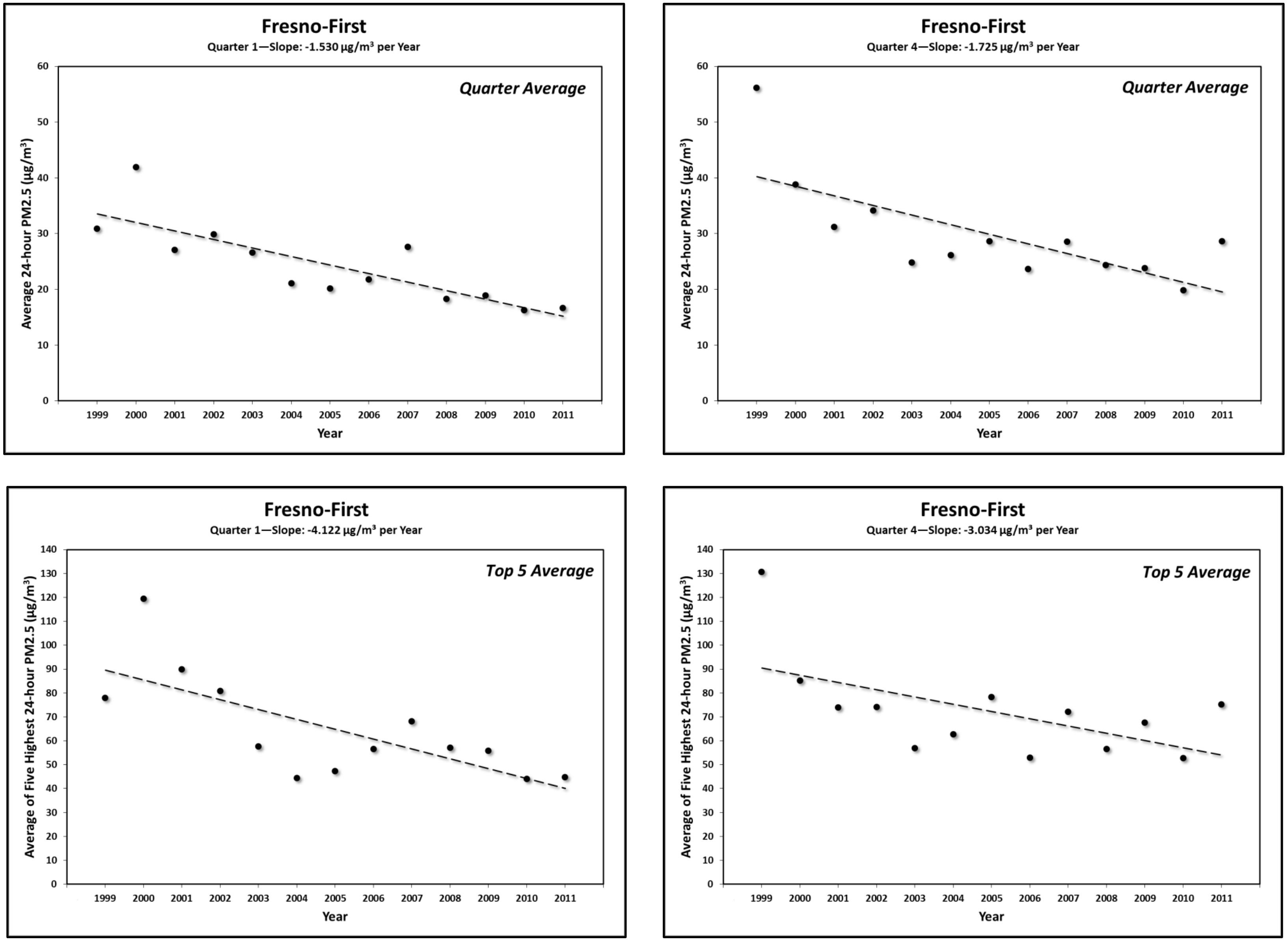




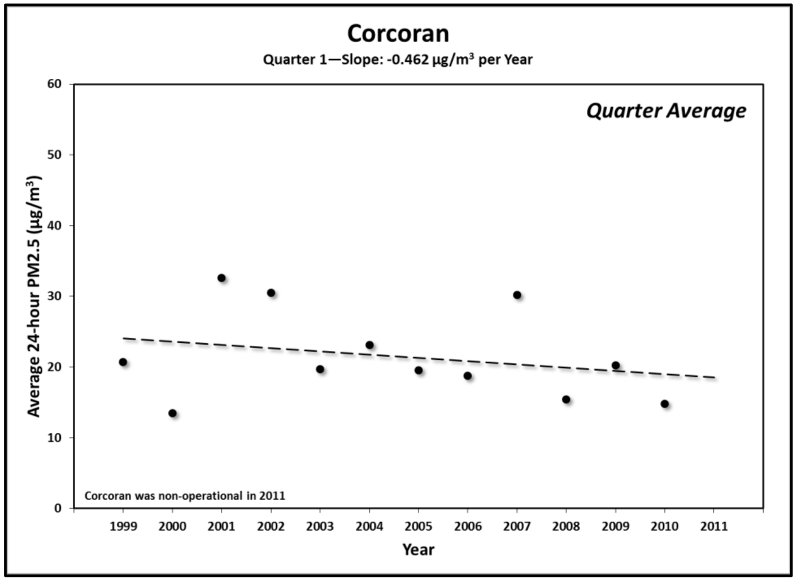


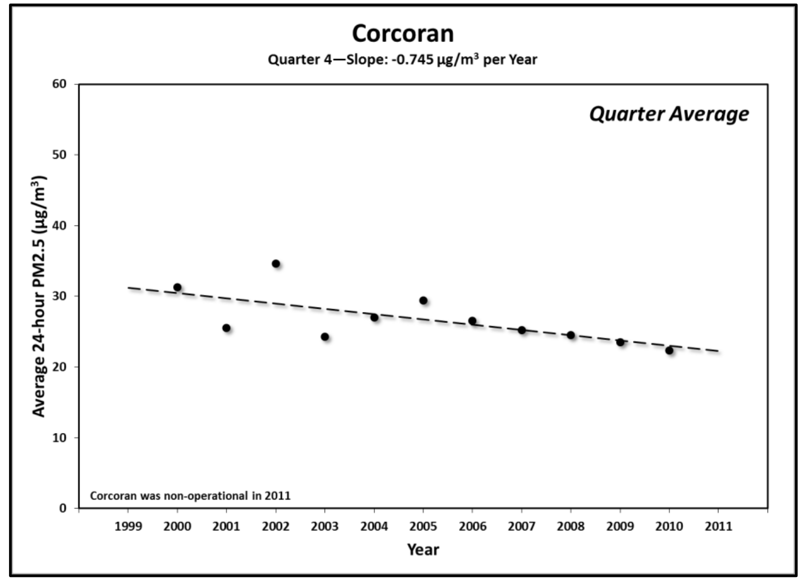


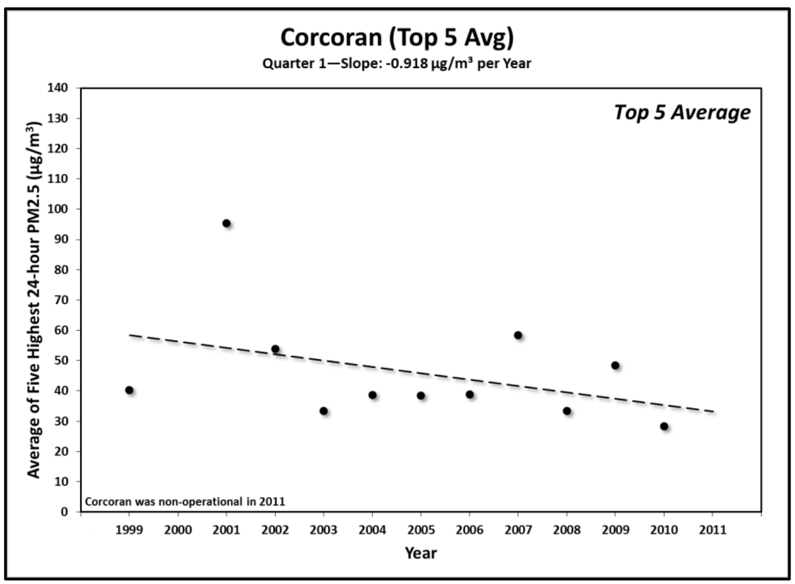
Figures A-9.5 through A-9.8 1st and 4th Quarter PM2.5 Average Trends at Fresno-First

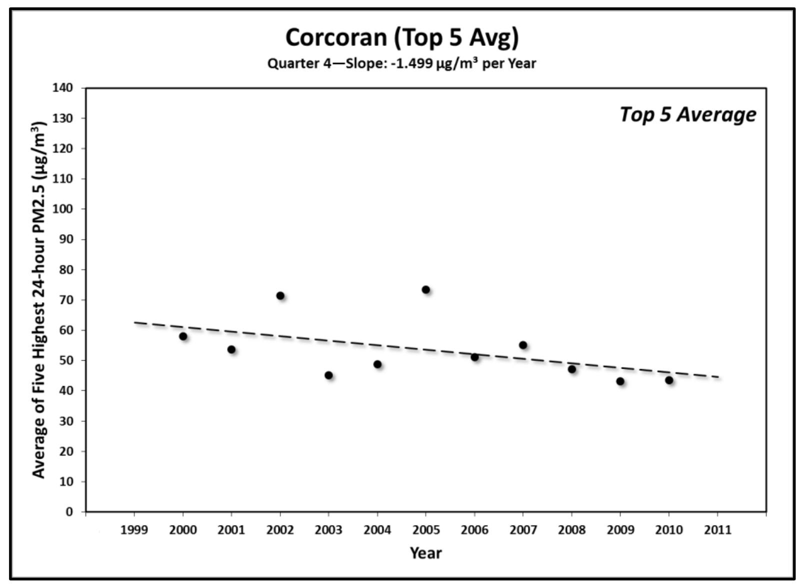


Figures A-9.9 through A-9.12 1st and 4th Quarter PM2.5 Average Trends at Corcoran

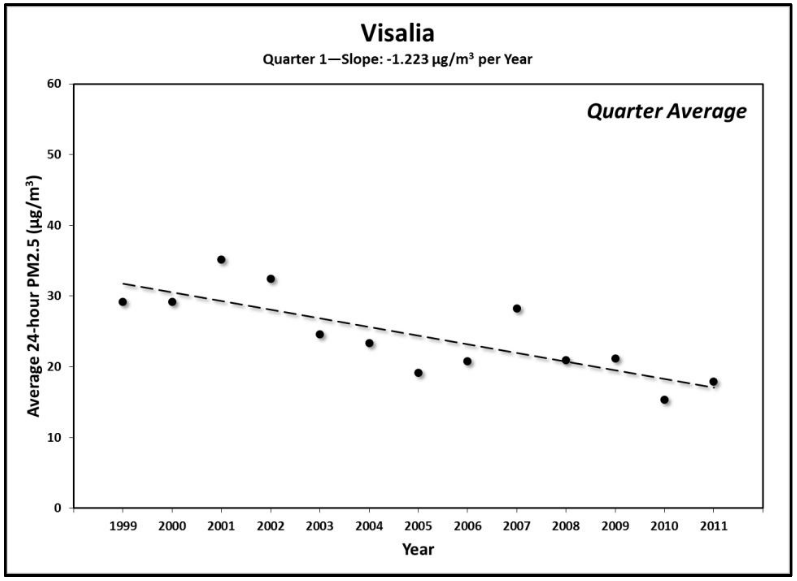


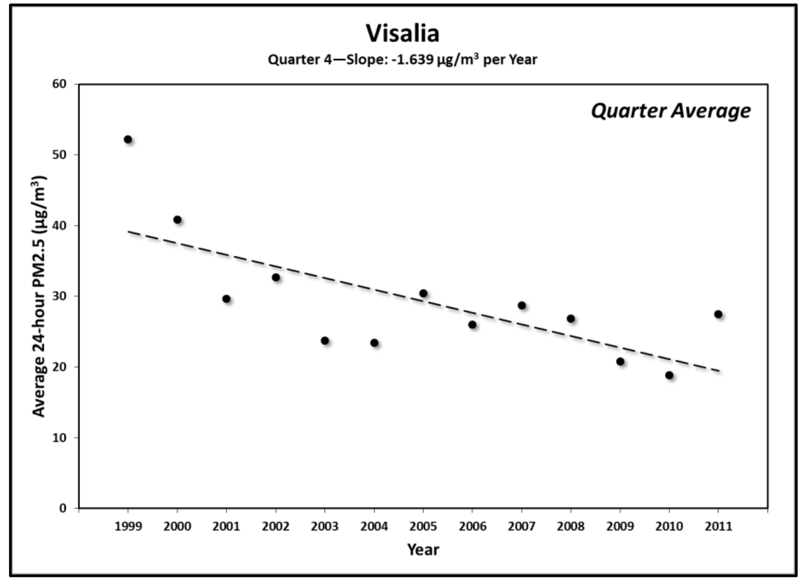


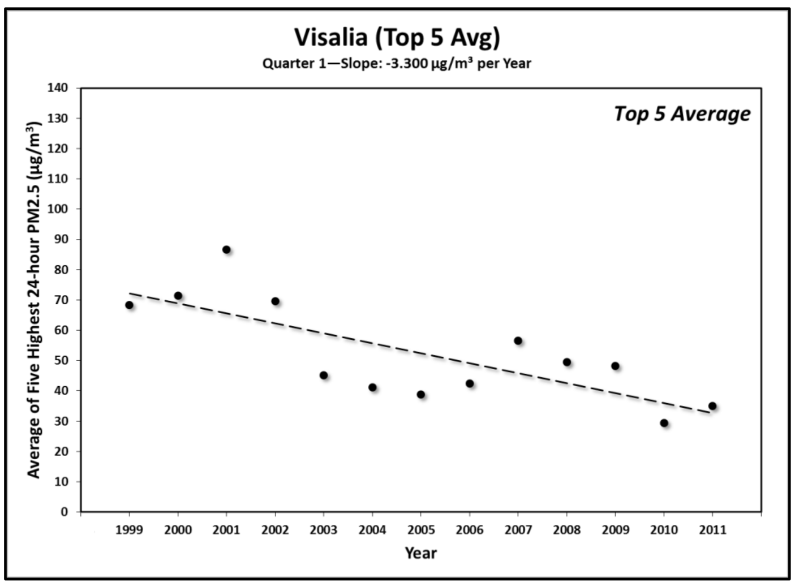


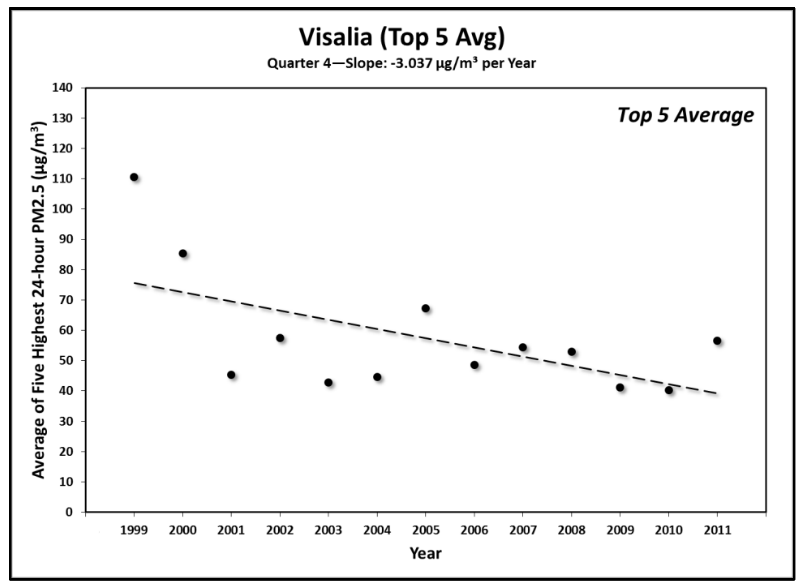


Figures A-9.13 through A-9.16 1st and 4th Quarter PM2.5 Average Trends at Visalia

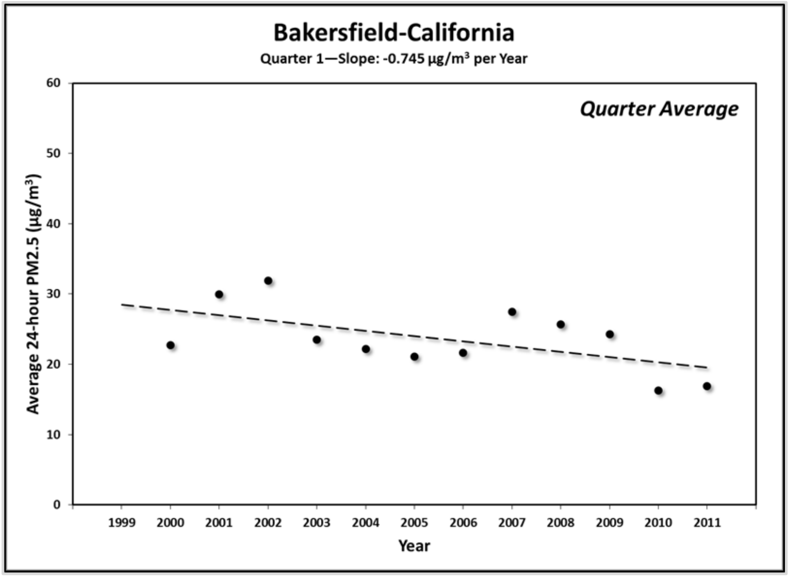


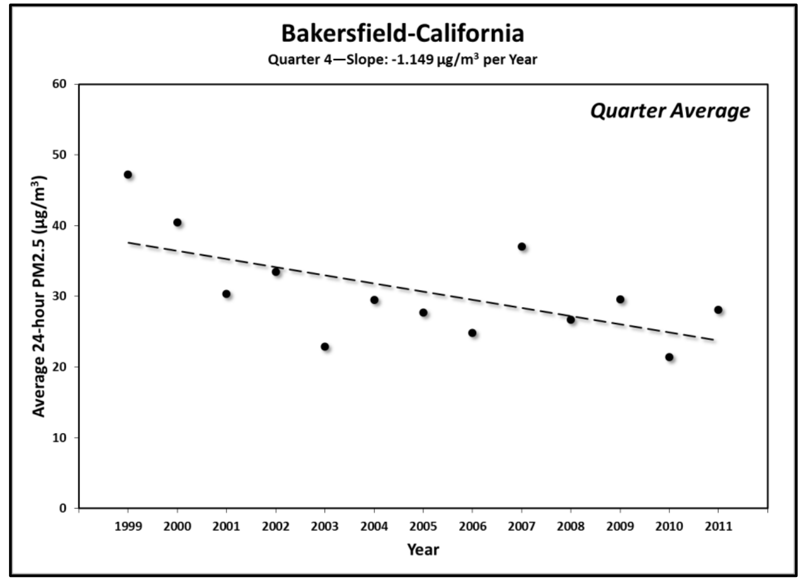


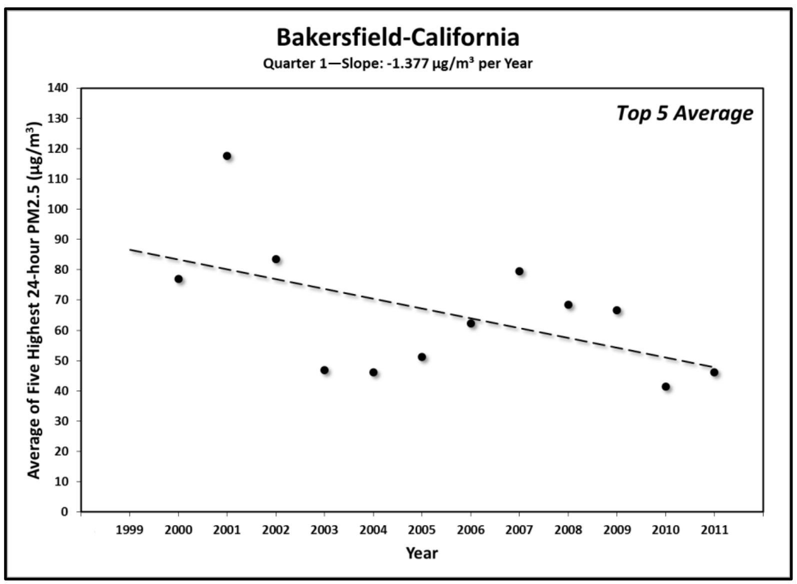


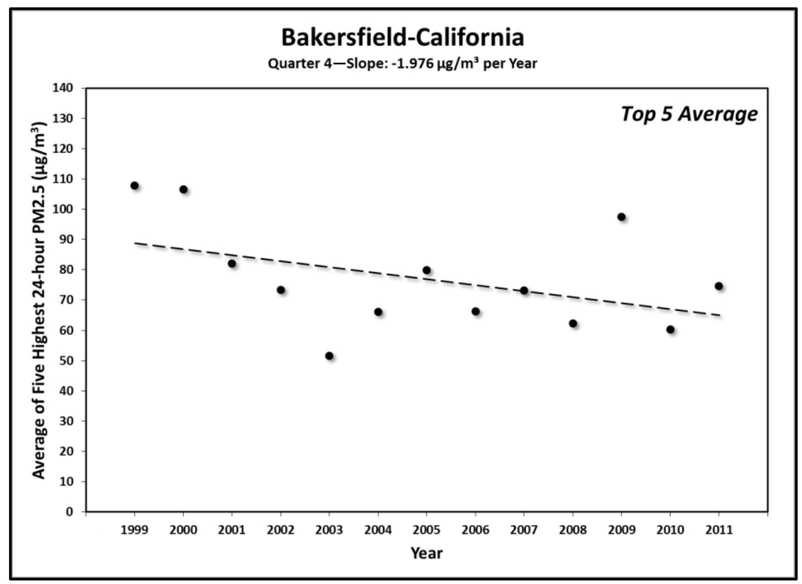


Figures A-9.17 through A-9.20 1st and 4th Quarter PM2.5 Average Trends at Bakersfield-California

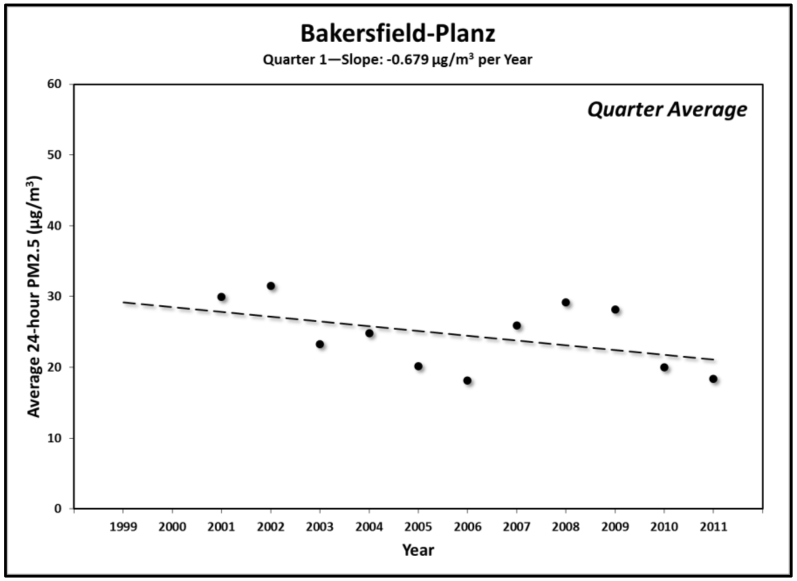


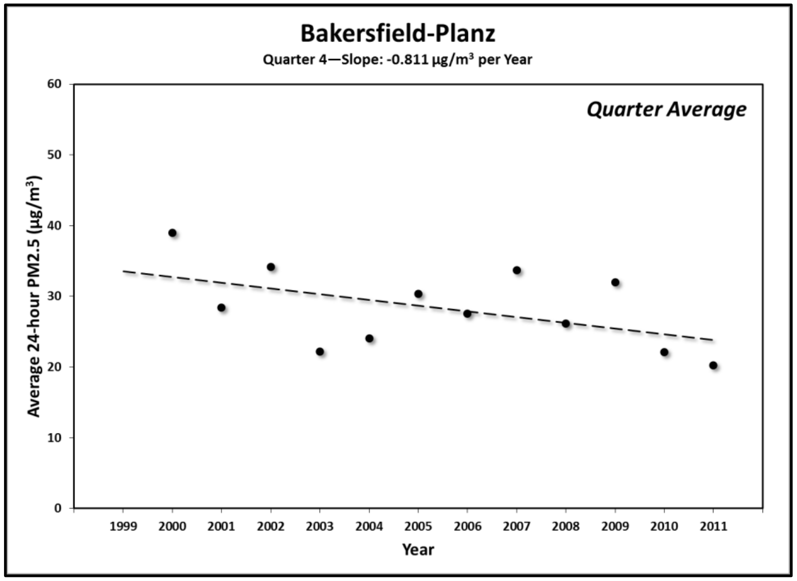


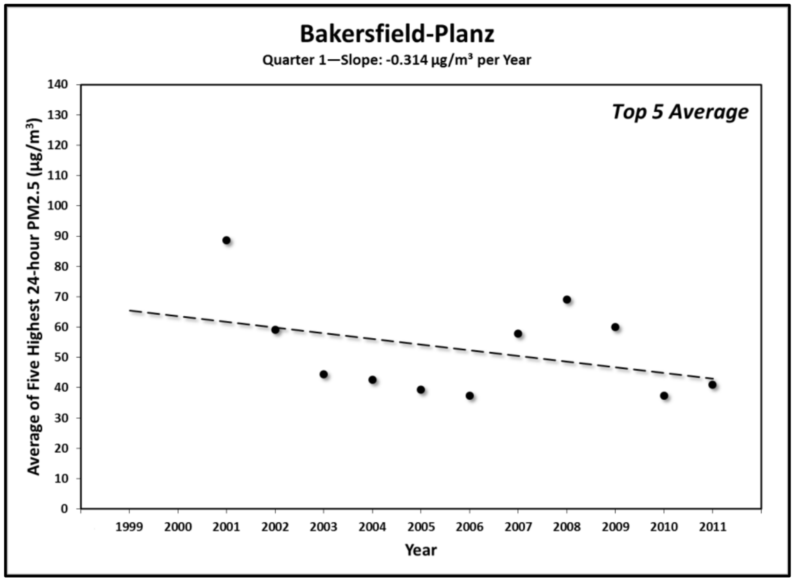


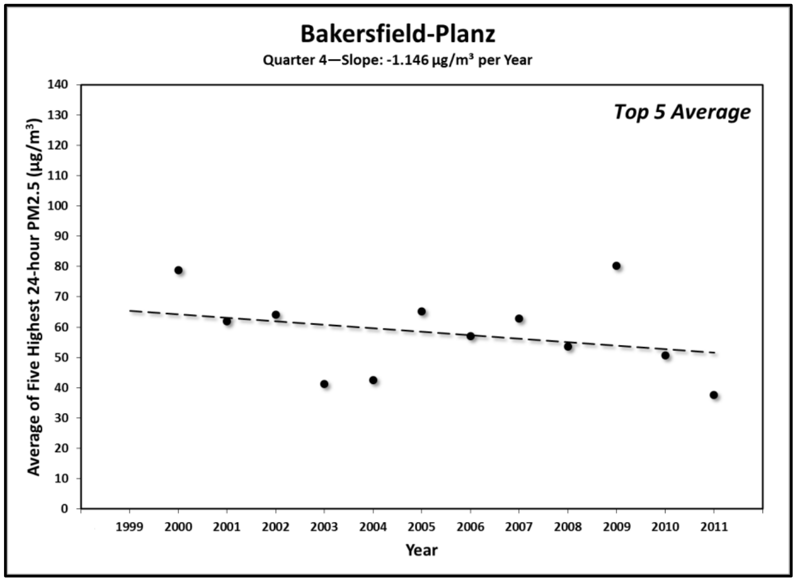


Figures A-9.21 through A-9.24 1st and 4th Quarter PM2.5 Average Trends at Bakersfield-Planz









A.3.3 Annual Trends of Diurnal PM2.5 Concentration Profiles

The District collects hourly PM2.5 concentration data from 17 of the 34 air monitoring stations in the Valley using real-time PM2.5 monitors. The District uses this data every day to produce daily air quality forecasting, wood burning declarations, public health notifications, and Real-time Air Advisory Network (RAAN) notifications for schools. Based on historical hourly data, the District has compiled long-term diurnal profiles to evaluate how PM2.5 concentration vary throughout the day at each of the Valley monitoring sites that measure such data. An understanding of such profiles helps to develop control strategies and programs that target activities during times of peak concentrations.

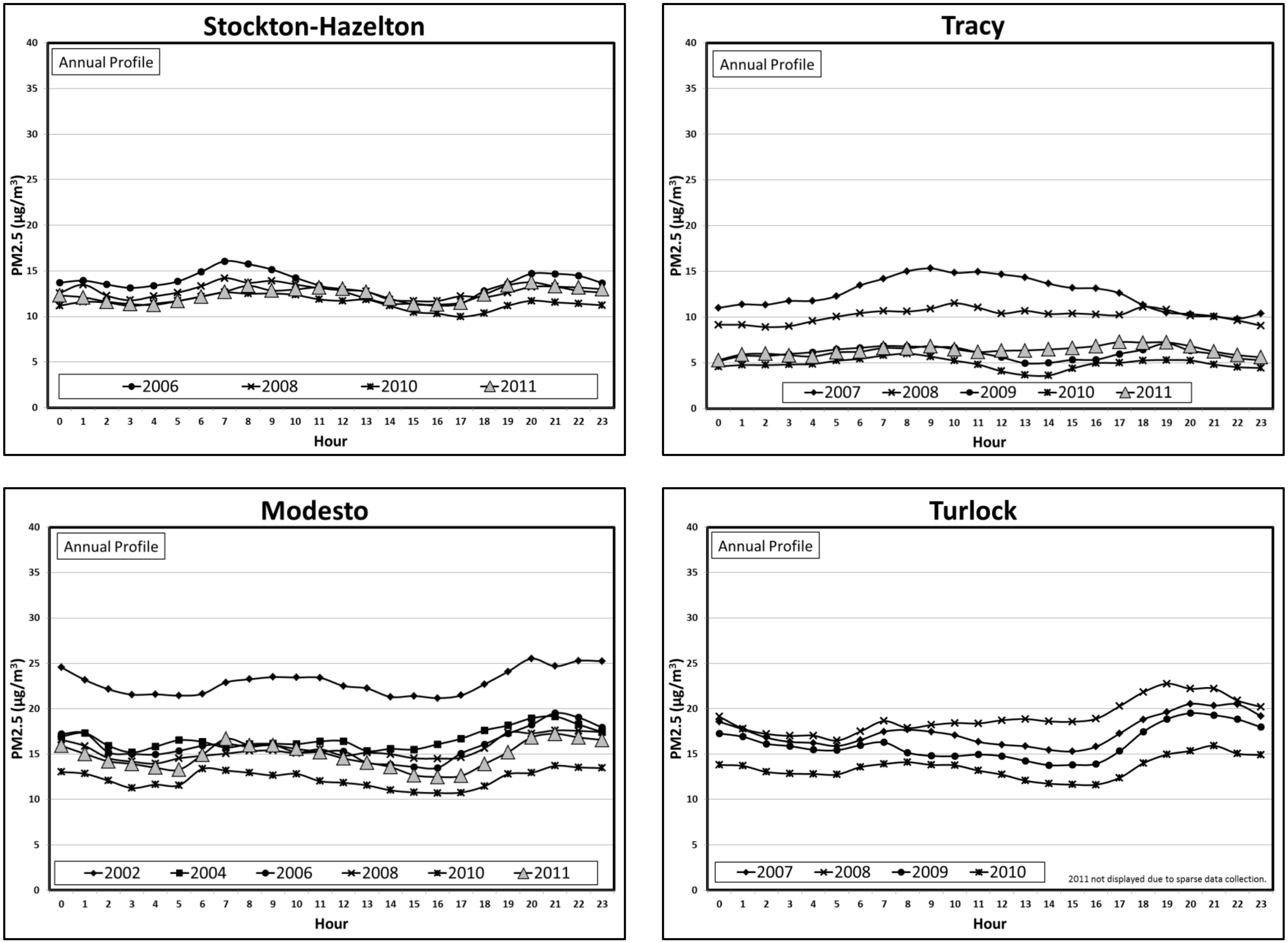
Calculating and comparing annual and 24-hour averages for PM2.5 can be helpful in their own right; however, these metrics can often mask the trend in hourly concentrations throughout the day. An hourly analysis of PM2.5 measurements can show what portions of the day tend to have the highest concentrations and which portions of the day have the lowest. Comparing the diurnal (or daily) profiles over time shows how this curve has changed from year to year.

The District compares relative changes in hourly PM2.5 concentrations from year to year at each monitoring site to better understand the implications and effectiveness of PM2.5 control measures, especially the use of wood-burning prohibitions. Such prohibitions became mandatory prior to the 2003–2004 winter season and were strengthened prior to the 2008–2009 winter season.

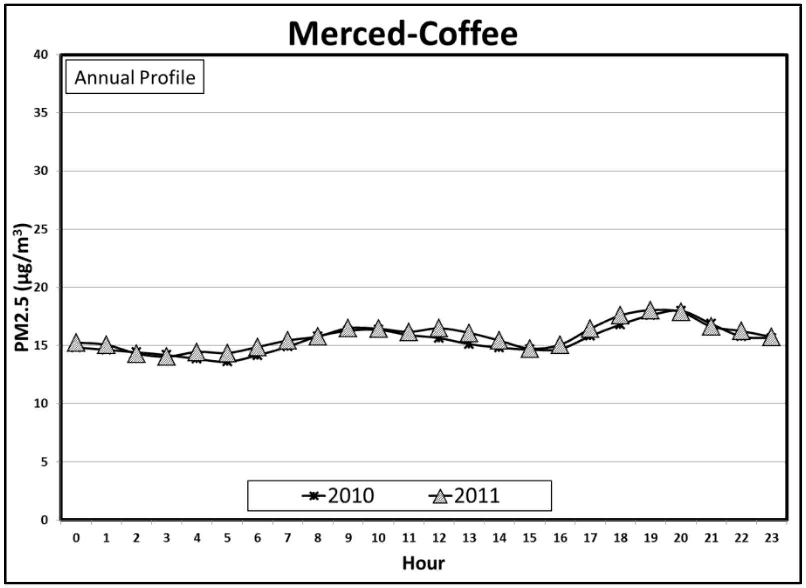
Figures A-10.1 through A-10.14 show the yearly average diurnal profiles of most of the real-time monitoring sites in the Valley. Sites profiled here are those with the most complete data record, in which a comparison could be made with previous years.

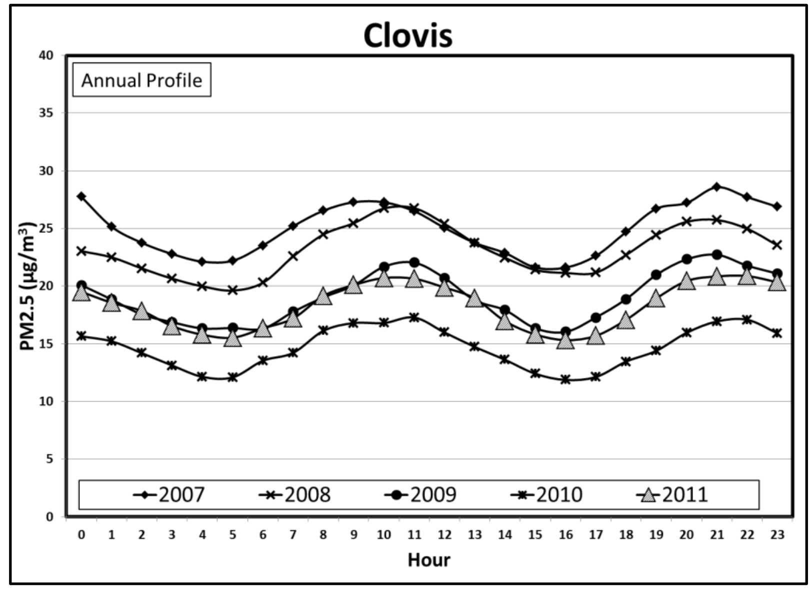
As shown in these profiles, the year 2011 (represented by triangles in all of the charts) tended to experience higher hourly PM2.5 concentrations when compared to 2010. In the larger metropolitan areas like Bakersfield and Fresno, this difference between 2011 and 2010 was more pronounced. Although concentrations were higher in 2011, partly because of unfavorable meteorology, the evening peaks were “flatter” (less pronounced) than in years past. Focusing on the Bakersfield-California and Fresno-First sites, the higher evening peaks in the year 2002 can be observed. Comparing this to the evening peaks in recent years, including 2011, one can see that the peak is not as pronounced. This could be attributable to more wood-burning prohibitions, which became mandatory during the winter of 2003-04.

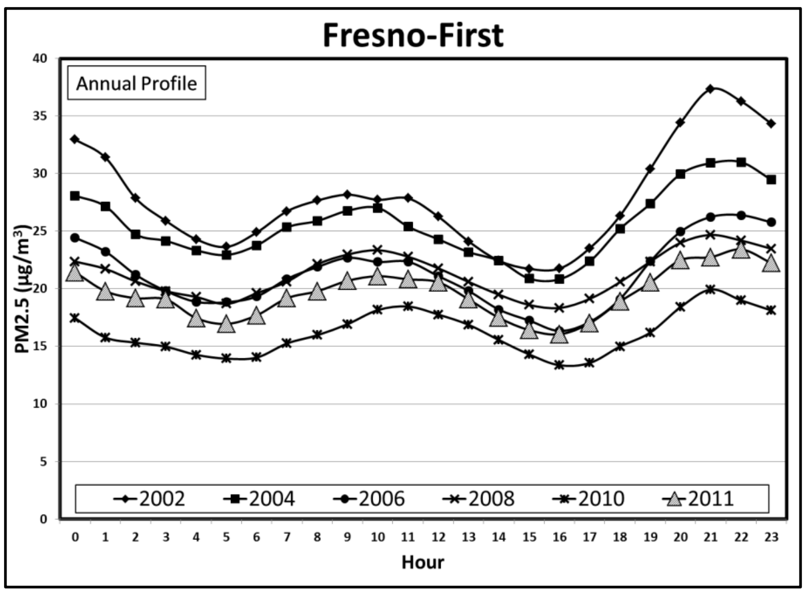
Figures A-10.1 through A-10.4 PM2.5 Diurnal Profiles: Stockton-Hazelton, Tracy, Modesto, Turlock

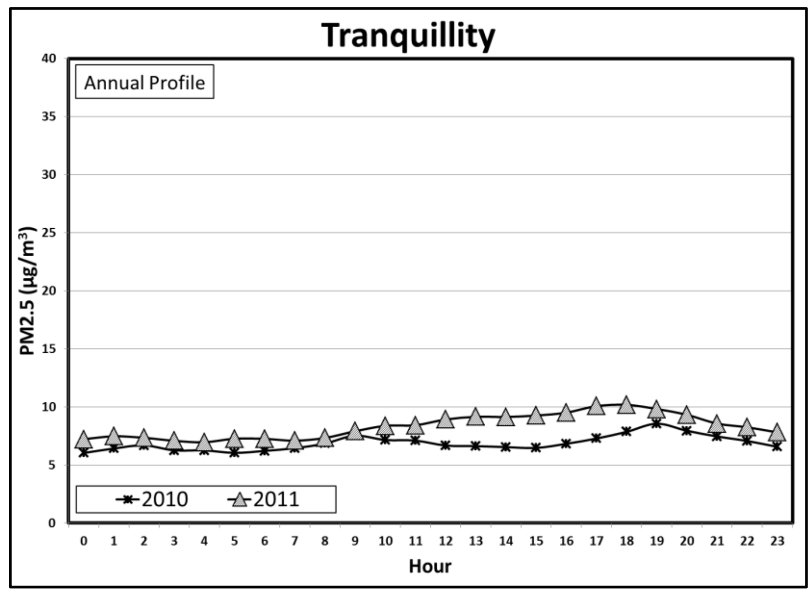


Figures A-10.5 through A-10.8 PM2.5 Diurnal Profiles: Merced-Coffee, Clovis, Fresno-First, Tranquillity

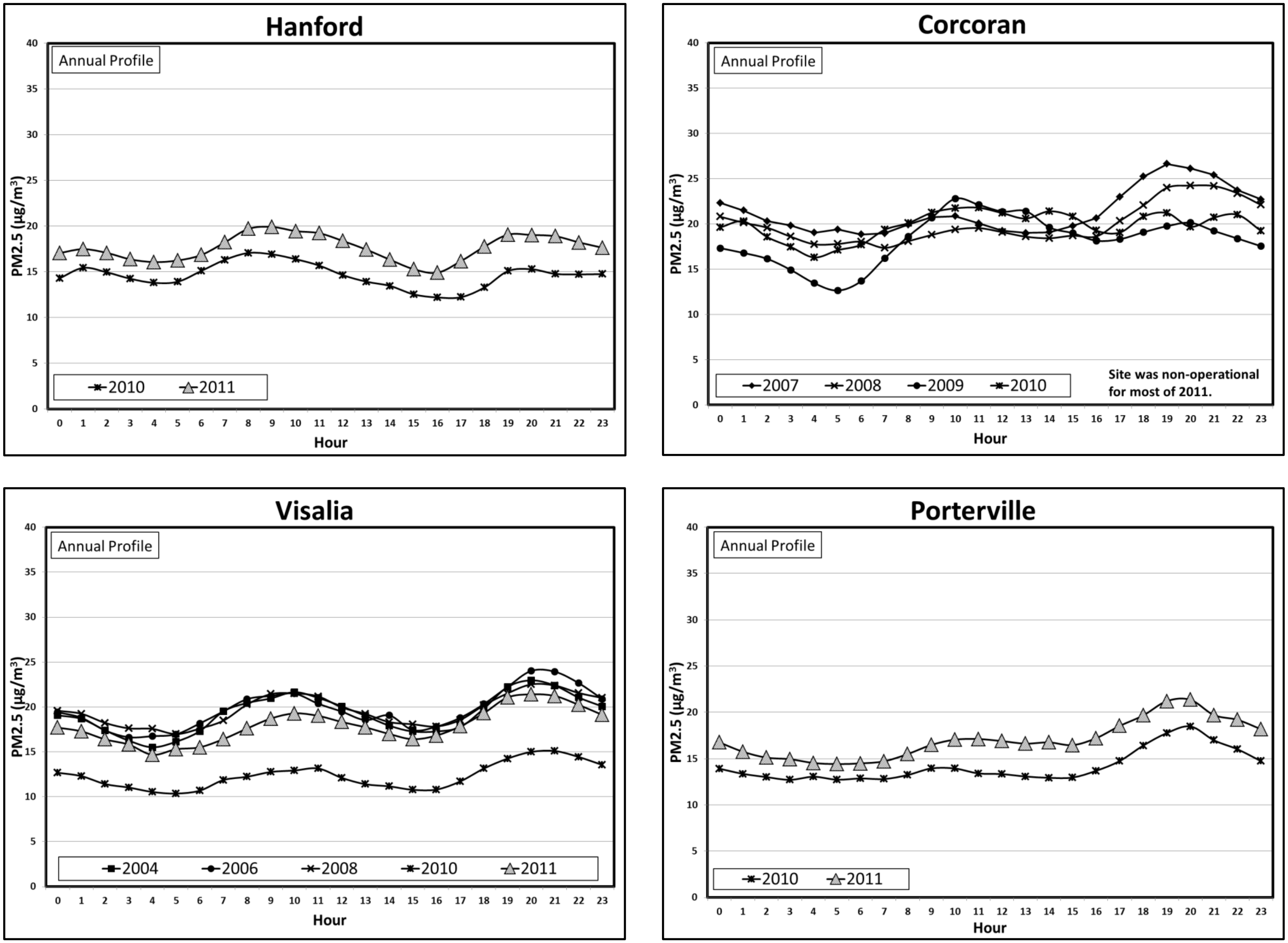




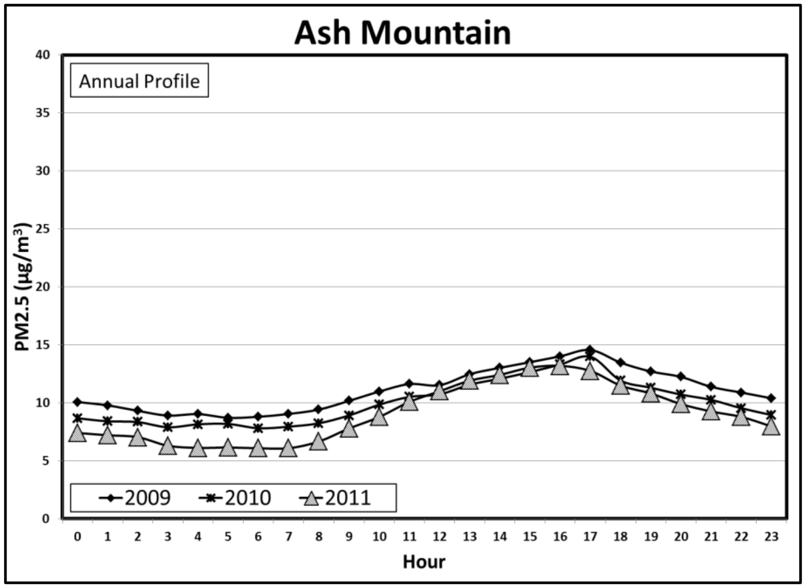


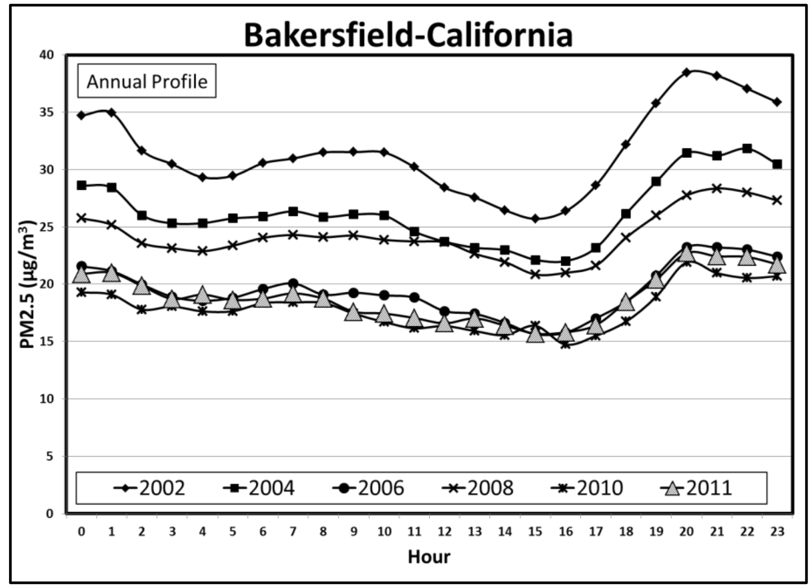


Figures A-10.9 through A-10.12 PM2.5 Diurnal Profiles: Hanford, Corcoran, Visalia, Porterville



Figures A-10.13 through A-10.14 PM2.5 Diurnal Profiles: Ash Mountain, Bakersfield-California





A.3.4 PM2.5 Driven Air Quality Index Analysis

The EPA and the District use the Air Quality Index (AQI) to provide daily information about the Valley's air quality, to inform the public about how unhealthy air may affect them, and educate the public about how they can protect their health. AQI scales exist for all of the criteria pollutants regulated by the Clean Air Act, including PM2.5. The current 24-hour average PM2.5 AQI scale is defined in Table A-8.

Table A-8 24-Hour PM2.5 AQI Scale

Concentration (μg/m^3)	AQI Category	AQI Color	AQI Range
0 - 15.4	Good	Green	0-50
15.5 - 40.4	Moderate	Yellow	51-100
40.5 - 65.4	Unhealthy for Sensitive Groups	Orange	101-150
65.5 - 150.4	Unhealthy	Red	151-200
150.5 - 250.4	Very Unhealthy	Purple	201-300
250.5+	Hazardous	Maroon	301+

The District analyzed the trends in the PM2.5 data from the sites with at least two years of daily AQI observations based on real-time data. For this analysis, the AQI reflects only PM2.5 data and not ozone or PM10. By excluding other pollutants, the District is able to isolate the change in air quality related to PM2.5 only.

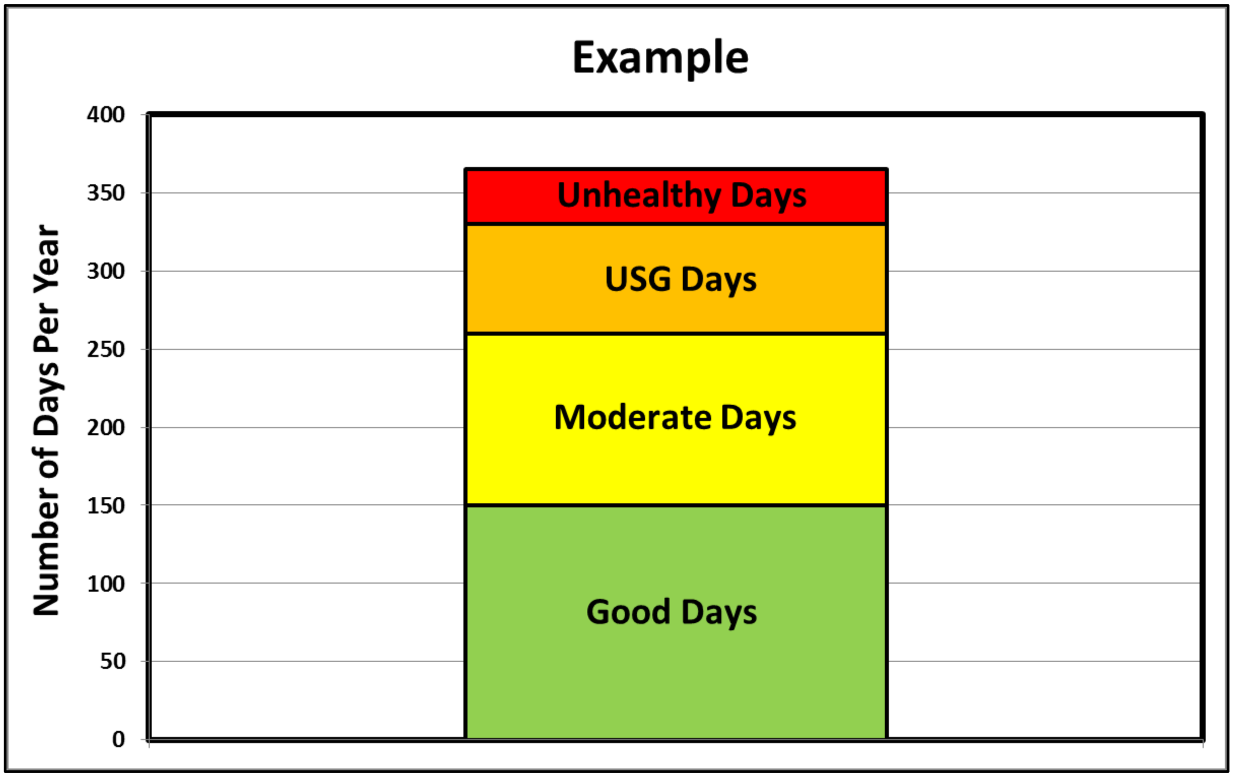
For the majority of the Valley sites, the observed AQI data for the 2008–2010 timeframe shows an improvement in PM2.5 air quality. Over these three years, the frequency of Good AQI days increased sharply, coupled with a decrease in the frequency of the Moderate and Unhealthy-for-Sensitive-Groups (USG) categories. For example, at the Fresno-First site, the number of Good days increased from 155 in 2008, to 205 in 2009, and to 227 in 2010. At the same time, the USG days at the Bakersfield-California site decreased from 61 in 2008, to 34 in 2009, and to 16 in 2010. This trend shows a progressive “shift in improvement” of the AQI and air quality—as air quality improves there will more AQI days falling within the Good and Moderate categories and fewer in the USG category.

Although the improvement over the 2008–2010 timeframe is partly attributable to favorable meteorology, emissions reductions were also occurring over these three years. The District’s Rule 4901 (Wood Burning Fireplaces and Wood Burning Heaters) was strengthened just before the 2008–2009 winter season, lowering the curtailment threshold from 65 μg/m^3 to 30 μg/m^3. The sharp improvement in PM2.5 air quality began as the amended wood-burning rule took effect, which supports the effectiveness of Rule 4901.

In 2011, the PM2.5 air quality declined throughout the majority of the District as compared to previous years. Abnormally stagnant meteorology during the 2011–2012 winter season contributed greatly to this deterioration. Despite the overall air quality decline there were still more Good AQI days and fewer USG AQI days than in previous years. For example, in 2011 the Modesto site observed 252 Good AQI days and 16 USG AQI days, compared to 2006 with 233 Good AQI days and 22 USG days. Although the air quality for the year 2011 did not continue the favorable trend from 2008–2010, it was still not as severe as in years prior to 2008.

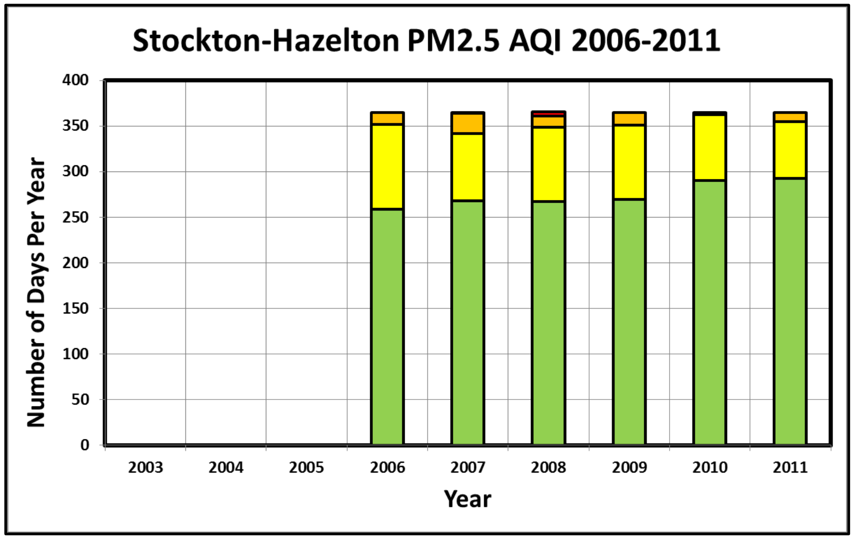
Figure A-11 is shown as a reference for interpreting Figures A-12.1 through A-12.12. The stacked bars represent the number of days within each year that fell within each of the AQI categories (totaling 365 days[8]). Within each stacked bar, the categories are ordered as Good, Moderate, etc. from the bottom up.

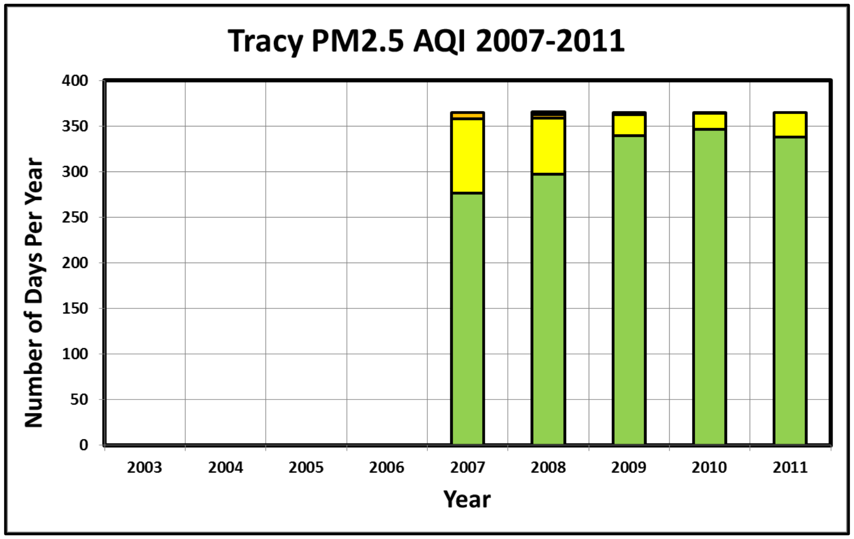
Figure A-11 Air Quality Index (AQI) Categories

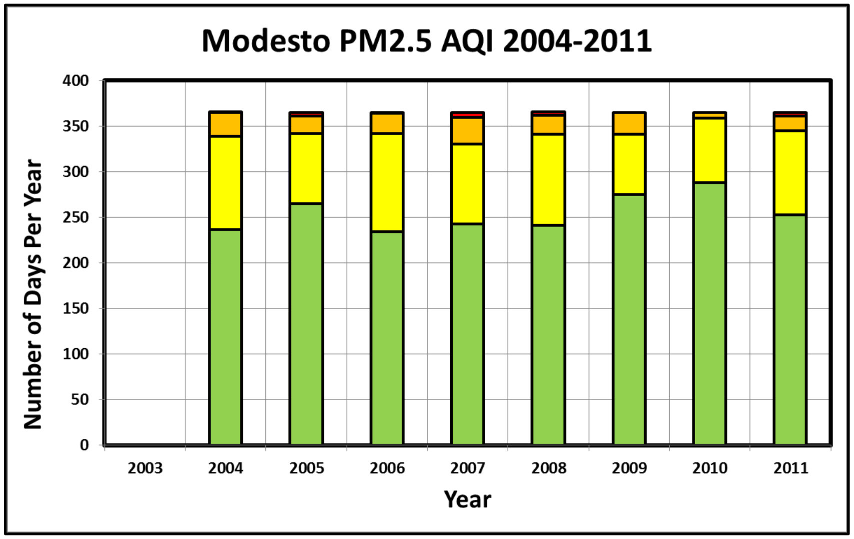


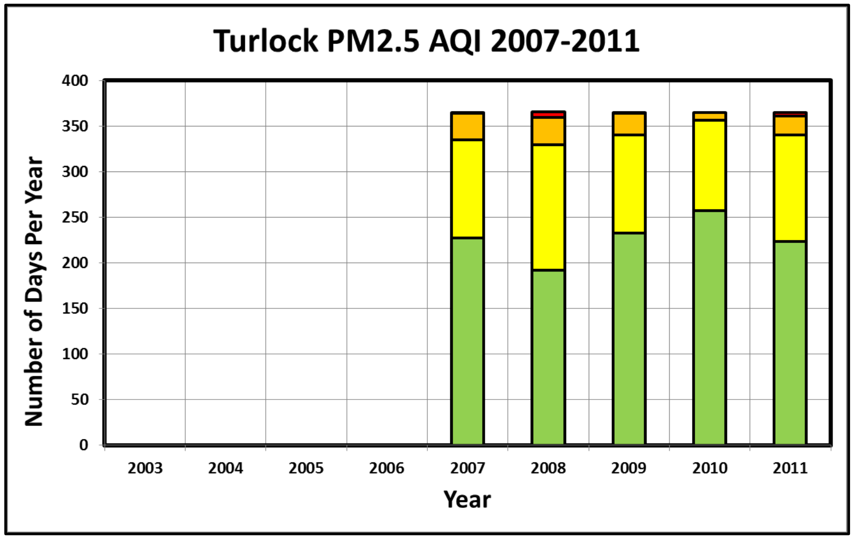
[8] Note: Because of regular maintenance or repairs, monitors may be non-operational for a day or longer. For years with "missing" days, proportional adjustments are made to estimate the missing days so as to provide a full year's data to display.

Figures A-12.1 through A-12.4 Number of Days per AQI Category per Year: Stockton-Hazelton, Tracy, Modesto, and Turlock

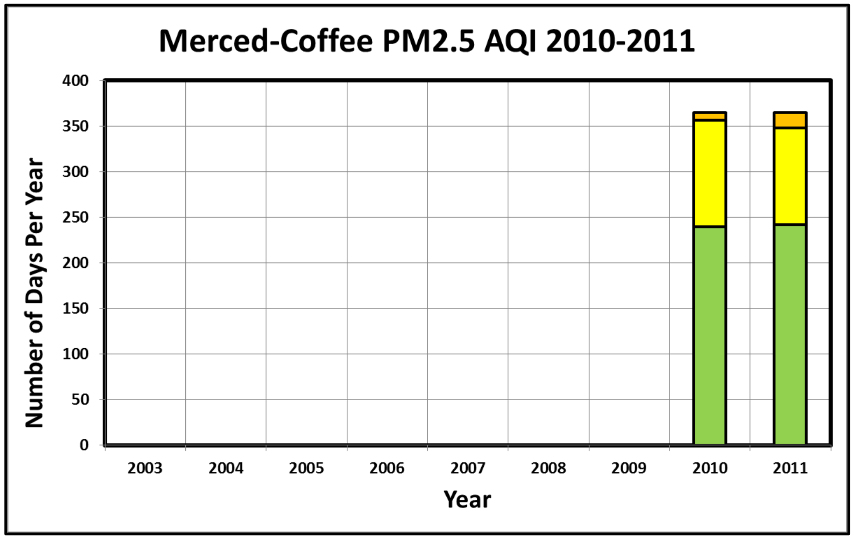


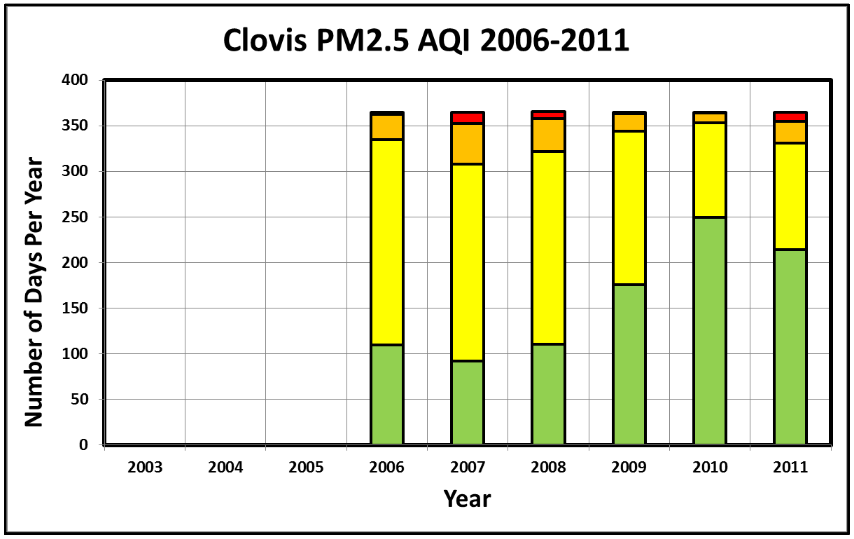


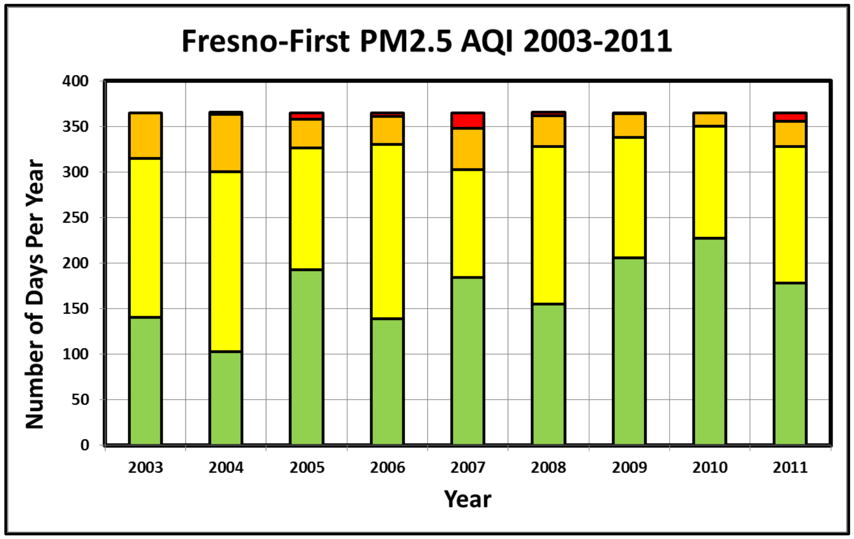


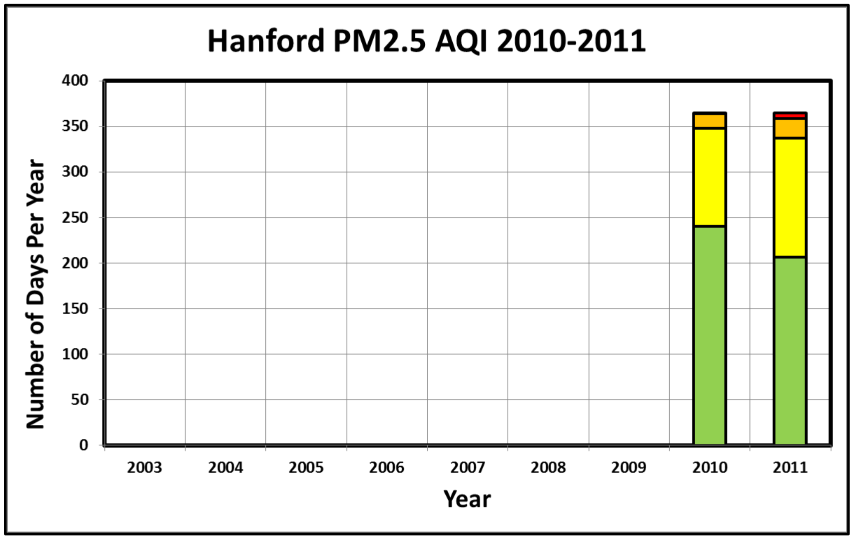


Figures A-12.5 through A-12.8 Number of Days per AQI Category per Year; Merced, Clovis, Fresno-First, and Hanford

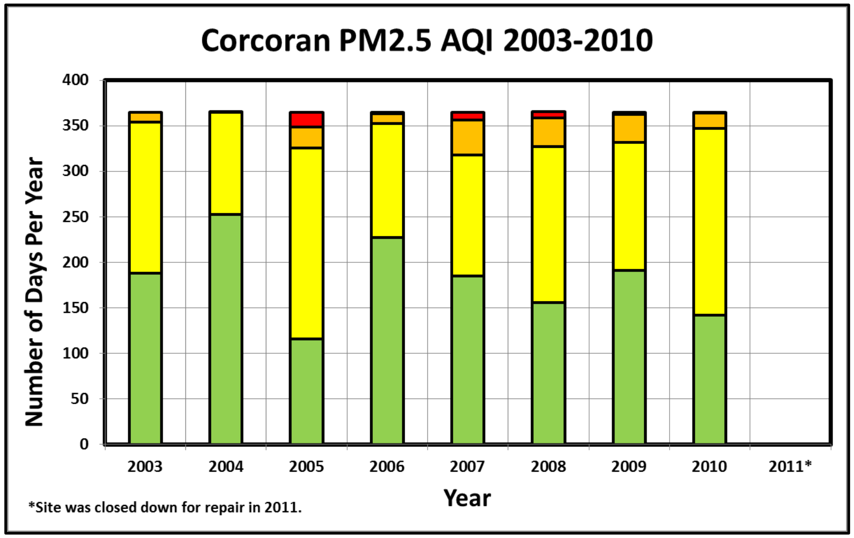


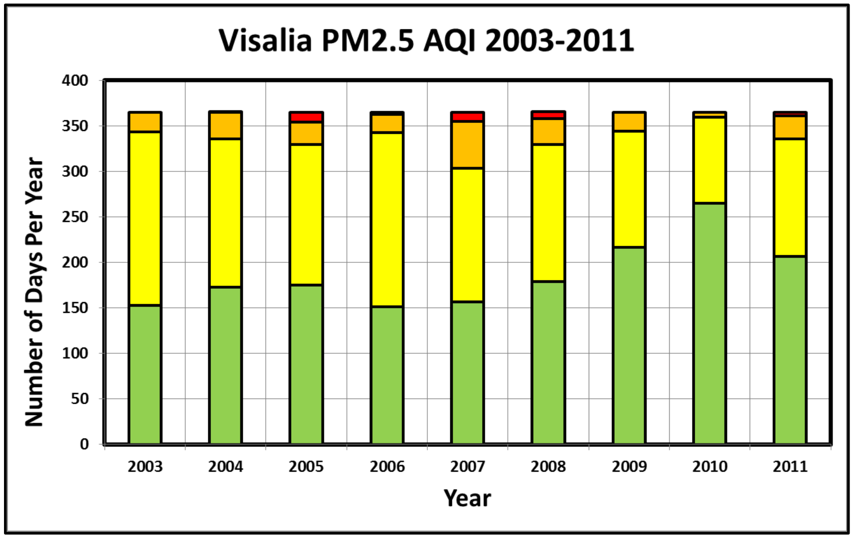


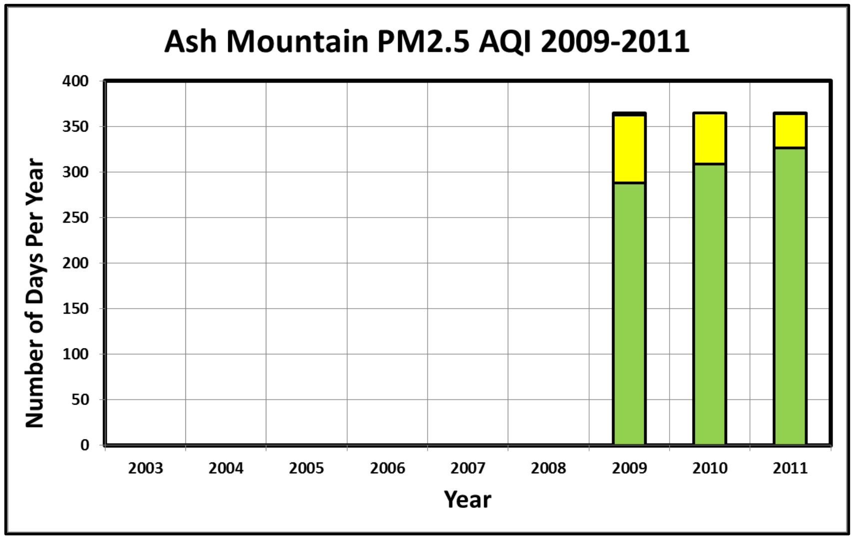


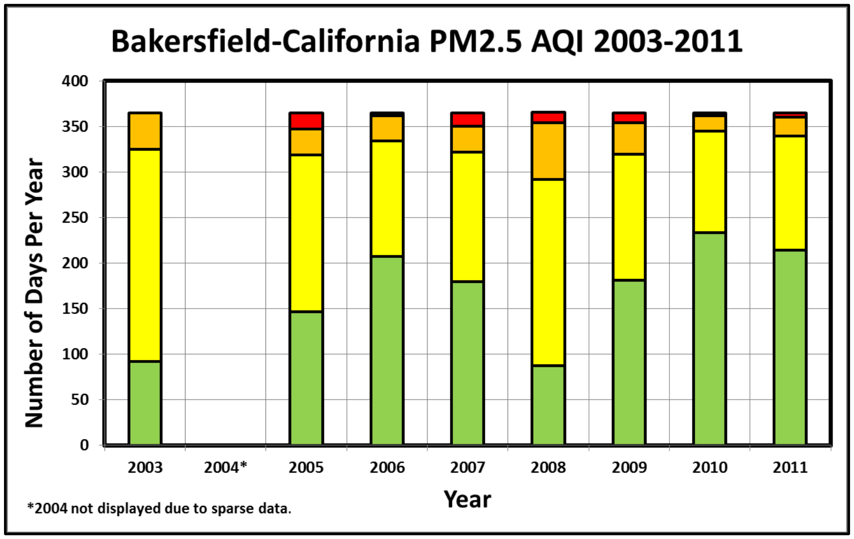


Figures A-12.9 through A-12.12 Number of Days per AQI Category per Year; Corcoran, Visalia, Ash Mountain, and Bakersfield-California







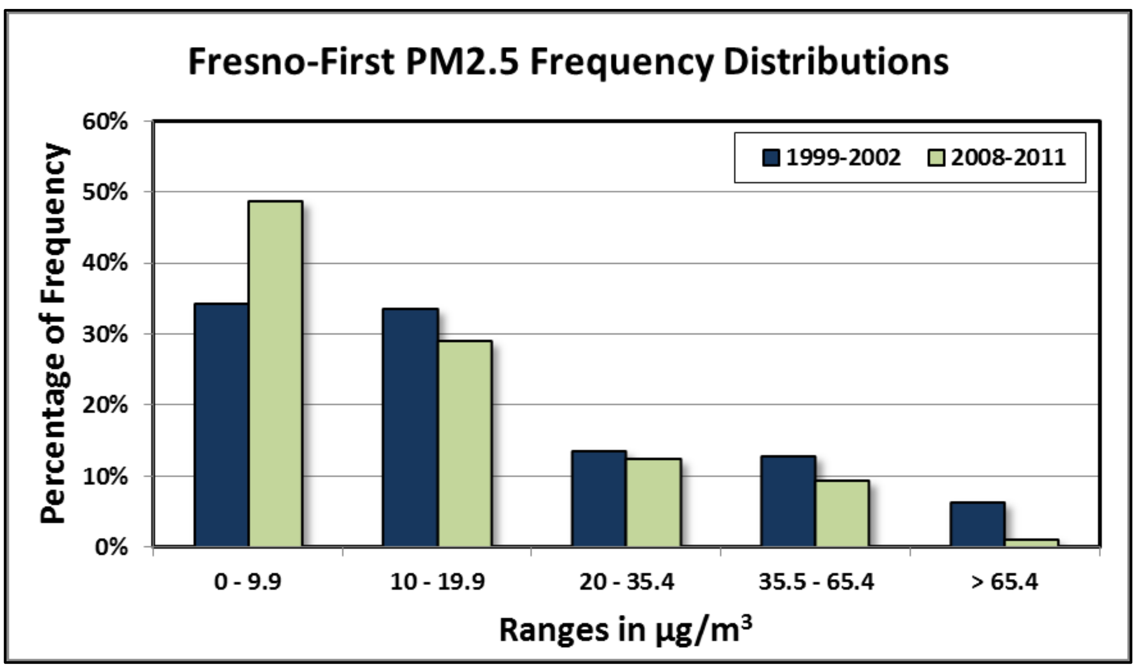


A.3.5 PM2.5 Concentration Frequency Distributions

The District analyzed filter-based PM2.5 data from various sites throughout the Valley to form histograms based on the distribution of concentrations over the time periods of 1999–2003 and 2008–2011. In this analysis, the concentrations were separated into the concentration categories of 0–9.9 $\mu g/m^3$, 10–19.9 $\mu g/m^3$, 20–35.4 $\mu g/m^3$, 35.5–65.4 $\mu g/m^3$, and greater than 65.4 $\mu g/m^3$. For each air monitoring site, the observations for each time period were grouped into the appropriate categories depending upon their concentration. The frequency of the observations within each category were converted to a percentage of the total time period and displayed as a bar chart comparing the distribution of 1999–2002 with 2008–2011. The air monitoring sites included in this analysis were Modesto, Fresno-First, Corcoran, Visalia, and Bakersfield-Planz because of these sites had a robust set of measurements beginning in 1999, except Bakersfield-Planz, which began operation in2000.

The data, as represented in Figure A-13 for the Fresno-First site, shows that in the most recent four years (2008–2011) there has been a significant increase in the percentage of days with low PM2.5 concentrations (under 10 $\mu g/m^3$) when compared to 1999–2002. This increase is observed among all of the sites in this analysis, as seen in Figures A-14 through A-17. Data from all the sites reveals a dramatic decrease in the percentage of days that exceed the 1997 24-hour PM2.5 standard of 65 $\mu g/m^3$.

Figure A-13 Histogram Comparison for Fresno-First



While the Corcoran, Visalia, and Bakersfield-Planz sites show an increase in the frequency of measurements in the 20–35.4 $\mu g/m^3$ category, as progress continues to be made in reducing PM2.5, the curve of the overall distribution will become more sharply pushed to the left as higher concentrations become less frequent and lower concentrations become more frequent.

Figure A-14 Histogram Comparison for Modesto

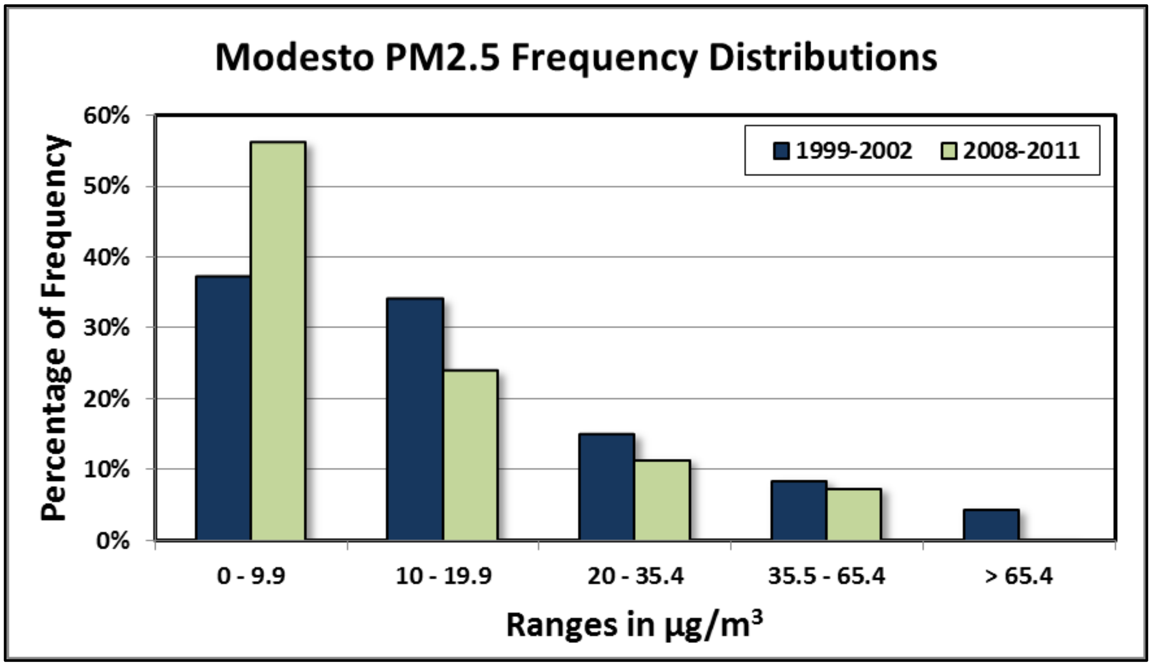
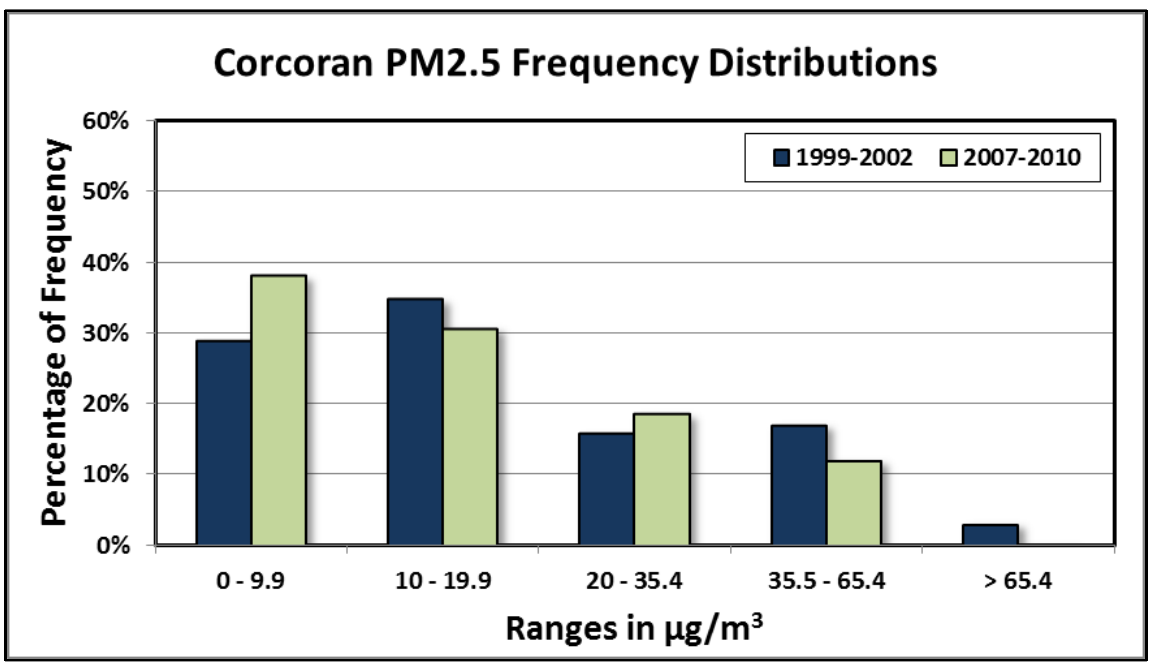


Figure A-15 Histogram Comparison for Corcoran[9]



[9] The Corcoran site was non-operational during 2011, thus data is only represented through 2010

Figure A-16 Histogram Comparison for Visalia

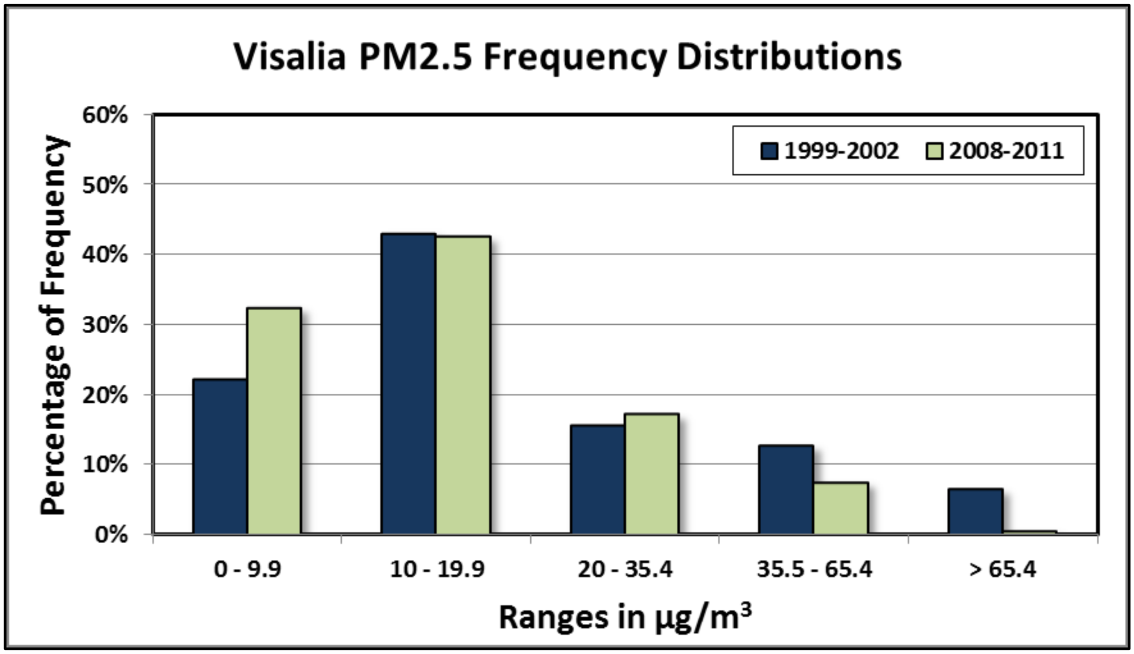
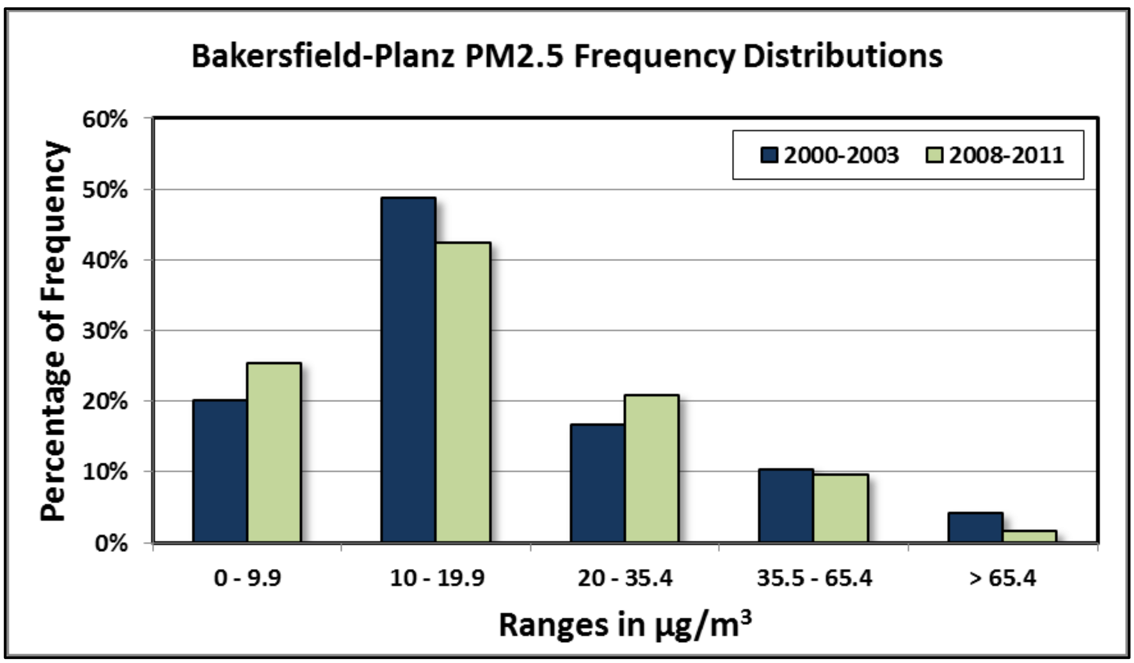


Figure A-17 Histogram Comparison for Bakersfield-Planz

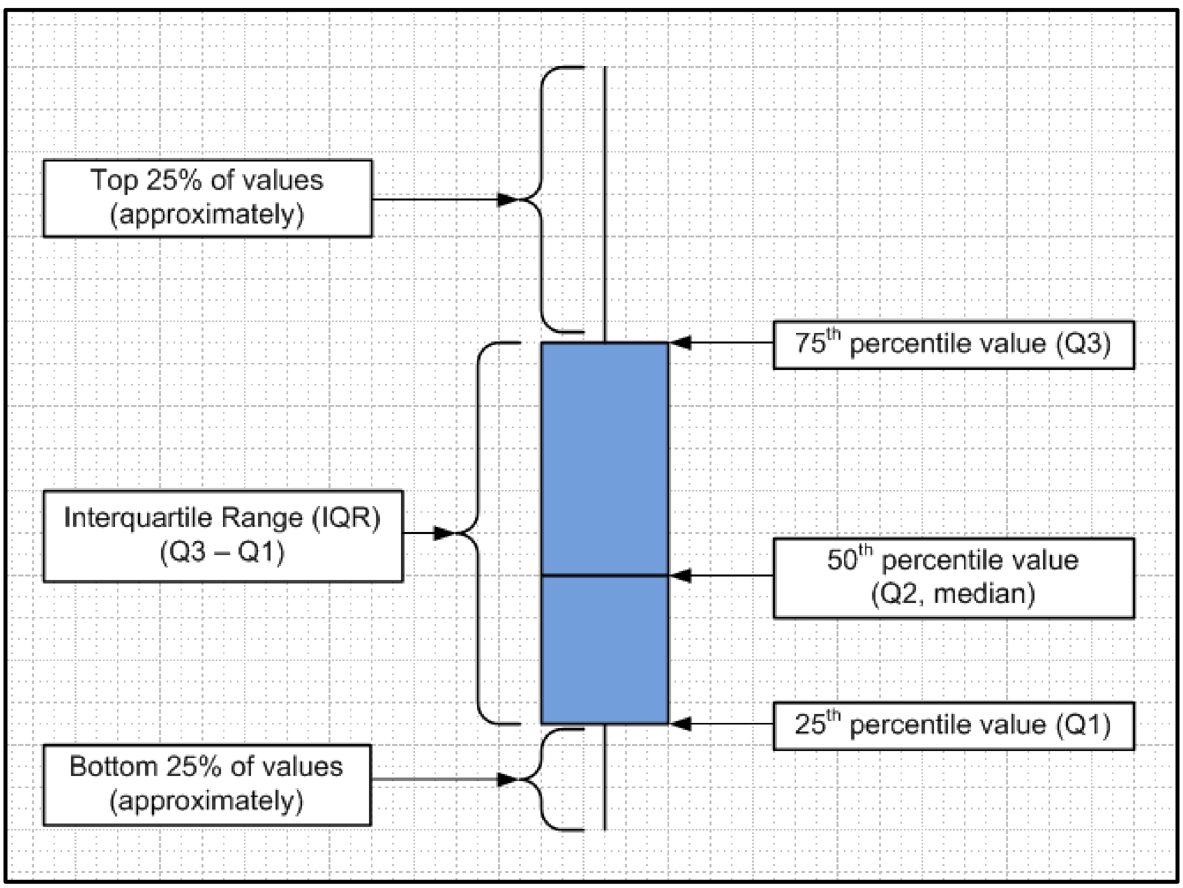


A.3.6 PM2.5 Concentration Distributions

While evaluating changes in peak PM2.5 concentrations increases our understanding of air quality and informs the attainment planning process, evaluation of non-peak concentrations can also be useful in providing a wider perspective on the progress of air quality improvement.

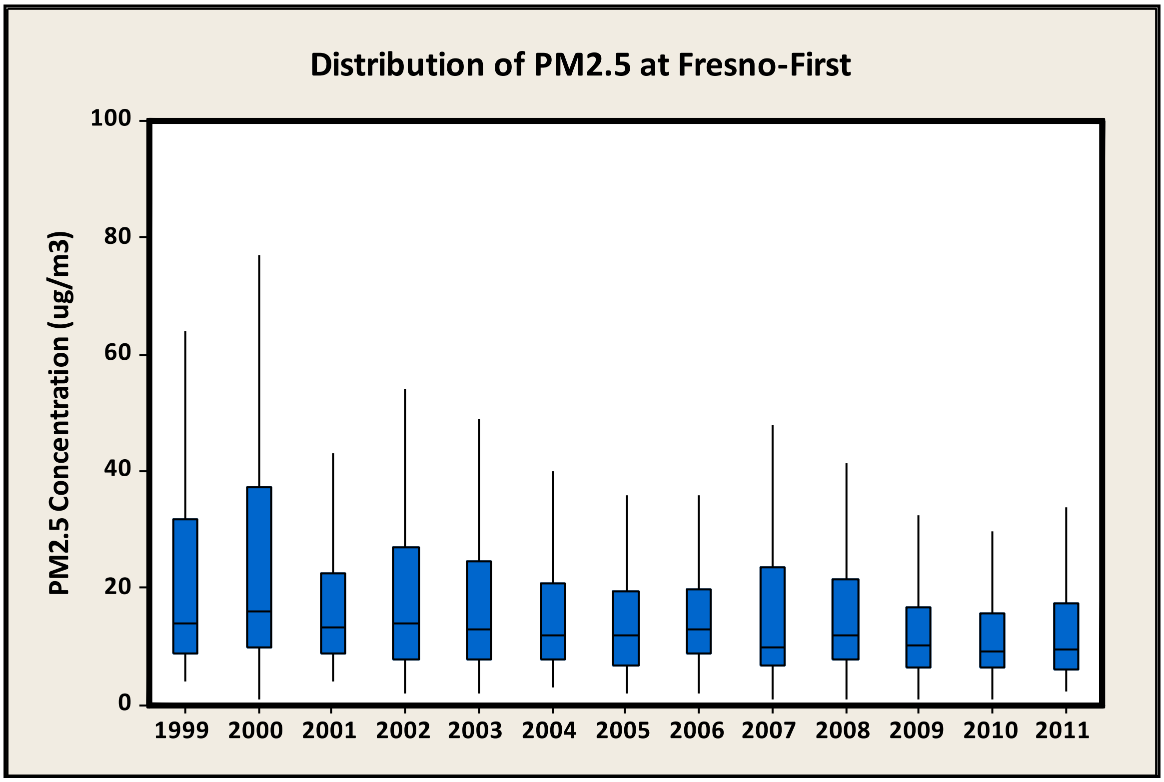
To accomplish such an evaluation, the District constructed box-and-whisker plots for a number of air monitoring sites in Valley using data collected from filter-based PM2.5 monitors. Figure A-18 diagrams the use of the box-and-whisker plots as follows: the box-and-whisker diagram for each year is a representation of the 25th (Q1), 50th (Q2), and 75th (Q3) percentile values in the PM2.5 concentration dataset. The “whiskers” extending from each end of the box represent the outer ends of the dataset (approximately the top and bottom 25% of the values), where any point outside of these boundaries is considered an outlier for this analysis method. The difference between Q3 and Q1 is called the interquartile range (IQR). For ease of viewing, the outlier values are not displayed in these plots.

Figure A-18 Box-and-Whisker Plot Interpretation



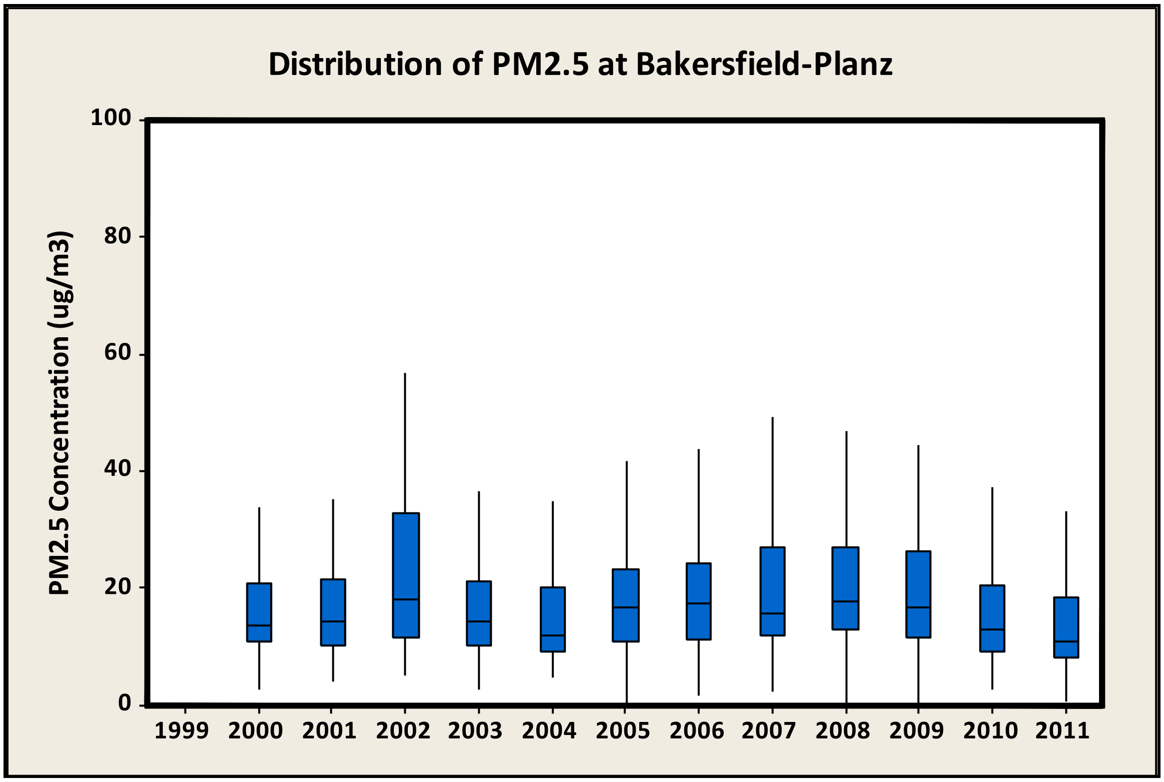
Focusing on the Fresno-First plot in Figure A-19, air quality improvement is evident when comparing the 1999 and 2000 box-and-whisker diagrams to those of recent years. Not only has the IQR been reduced, but the top 25% of the values has decreased sharply. This shows that the entire dataset of PM2.5 concentrations has been shifting downward in addition to the reduction of peak values. Since the winter of 2011–2012 experienced meteorology conducive to the formation of high PM2.5 concentrations, an increase in the IQR, Q3, and top 25% values is evident when comparing 2011 to 2010. This increase in 2011 is observed among most of the sites in the Valley.

Figure A-19 Box-and-Whisker Plot of PM2.5 at Fresno-First



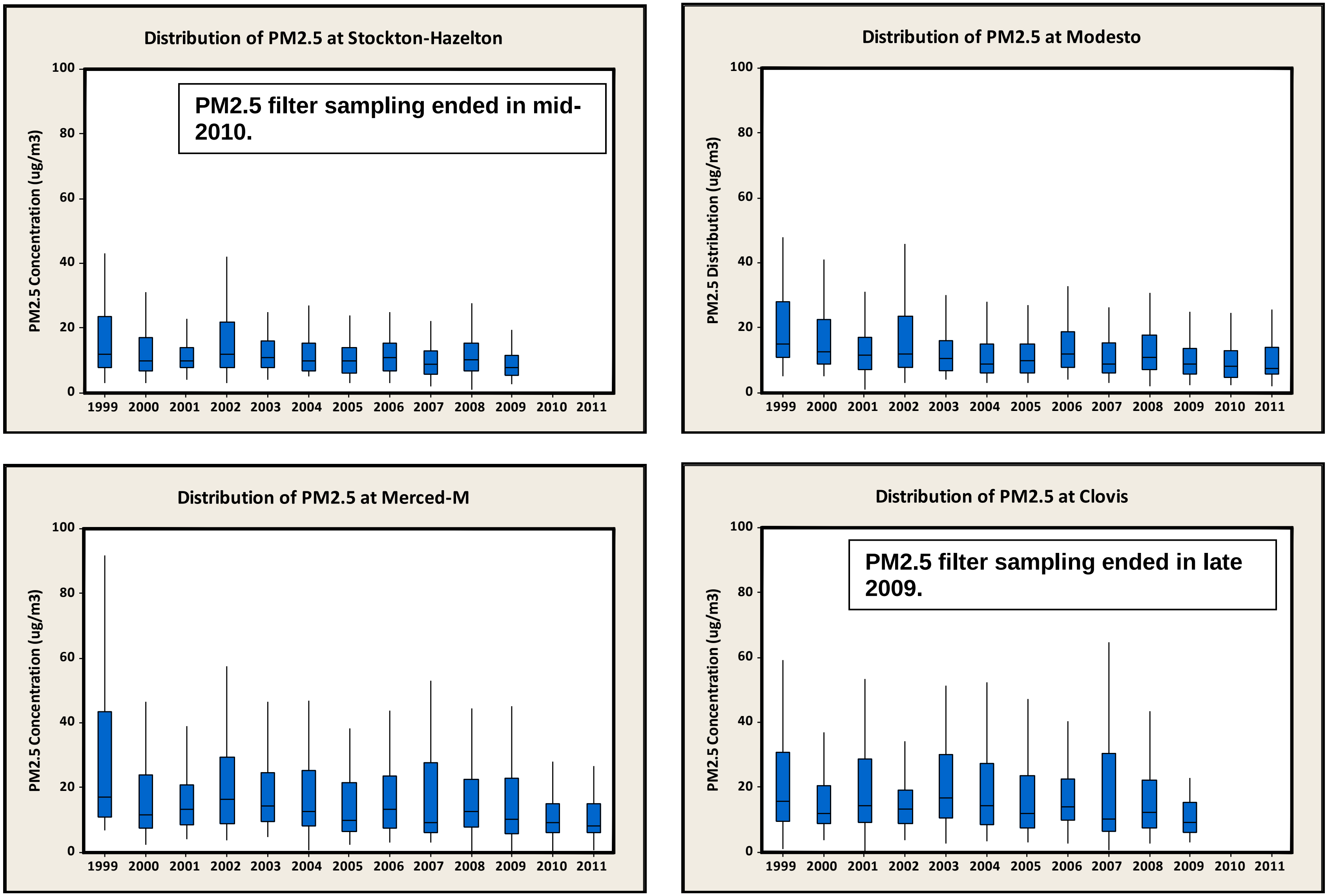
An exception to the increase in 2011 was at the Bakersfield-Planz air monitoring site, where a steady downward slope among most of the components of the plot has occurred from 2008 through 2011, as seen in Figure A-20. Since Bakersfield-Planz has historically been one of the highest PM2.5 sites in the Valley, this improvement is important and needs to continue to occur not only at this site but all other sites in order for the region to attain current and future PM2.5 standards.

Figure A-20 Box-and-Whisker Plot of PM2.5 at Bakersfield-Planz

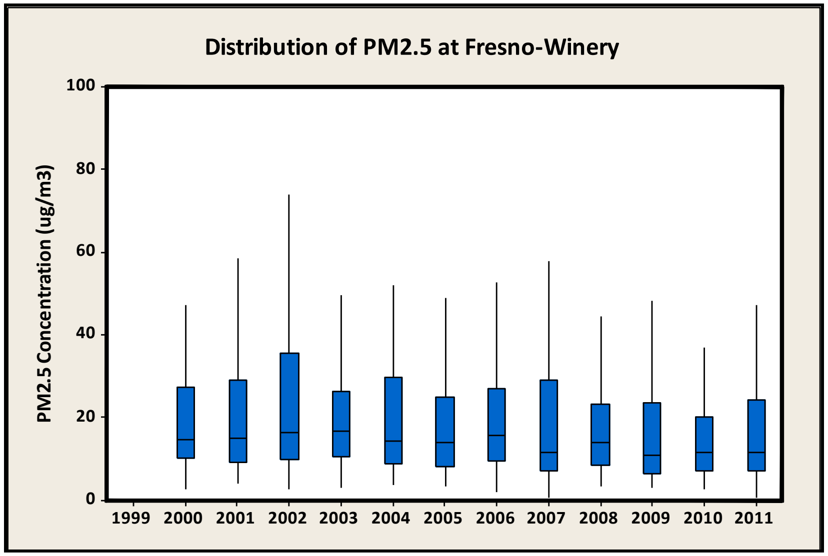


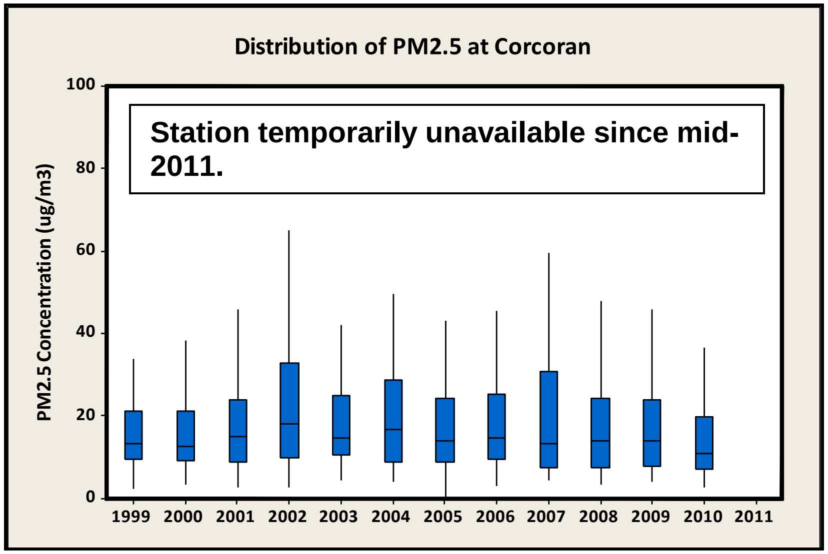
The northern most air monitoring sites (Stockton-Hazelton and Modesto) tend to have smaller IQRs than the sites in the central and southern portions of the San Joaquin Valley. This shows that PM2.5 in the northern part of the Valley tends to have a tighter dataset, where less variance occurs. Since the highest concentrations of PM2.5 usually occur in the central and southern portions of the Valley, the IQR values for the sites in these regions are higher, showing greater variance.

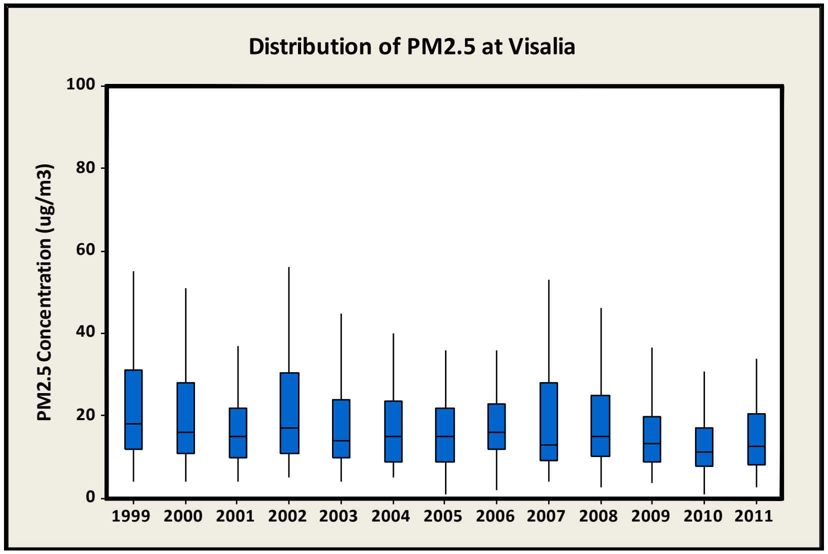
Figures A-21.1 through A-21.4 PM2.5 Distributions for Stockton-Hazelton, Modesto, Merced-M, and Clovis

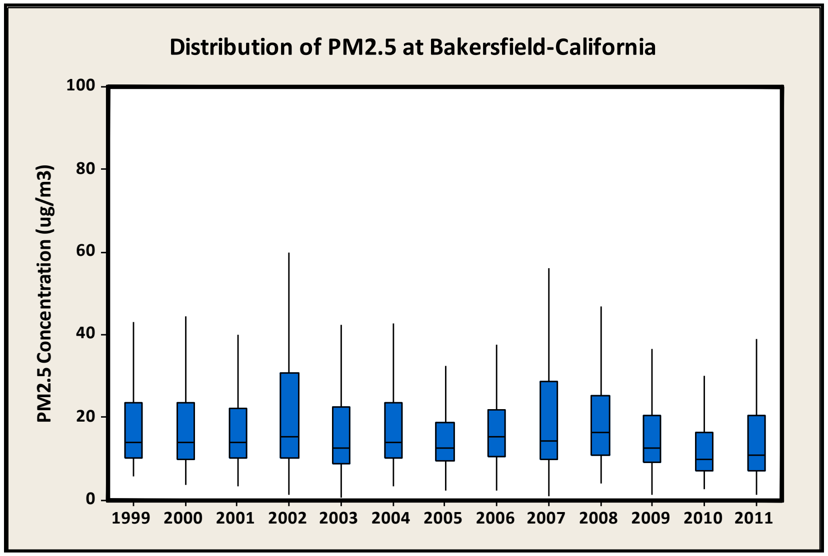


Figures A-21.5 through A-21.8 PM2.5 Distributions for Fresno-Winery, Corcoran, Visalia, and Bakersfield-California









A.3.7 PM2.5 Concentration by Day of Week

Just as public activity varies throughout the week, so do the daily average PM2.5 concentrations. The District evaluated real-time 24-hour average concentrations from a number of monitoring sites in the Valley to quantify such variance from three wood-burning seasons (November through February): 2008–2009, 2009–2010, and 2010–2011. The air monitoring sites included in this analysis were Modesto, Fresno-First, Corcoran, Visalia, and Bakersfield-California.

Figures A-22 through A-26 show the results of the District's analysis for the five air monitoring sites. In general, Thursday and Friday recorded the highest 24-hour average PM2.5 concentrations over the seven-day week. This suggests a build-up of emission beginning on Monday and progressing toward the end of the work week. This pattern would be more pronounced during stagnation episodes, where emissions would not have a chance to disperse.

Figure A-22 Day of Week PM2.5 Concentrations at Modesto

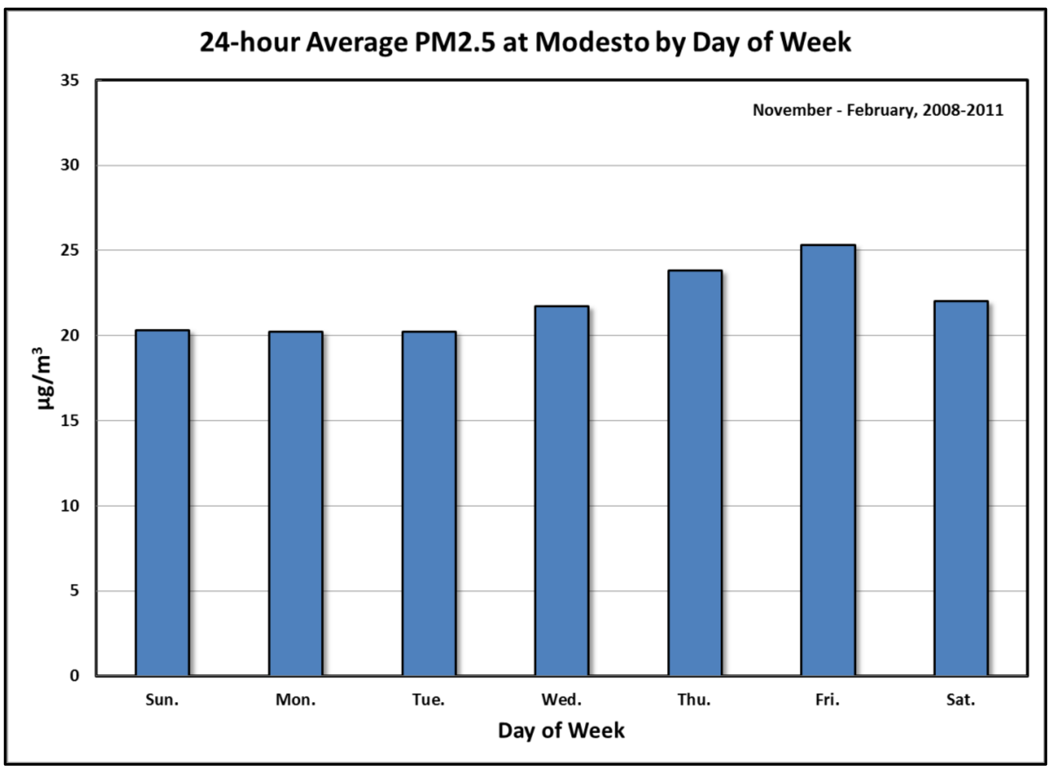


Figure A-23 Day of Week PM2.5 Concentrations at Fresno-First

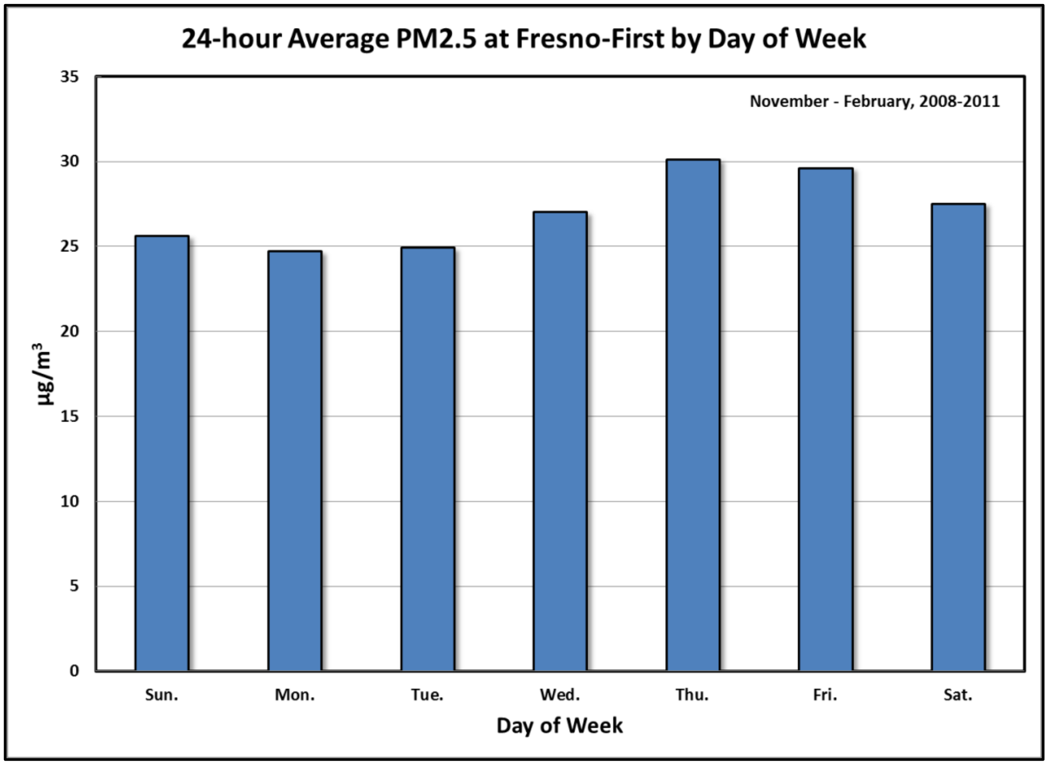


Figure A-24 Day of Week PM2.5 Concentrations at Corcoran

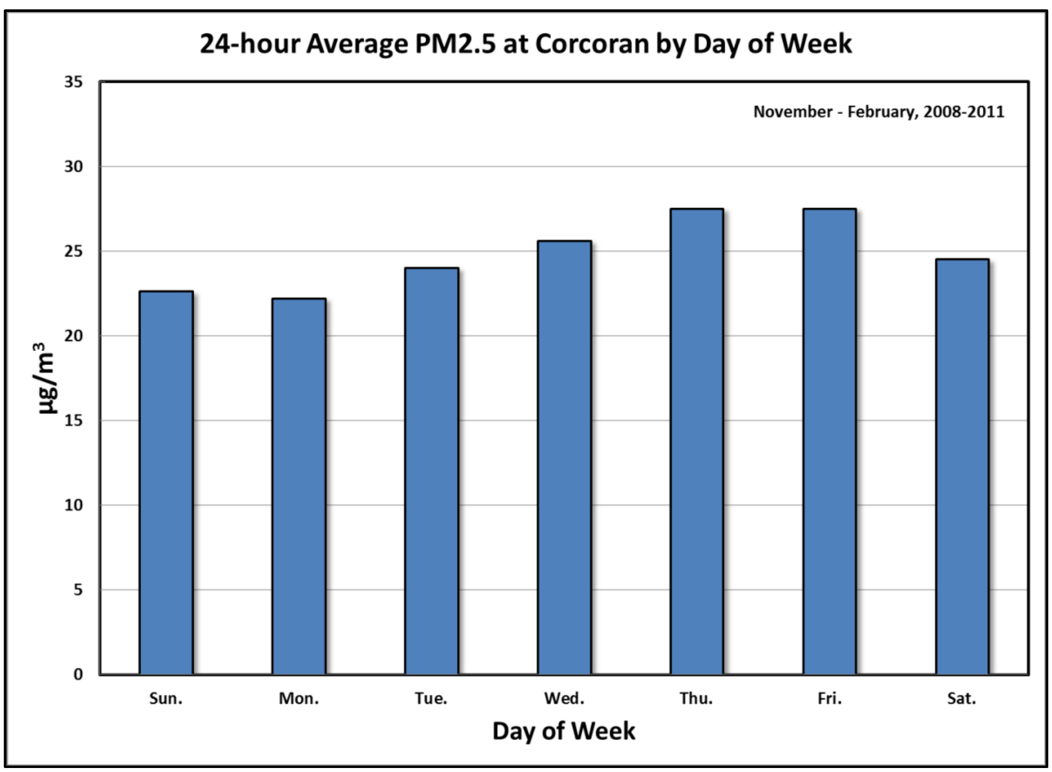


Figure A-25 Day of Week PM2.5 Concentrations at Visalia

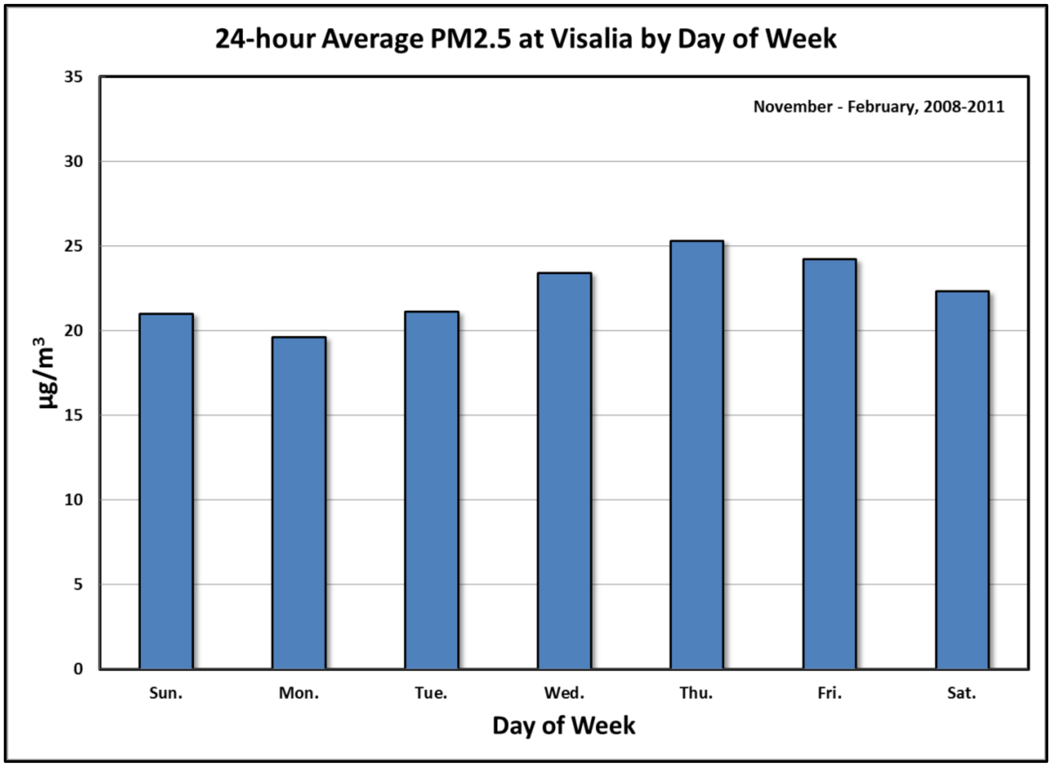
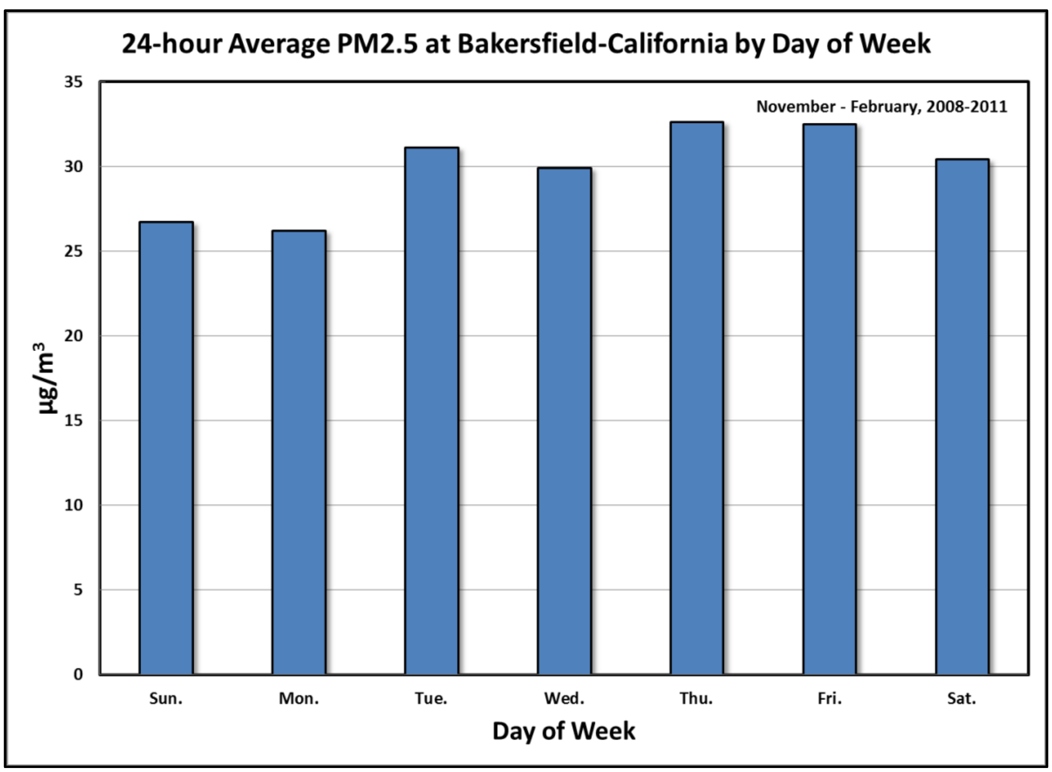


Figure A-26 Day of Week PM2.5 Concentrations at Bakersfield-California



The analysis also shows a declining average PM2.5 concentration from Saturday into Monday, perhaps as a result of the variation in vehicle activity when comparing the weekend to the weekday. The typical weekday will have significant vehicle emissions in the morning as people commute to work and school, followed by lighter traffic during the day, and heavy activity again at the end of the day for the commute home. Contrastingly, the weekend activity is spread more uniformly throughout the day. This temporal difference in emissions activity may contribute to lower PM2.5 emissions, which tend to carry over into the early days of the next week before the next build-up begins.

Comparing the trends between the air monitoring sites included in this analysis reveals that the Fresno-First and Bakersfield-California sites (the largest urban centers in the central and southern valley) tend to have the highest PM2.5 concentrations on Thursday and Friday, ranging from 30 to 35 $\mu g/m^3$. The difference between the highest concentration and the lowest concentration among the days of the week is about 5 $\mu g/m^3$ for most of the sites; however this difference at Bakersfield-California is more pronounced.

As the San Joaquin Valley faces the challenges of future PM2.5 standards, having this understanding of what days of the week tend to have the highest concentrations may aid in developing a successful attainment strategy. Targeting emissions that contribute to the build-up as the week progresses may help in reducing the peaks at the end of the week.

A.4 METEOROLOGY, PM2.5 SPECIATION, AND RULE EFFECTIVENESS

The District takes full advantage of the robust data set produced by the extensive air monitoring network in the Valley, as seen in the previous sections of this appendix. However, there is other information that adds to the comprehensive understanding of PM2.5 concentrations and is critical in all aspects of developing and implementing a successful attainment plan, including meteorology, PM2.5 speciation, and the overall effectiveness of previous control measures.

A.4.1 Meteorologically Adjusted Trends

In order to understand the effectiveness of emission control strategies and regulations on ambient air pollution levels, it is important to first understand and be able to delineate the effect of meteorology versus changes in emissions as a response to control measures. The strong linkage between meteorological conditions and air pollutant levels can obscure the effects of the change of emission levels over time resulting from a regulatory program. Therefore, the meteorological effects need to be removed so that the emissions-related trends may be studied more effectively.

The District used the Classification and Regression Trees (CART) method to define the relationship between PM2.5 concentrations and meteorological conditions in both the

Bakersfield and Fresno areas of the Valley. Three years (2004–2006) were selected as base years to define these relationships. The CART model was able to explain approximately 75–80% of the variation in daily PM2.5 concentrations during these years based on the local meteorological conditions. Based on the CART-defined relationships, daily PM2.5 concentrations were predicted for all the other years using the observed meteorological data and assuming the emissions stayed constant (i.e. the predicted concentrations only represent the PM2.5 conduciveness of meteorology). The measured PM2.5 concentrations were then corrected for the influences of meteorology to estimate the meteorologically adjusted trends. For example, in a year with meteorology conditions that were more conducive to PM2.5 formation, PM2.5 concentrations were adjusted downward. Conversely, PM2.5 concentrations were adjusted upward in years with meteorological conditions that were less conducive.

As shown in Figures A-27 and A-28, the meteorologically adjusted trend at Bakersfield indicates a greater decline than the unadjusted trend, while the two trends are generally similar at Fresno. Overall, the meteorologically adjusted trends indicate that the PM2.5 annual averages decreased about 40–50% in both the Bakersfield and Fresno areas from 1999 to 2010, with an average rate of decrease of approximately 0.8 µg/m³ per year. These meteorologically adjusted trends provide a more robust indicator of the impacts of emission reductions from on-going control programs.

Figures A-27 and A-28 show the trend of observed PM2.5 represented as a solid line, and the trend of meteorologically adjusted PM2.5 is represented by a dashed line.

Figure A-27 Meteorologically Adjusted PM2.5 Trend for Bakersfield

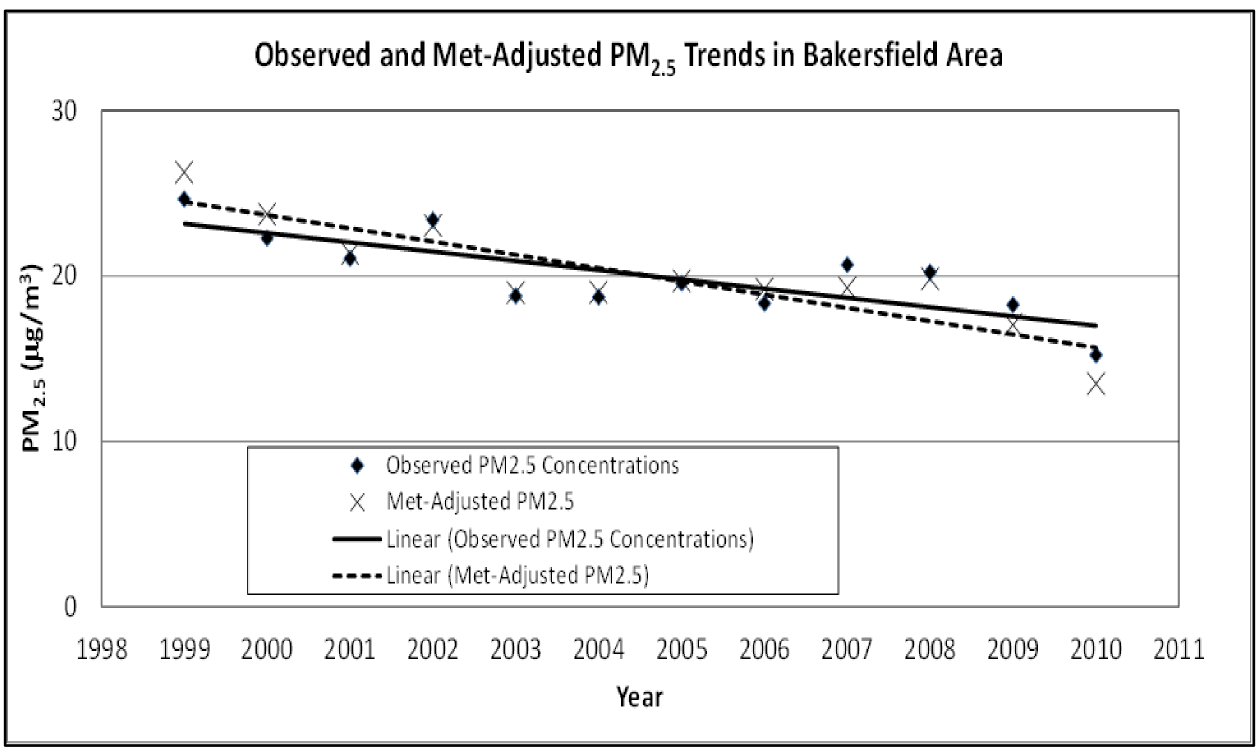
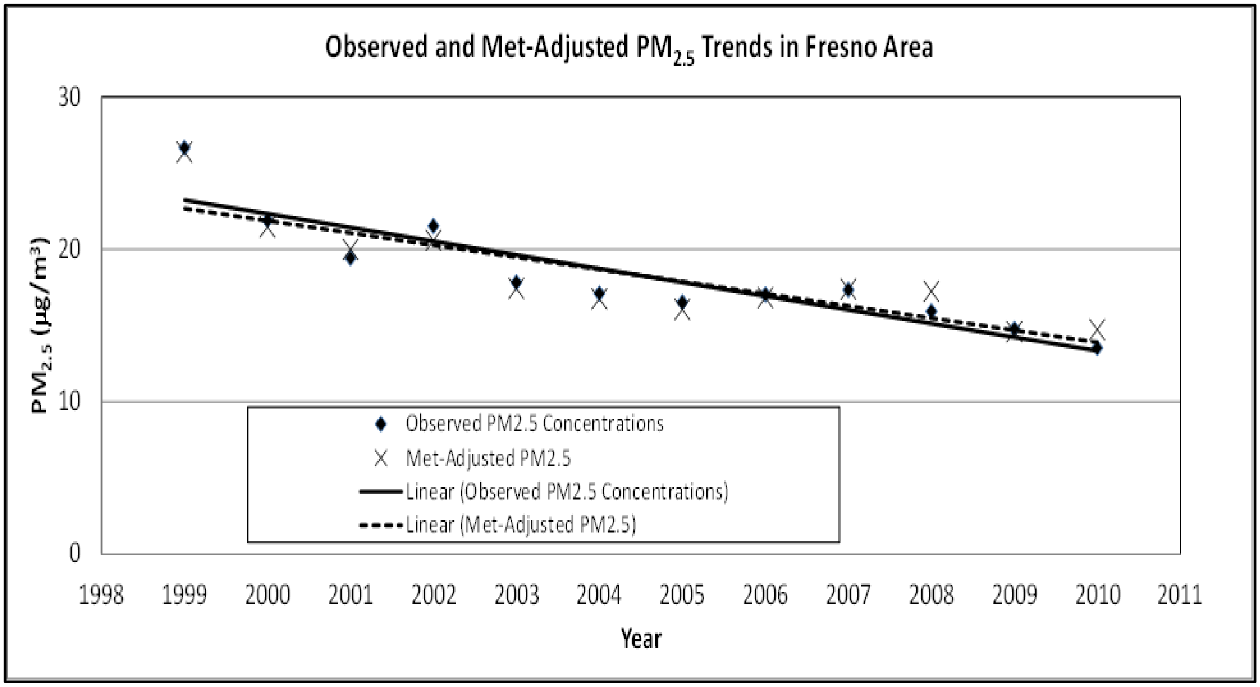


Figure A-28 Meteorologically Adjusted PM2.5 Trend for Fresno



A.4.2 Trends in PM2.5 Species

Analyzing the trends among the species of PM2.5 is often more telling than focusing on the PM2.5 mass alone. Valley PM2.5 concentrations have been decreasing over time, but some components, or species, of PM2.5 may be decreasing more rapidly than others. The results of a speciation analysis can show which species of PM2.5 are most dominant for an area, and therefore guide a more targeted control strategy for reducing the overall mass concentration. The following analysis shows the relative contribution and temporal change in the key species of PM2.5 at a number of sites in the Valley.

Figures A-29 and A-30 shows the contribution of various species to the overall PM2.5 mass concentration in the Fresno and Bakersfield areas, respectively. Figure A-29, for Fresno, shows that on a peak PM2.5 day the concentration consists of about 51% ammonium nitrate and 33% organic carbon. In comparison, a peak PM2.5 day in Bakersfield (Figure A-30) is comprised of 67% ammonium nitrate and 16% organic carbon. The understanding of this difference can help reveal what sources of pollution are contributing to PM2.5 in each area of Valley, which will ultimately aid in developing an effective control strategy.

Figure A-29 Species Contribution to PM2.5 Mass in Fresno

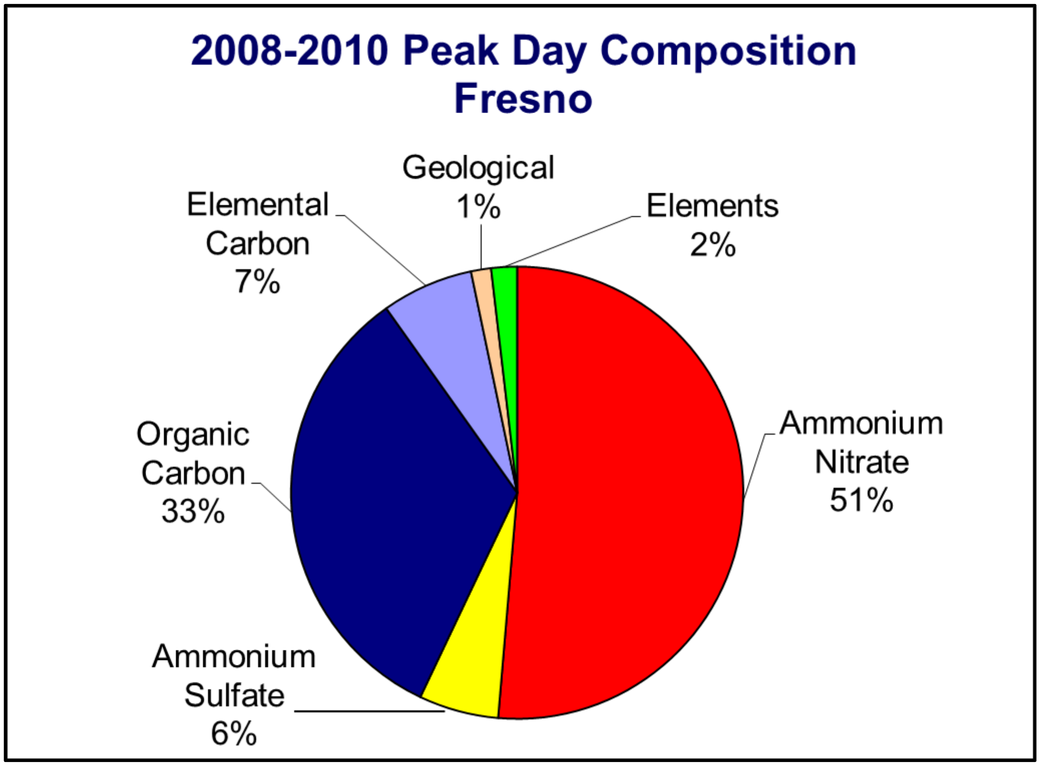
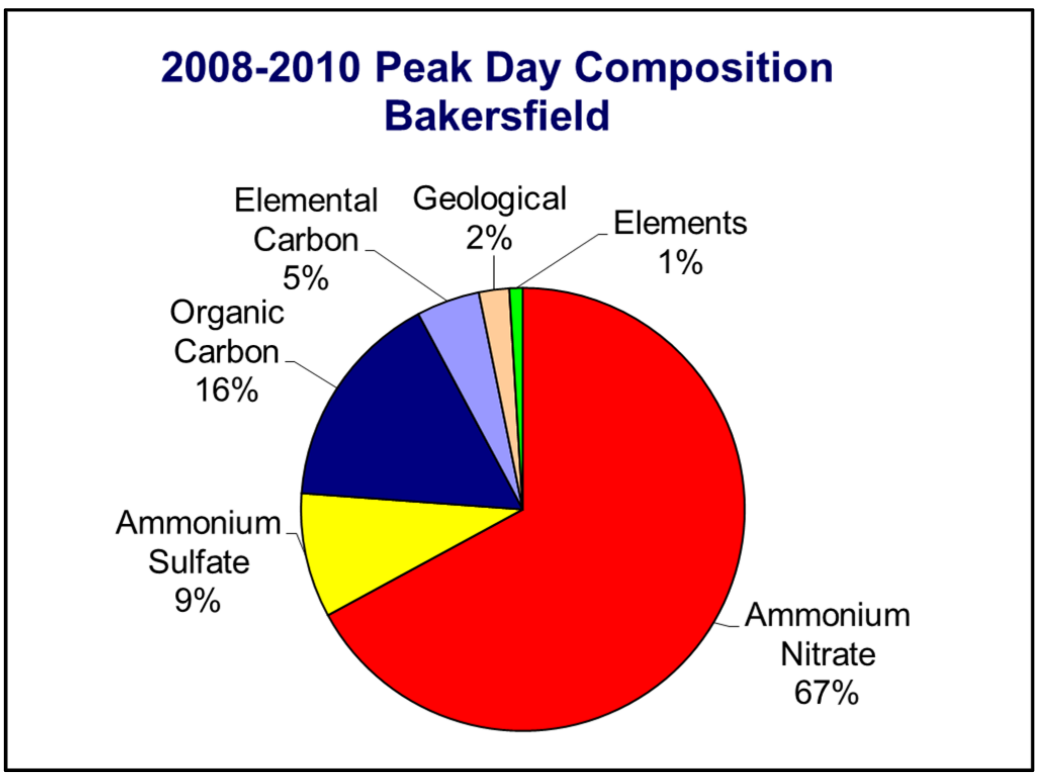


Figure A-30 Species Contribution to PM2.5 Mass in Bakersfield



Chemical speciation data is regularly collected at four sites in the Valley: Modesto, Fresno-First, Visalia, and Bakersfield-California. As previously mentioned, ammonium nitrate, ammonium sulfate, and carbon compounds are the major constituents of PM2.5. In the following trend analysis, concentrations at each site from each of the PM2.5 species were averaged over each year from 2002–2010. On an annual average, concentrations of these key constituents have all shown significant decreases. Ammonium nitrate concentrations in the basin declined about 50% between 2002 and 2010. During the same time frame, concentrations of ammonium sulfate and carbon compounds declined about 30%. The most significant declines occurred between 2002 and 2003, and again between 2007 and 2010.

The decline in ammonium nitrate provides evidence of a successful NOx control strategy in the Valley, which in turn has been effective in reducing PM2.5 mass. As ammonium nitrate concentrations further decline into the future, and as more stringent federal PM2.5 health standards are established, the results of species trends analyses will grow in importance as targeted control strategies will need to be developed.

Note that between 2007 and 2009, the carbon collection and analysis method was changed to improve comparability with rural Interagency Monitoring of Protected Visual Environments (IMPROVE) PM2.5 carbon data. Since the change was implemented mid-year, there are gaps in the carbon data for years with partial data from the old and new method.

Figures A-31 through A-34 display the species trends for the four speciation sites in the Valley.

Figure A-31 PM2.5 Species Trends at Modesto

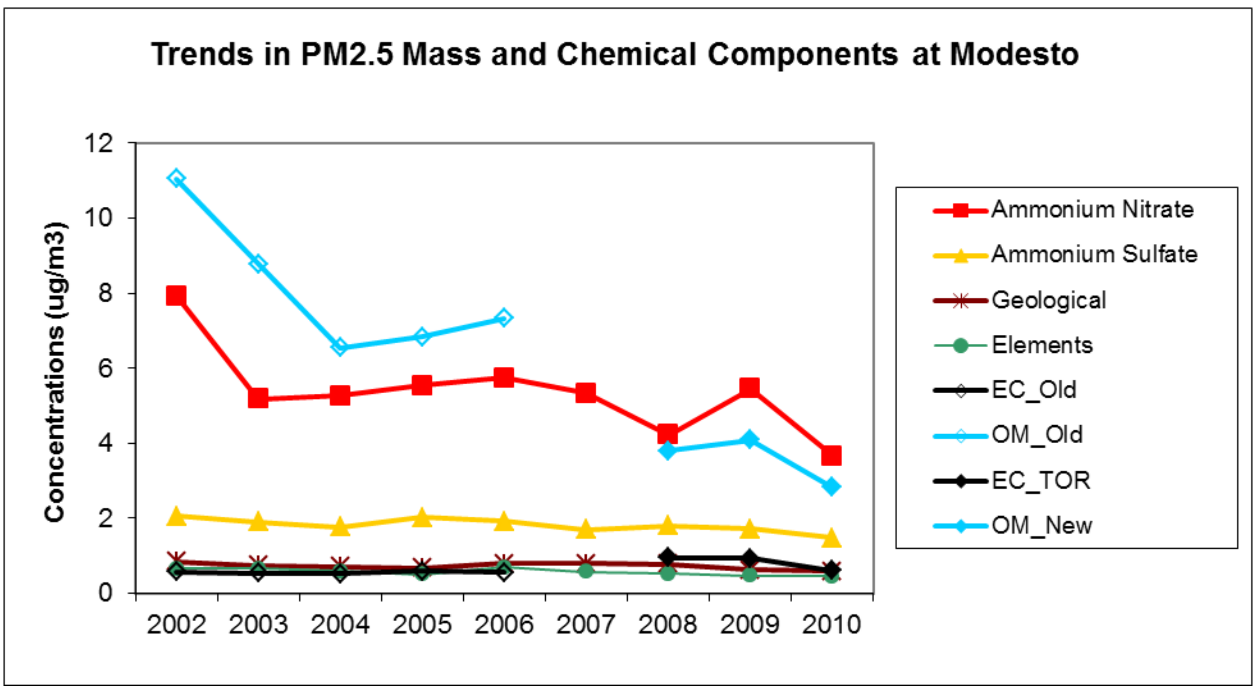


Figure A-32 PM2.5 Species Trends at Fresno-First

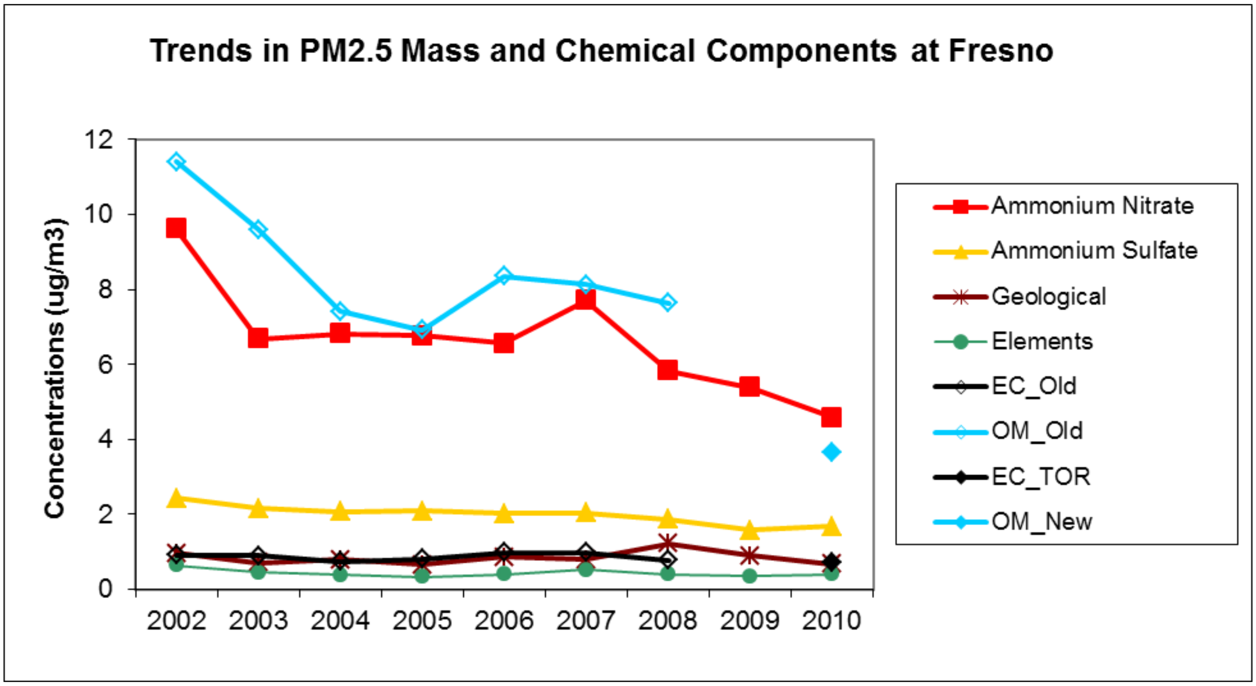


Figure A-33 PM2.5 Species Trends at Visalia

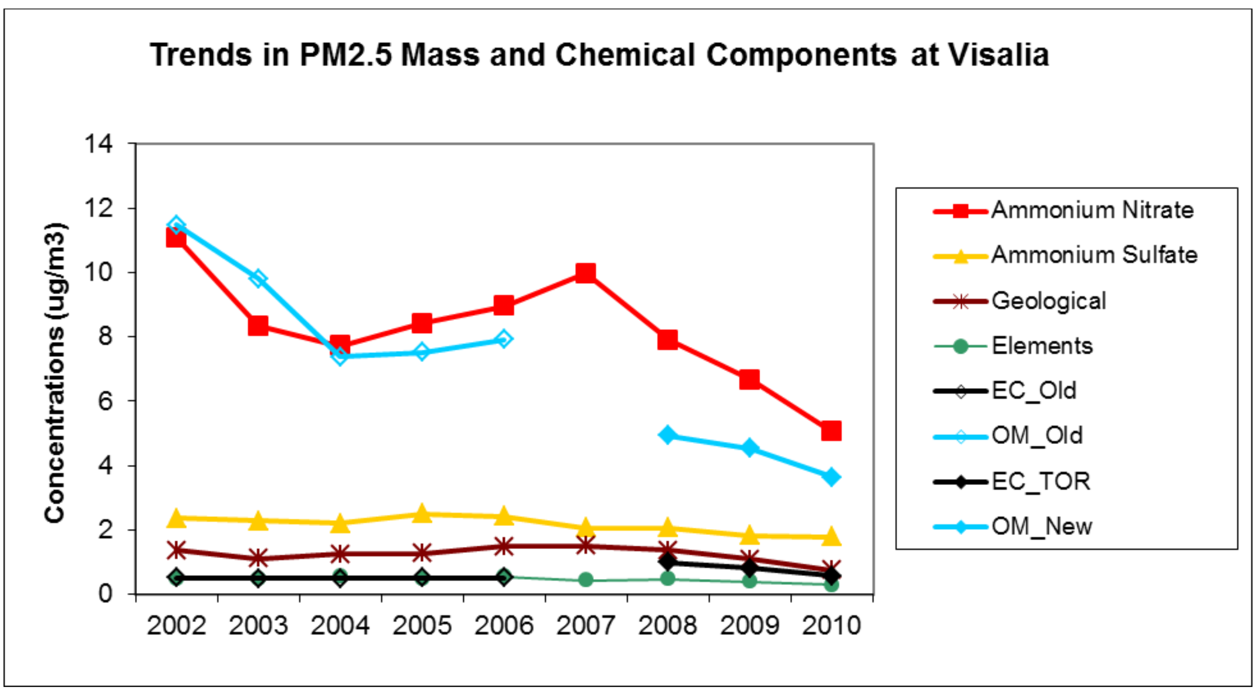
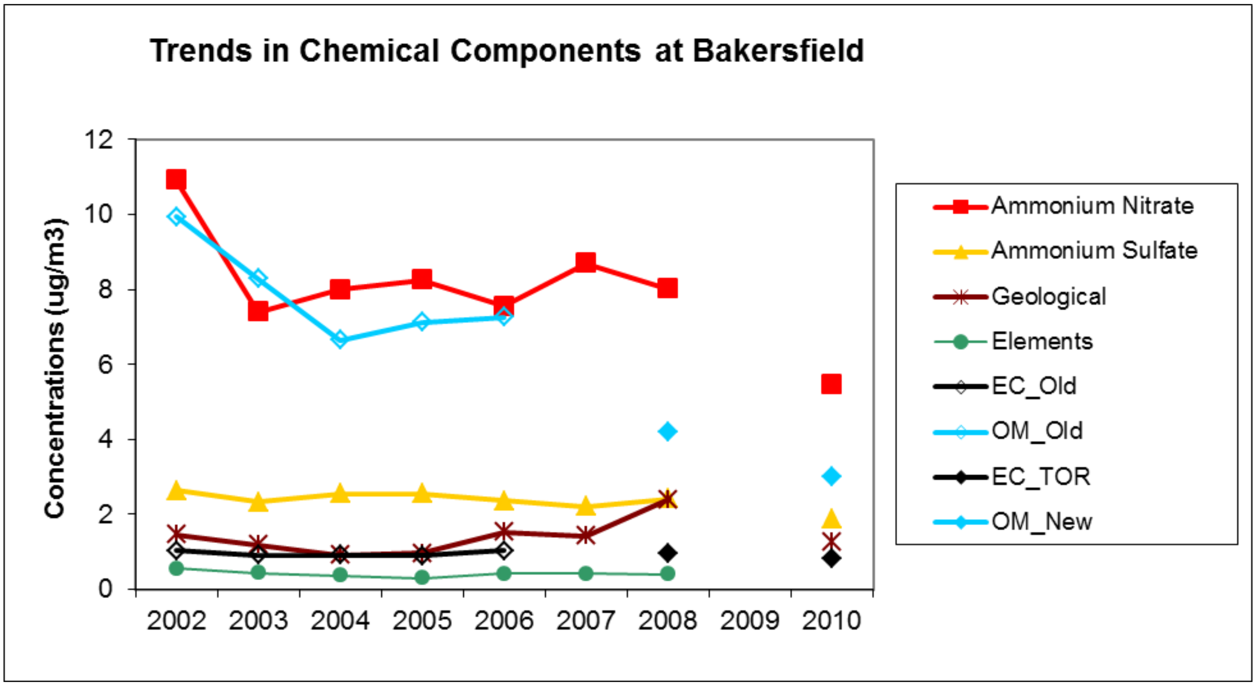


Figure A-34 PM2.5 Species Trends at Bakersfield-California



A.4.3 Effectiveness of District Rule 4901

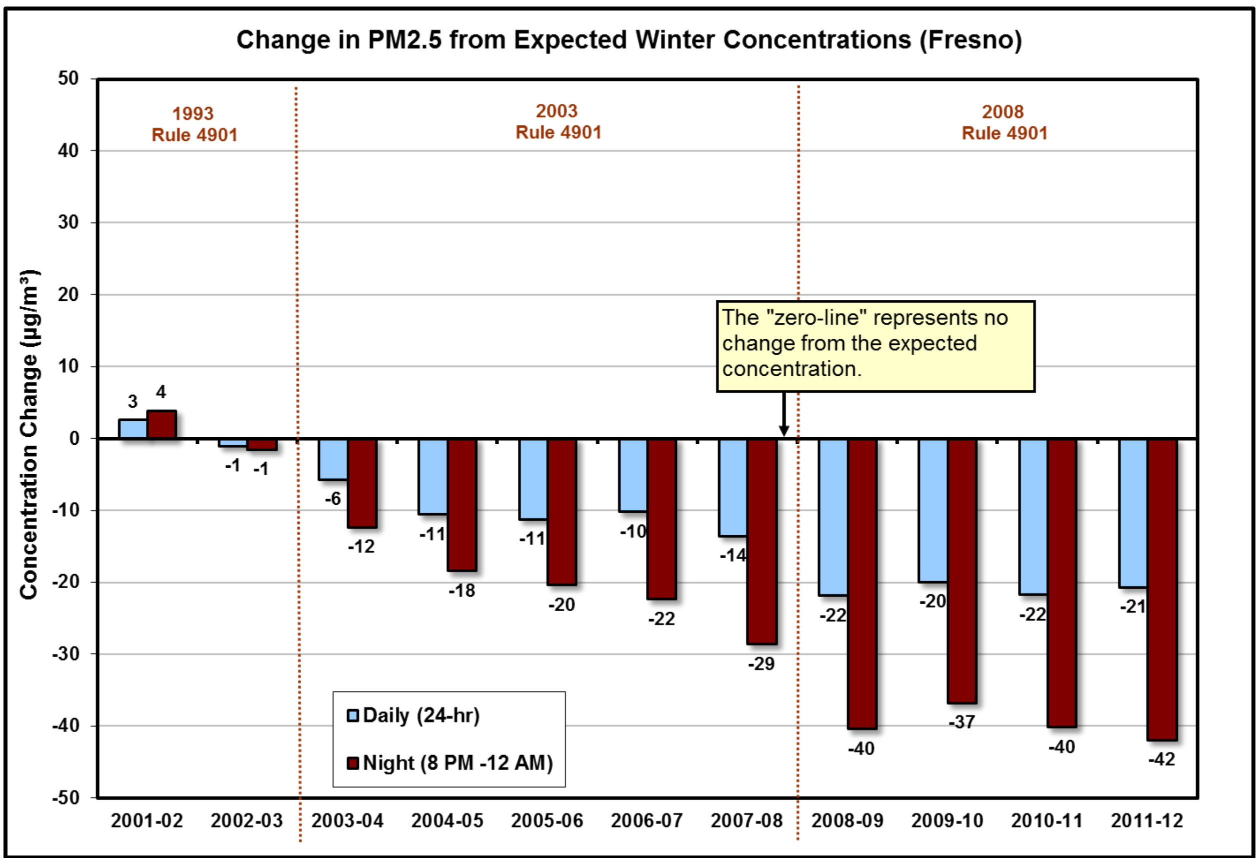
Emissions from residential wood-burning have historically been one of the greatest sources of directly emitted PM2.5 in the Valley. Before residential wood-burning curtailments became mandatory during episodes of high PM2.5 concentrations, the air quality during the wintertime was often unhealthy in large part due to extensive wood-burning. Through the establishment of District Rule 4901, residential wood-burning is not allowed on days when high concentrations of PM2.5 are predicted. This reduction in wood-burning emissions through the rule has greatly reduced the potential for high PM2.5 concentrations. The following analysis displays the effect that Rule 4901 has had on PM2.5 in the Fresno area.

To conduct this analysis, a statistical model was developed to quantify PM2.5 reductions and evaluate air quality improvements attributable to the 2003 and 2008 amendments to Rule 4901. This statistical model was developed through generalized linear model techniques with logarithmic transformations based on the relationships between meteorology and PM2.5 concentrations that existed prior to the 2003 Rule 4901 amendments. Daily and hourly observed PM2.5 concentrations served as dependent variables with meteorological parameters such as wind speed, temperature, and stability serving as independent variables.

Since this model was developed with data before wood-burning curtailments came into effect, its output shows a prediction of what PM2.5 concentrations would be like if Rule 4901 were not in place. Comparing these predicted concentrations against what was observed, a difference can be calculated that represents the emissions reductions that have occurred since wood-burning curtailments began. As shown in Figure A-35, a consistent pattern of model-predicted values being higher than what was actually observed provides compelling statistical evidence that a control measure, i.e., wood-burning curtailments, was responsible for the discrepancy. Reductions in emissions from other sources may have also attributed to the differences, but these reductions would be minor when compared to the reductions from residential wood-burning.

Note that the 2003 amendment to the rule established a curtailment threshold at 65 µg/m^3 of PM2.5, and the 2008 amendment lowered this threshold to 30 µg/m^3 of PM2.5 or 135 µg/m^3 of PM10. This modeling indicates that as of the 2011–2012 wood-burning season, there has been a 41% (21 µg/m^3) improvement in the 24-hour average PM2.5 in Fresno since the 2003 and 2008 amendments to Rule 4901. This improvement is exemplified in PM2.5 concentrations measured during the evening hours of 8:00 p.m. to 12:00 a.m. The average evening PM2.5 concentrations have improved by 50 percent (42 µg/m^3) over the same time period. As shown in this analysis, the 2008 amendment to Rule 4901 has approximately doubled the seasonal improvements attributable to the 2003 amendment.

Figure A-35 Effect of Rule 4901 on Winter (November through February) PM2.5 Concentrations in Fresno



Overall, the Valley's PM2.5 concentrations have dramatically decreased since the 2003 and 2008 Rule 4901 amendments. Without this further analysis, it would have been unclear if decreases in PM2.5 concentrations could be attributed to reductions in residential wood-burning or changes in seasonal weather patterns. Rule 4901 will continue to play an important role in reducing PM2.5 concentrations throughout the San Joaquin Valley both within and beyond the timeframe of this plan.

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Appendix B

Emissions Inventory

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Appendix B: Emissions Inventory

Emissions inventories are estimates of the amount and type of pollutants emitted into the atmosphere by industrial facilities, mobile sources, and smaller sources such as consumer products and paint. Emissions inventories serve as 1) a primary input to air quality modeling used in attainment demonstrations; 2) the emissions data used for developing control strategies; and 3) a means to track progress in meeting the emission reduction commitments. The inventories in this appendix are used to study and propose control measures, to track emissions for Rate of Progress (ROP), to track Emissions Reduction Credits (ERCs), to establish motor vehicle conformity budgets for transportation planning, and to assist in demonstrating attainment.

An emissions inventory is a critical tool in the evaluation of air pollution. 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. Emissions inventories are an estimate of the air pollution emissions that are actually released into the environment—they are not measurements of ambient concentrations. The following are examples of pollution sources by key sectors:

- Industrial or stationary point sources—power plants and oil refineries;
- Area-wide sources—consumer products and residential fuel combustion;
- On-road sources—passenger vehicles and heavy-duty trucks;
- Off-road mobile sources—aircraft, trains, ships, recreational boats, construction equipment and farm equipment; and
- Nonanthropogenic (natural) sources—biogenic (or vegetation), geogenic (petroleum seeps), and wildfires.

The United States Environmental Protection Agency (U.S. EPA) establishes requirements pertaining to emissions information that must be included as part of the SIP submittal package. For the PM2.5 Plan, the regulations require that the emissions inventory contain emissions data for directly emitted PM2.5 and its precursors: oxides of nitrogen (NOx), reactive organic gases (ROG), sulfur oxides (SOx), and ammonia (NH3).

As discussed in Appendix A and throughout this plan, the Valley's attainment challenges under the national 24-hour PM2.5 standard set in 2006 occur in the winter months. For this reason, this plan focuses on winter average daily emissions inventories, with emissions presented as tons per day (tpd). This winter average daily inventory represents emissions from the months of November to April.

Emissions inventories are usually developed at various geographical resolutions encompassing district, air basin, and county levels. The inventories presented in this appendix are the total emissions for the San Joaquin Valley Air Basin.

This appendix includes emissions for the San Joaquin Valley Air Basin for the years 2007, 2012, 2014, 2015, 2016, 2017, 2018, and 2019. The base year (the year from which the inventory is projected forward and backward) for these inventories is 2007. The year 2012 has been included as a reference point for the current year. Years 2014 and 2019 have been included as 2014 is the attainment deadline for the 1997 federal PM2.5 standard, and 2019 is the longest attainment timeframe allowed under the 2006 federal PM2.5 standard. Naturally, the years in between 2014 and 2019 have been included to show the progression of the inventory.

The tables in this appendix include:

- Table B-1 Directly emitted PM2.5, Winter Daily Averages
- Table B-2 NOx, Winter Daily Averages
- Table B-3 SOx, Winter Daily Averages
- Table B-4 VOC, Winter Daily Averages
- Table B-5 Ammonia, Winter Daily Averages

Tables B-1 through B-5 are followed by an overview of emissions inventory calculations and revisions, as well as a discussion on population projections that influence the emissions inventory.

B.1 EMISSIONS INVENTORY TABLES

Table B-1 Directly Emitted PM2.5 (Winter Daily Averages in tons per day)

Directly Emitted PM2.5 (tpd)								
SUMMARY CATEGORY NAME	WINTER AVERAGE							
	2007	2012	2014	2015	2016	2017	2018	2019
STATIONARY SOURCES								
FUEL COMBUSTION								
ELECTRIC UTILITIES	1.4	1.4	1.3	1.3	1.3	1.3	1.3	1.3
COGENERATION	0.8	0.8	0.8	0.9	0.9	0.9	1.0	1.0
OIL AND GAS PRODUCTION (COMBUSTION)	1.9	1.7	1.6	1.6	1.6	1.5	1.5	1.5
PETROLEUM REFINING (COMBUSTION)	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
MANUFACTURING AND INDUSTRIAL	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
FOOD AND AGRICULTURAL PROCESSING	0.8	0.5	0.5	0.5	0.4	0.4	0.4	0.4
SERVICE AND COMMERCIAL	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
OTHER (FUEL COMBUSTION)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL FUEL COMBUSTION**	**5.6**	**5.1**	**5.0**	**4.9**	**4.9**	**4.9**	**4.9**	**4.9**
WASTE DISPOSAL								
SEWAGE TREATMENT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LANDFILLS	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
INCINERATORS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SOIL REMEDIATION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER (WASTE DISPOSAL)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL WASTE DISPOSAL**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**
CLEANING AND SURFACE COATINGS								
LAUNDERING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DEGREASING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COATINGS AND RELATED PROCESS SOLVENTS	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
PRINTING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ADHESIVES AND SEALANTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER (CLEANING AND SURFACE COATINGS)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL CLEANING AND SURFACE COATINGS**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**
PETROLEUM PRODUCTION AND MARKETING								
OIL AND GAS PRODUCTION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PETROLEUM REFINING	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
PETROLEUM MARKETING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER (PETROLEUM PRODUCTION AND MARKETING)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Directly Emitted PM2.5 (tpd)								
SUMMARY CATEGORY NAME	**WINTER AVERAGE**							
	2007	**2012**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
*** TOTAL PETROLEUM PRODUCTION AND MARKETING**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**
INDUSTRIAL PROCESSES								
CHEMICAL	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
FOOD AND AGRICULTURE	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8
MINERAL PROCESSES	1.5	1.5	1.6	1.6	1.7	1.7	1.8	1.8
METAL PROCESSES	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
WOOD AND PAPER	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
GLASS AND RELATED PRODUCTS	0.6	0.5	0.5	0.5	0.5	0.5	0.5	0.5
ELECTRONICS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER (INDUSTRIAL PROCESSES)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
*** TOTAL INDUSTRIAL PROCESSES**	**3.4**	**3.2**	**3.4**	**3.4**	**3.5**	**3.6**	**3.7**	**3.7**
**** TOTAL STATIONARY SOURCES**	**9.4**	**8.7**	**8.8**	**8.7**	**8.8**	**8.9**	**9.0**	**9.0**
AREA-WIDE SOURCES								
SOLVENT EVAPORATION								
CONSUMER PRODUCTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ARCHITECTURAL COATINGS AND RELATED PROCESS SOLVENTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PESTICIDES/FERTILIZERS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ASPHALT PAVING / ROOFING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL SOLVENT EVAPORATION**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
MISCELLANEOUS PROCESSES								
RESIDENTIAL FUEL COMBUSTION	21.5	9.4	9.1	9.1	9.1	9.1	9.1	9.1
FARMING OPERATIONS	12.0	11.8	11.8	11.8	11.7	11.7	11.7	11.6
CONSTRUCTION AND DEMOLITION	1.1	1.0	1.0	1.0	1.0	1.1	1.1	1.1
PAVED ROAD DUST	4.8	4.5	4.5	4.5	4.5	4.5	4.5	4.5
UNPAVED ROAD DUST	4.5	4.3	4.3	4.4	4.4	4.4	4.4	4.4
FUGITIVE WINDBLOWN DUST	5.0	4.8	4.7	4.7	4.7	4.6	4.6	4.6
FIRES	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
MANAGED BURNING AND DISPOSAL	10.1	7.4	7.4	7.4	7.3	7.3	7.3	7.3
COOKING	3.5	3.6	3.7	3.8	3.9	3.9	4.0	4.1
OTHER (MISCELLANEOUS PROCESSES)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL MISCELLANEOUS PROCESSES**	**62.5**	**47.1**	**46.7**	**46.7**	**46.8**	**46.8**	**46.8**	**46.8**
**** TOTAL AREA-WIDE SOURCES**	**62.5**	**47.1**	**46.7**	**46.7**	**46.8**	**46.8**	**46.8**	**46.8**
MOBILE SOURCES								
ON-ROAD MOTOR VEHICLES								
LIGHT DUTY PASSENGER (LDA)	1.0	0.9	0.9	1.0	1.0	1.0	1.0	1.0
LIGHT DUTY TRUCKS - 1 (LDT1)	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
LIGHT DUTY TRUCKS - 2 (LDT2)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4

Directly Emitted PM2.5 (tpd)								
SUMMARY CATEGORY NAME	WINTER AVERAGE							
	2007	2012	2014	2015	2016	2017	2018	2019
MEDIUM DUTY TRUCKS (MDV)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.5
LIGHT HEAVY DUTY GAS TRUCKS - 1 (LHDV1)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
LIGHT HEAVY DUTY GAS TRUCKS - 2 (LHDV2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MEDIUM HEAVY DUTY GAS TRUCKS (MHDV)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HEAVY HEAVY DUTY GAS TRUCKS (HHDV)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LIGHT HEAVY DUTY DIESEL TRUCKS - 1 (LHDV1)	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
LIGHT HEAVY DUTY DIESEL TRUCKS - 2 (LHDV2)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
MEDIUM HEAVY DUTY DIESEL TRUCKS (MHDV)	0.8	0.5	0.4	0.4	0.3	0.3	0.3	0.3
HEAVY HEAVY DUTY DIESEL TRUCKS (HHDV)	5.8	3.8	2.0	1.6	1.5	1.4	1.4	1.4
MOTORCYCLES (MCY)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HEAVY DUTY DIESEL URBAN BUSES (UB)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
HEAVY DUTY GAS URBAN BUSES (UB)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SCHOOL BUSES (SB)	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
OTHER BUSES (OB)	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MOTOR HOMES (MH)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL ON-ROAD MOTOR VEHICLES**	**9.1**	**6.7**	**4.8**	**4.4**	**4.3**	**4.2**	**4.2**	**4.3**
OTHER MOBILE SOURCES								
AIRCRAFT	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.6
TRAINS	0.6	0.4	0.4	0.4	0.4	0.4	0.4	0.4
SHIPS AND COMMERCIAL BOATS	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RECREATIONAL BOATS	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1
OFF-ROAD RECREATIONAL VEHICLES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OFF-ROAD EQUIPMENT	2.1	1.4	1.3	1.2	1.1	1.1	1.0	0.9
FARM EQUIPMENT	2.1	1.6	1.3	1.2	1.1	1.0	0.9	0.8
FUEL STORAGE AND HANDLING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL OTHER MOBILE SOURCES**	**6.1**	**4.6**	**4.1**	**4.0**	**3.8**	**3.6**	**3.4**	**3.8**
**** TOTAL MOBILE SOURCES**	**15.2**	**11.3**	**8.9**	**8.4**	**8.0**	**7.8**	**7.7**	**8.1**
GRAND TOTAL FOR SAN JOAQUIN VALLEY	**87.1**	**67.1**	**64.4**	**63.9**	**63.6**	**63.5**	**63.4**	**64.0**

Table B-2 NOx (Winter Daily Averages in tons per day)

NOx (tpd)								
SUMMARY CATEGORY NAME	WINTER AVERAGE							
	2007	2012	2014	2015	2016	2017	2018	2019
STATIONARY SOURCES								
FUEL COMBUSTION								
ELECTRIC UTILITIES	7.1	5.4	5.4	5.4	5.6	5.6	5.7	5.7
COGENERATION	3.0	1.6	1.7	1.8	1.8	1.9	2.0	2.0
OIL AND GAS PRODUCTION (COMBUSTION)	3.5	1.9	1.7	1.6	1.6	1.5	1.5	1.4
PETROLEUM REFINING (COMBUSTION)	0.7	0.5	0.5	0.5	0.5	0.5	0.5	0.5
MANUFACTURING AND INDUSTRIAL	5.1	4.8	4.8	4.8	4.8	4.8	4.8	4.7
FOOD AND AGRICULTURAL PROCESSING	12.7	7.5	7.1	5.1	3.8	3.5	3.3	3.2
SERVICE AND COMMERCIAL	4.0	3.6	3.6	3.5	3.6	3.6	3.6	3.6
OTHER (FUEL COMBUSTION)	0.6	0.5	0.5	0.4	0.4	0.4	0.4	0.4
*** TOTAL FUEL COMBUSTION**	**36.6**	**25.9**	**25.3**	**23.1**	**22.0**	**21.9**	**21.8**	**21.7**
WASTE DISPOSAL								
SEWAGE TREATMENT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LANDFILLS	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2
INCINERATORS	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
SOIL REMEDIATION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER (WASTE DISPOSAL)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL WASTE DISPOSAL**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**
CLEANING AND SURFACE COATINGS								
LAUNDERING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DEGREASING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COATINGS AND RELATED PROCESS SOLVENTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PRINTING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ADHESIVES AND SEALANTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER (CLEANING AND SURFACE COATINGS)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL CLEANING AND SURFACE COATINGS**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
PETROLEUM PRODUCTION AND MARKETING								
OIL AND GAS PRODUCTION	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1
PETROLEUM REFINING	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
PETROLEUM MARKETING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER (PETROLEUM PRODUCTION AND MARKETING)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

NOx (tpd)								
SUMMARY CATEGORY NAME	WINTER AVERAGE							
	2007	2012	2014	2015	2016	2017	2018	2019
*** TOTAL PETROLEUM PRODUCTION AND MARKETING**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**
INDUSTRIAL PROCESSES								
CHEMICAL	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.5
FOOD AND AGRICULTURE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MINERAL PROCESSES	0.2	0.1	0.1	0.2	0.2	0.2	0.2	0.2
METAL PROCESSES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WOOD AND PAPER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GLASS AND RELATED PRODUCTS	7.8	6.1	4.0	4.1	4.2	4.3	4.3	4.4
ELECTRONICS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER (INDUSTRIAL PROCESSES)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL INDUSTRIAL PROCESSES**	**8.4**	**6.7**	**4.6**	**4.7**	**4.8**	**4.9**	**5.0**	**5.0**
**** TOTAL STATIONARY SOURCES**	**45.6**	**33.1**	**30.5**	**28.4**	**27.4**	**27.4**	**27.3**	**27.3**
AREA-WIDE SOURCES								
SOLVENT EVAPORATION								
CONSUMER PRODUCTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ARCHITECTURAL COATINGS AND RELATED PROCESS SOLVENTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PESTICIDES/FERTILIZERS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ASPHALT PAVING / ROOFING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL SOLVENT EVAPORATION**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
MISCELLANEOUS PROCESSES								
RESIDENTIAL FUEL COMBUSTION	12.0	10.3	10.3	10.3	10.3	10.4	10.4	10.5
FARMING OPERATIONS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONSTRUCTION AND DEMOLITION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PAVED ROAD DUST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
UNPAVED ROAD DUST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FUGITIVE WINDBLOWN DUST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FIRES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MANAGED BURNING AND DISPOSAL	7.1	5.3	5.3	5.2	5.2	5.2	5.2	5.2
COOKING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER (MISCELLANEOUS PROCESSES)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL MISCELLANEOUS PROCESSES**	**19.0**	**15.6**	**15.6**	**15.6**	**15.6**	**15.6**	**15.7**	**15.7**
**** TOTAL AREA-WIDE SOURCES**	**19.0**	**15.6**	**15.6**	**15.6**	**15.6**	**15.6**	**15.7**	**15.7**
MOBILE SOURCES								
ON-ROAD MOTOR VEHICLES								
LIGHT DUTY PASSENGER (LDA)	18.8	11.3	8.6	7.6	6.9	6.1	5.6	5.2

NOx (tpd)								
SUMMARY CATEGORY NAME	WINTER AVERAGE							
	2007	2012	2014	2015	2016	2017	2018	2019
LIGHT DUTY TRUCKS - 1 (LDT1)	6.3	3.8	3.2	2.9	2.7	2.5	2.3	2.1
LIGHT DUTY TRUCKS - 2 (LDT2)	13.1	8.3	6.3	5.6	5.0	4.4	3.9	3.6
MEDIUM DUTY TRUCKS (MDV)	16.8	13.3	11.4	10.6	9.9	9.2	8.7	8.1
LIGHT HEAVY DUTY GAS TRUCKS - 1 (LHDV1)	5.2	4.7	4.4	4.3	4.2	4.0	4.0	3.9
LIGHT HEAVY DUTY GAS TRUCKS - 2 (LHDV2)	0.5	0.4	0.3	0.3	0.3	0.3	0.3	0.3
MEDIUM HEAVY DUTY GAS TRUCKS (MHDV)	1.2	0.9	0.7	0.7	0.6	0.6	0.5	0.5
HEAVY HEAVY DUTY GAS TRUCKS (HHDV)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.5
LIGHT HEAVY DUTY DIESEL TRUCKS - 1 (LHDV1)	15.2	12.0	10.5	9.9	9.3	8.7	8.1	7.7
LIGHT HEAVY DUTY DIESEL TRUCKS - 2 (LHDV2)	3.7	2.9	2.5	2.4	2.2	2.1	2.0	1.9
MEDIUM HEAVY DUTY DIESEL TRUCKS (MHDV)	19.7	13.0	11.9	10.6	9.7	8.8	8.1	7.3
HEAVY HEAVY DUTY DIESEL TRUCKS (HHDV)	187.4	106.0	91.2	80.9	72.3	66.5	61.8	58.4
MOTORCYCLES (MCY)	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.2
HEAVY DUTY DIESEL URBAN BUSES (UB)	2.1	2.1	1.9	1.9	1.9	1.9	1.9	1.8
HEAVY DUTY GAS URBAN BUSES (UB)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
SCHOOL BUSES (SB)	1.5	1.1	1.0	1.0	1.0	1.1	1.0	1.0
OTHER BUSES (OB)	2.3	1.6	1.4	1.2	1.1	1.0	0.9	0.9
MOTOR HOMES (MH)	0.9	0.7	0.7	0.6	0.6	0.6	0.5	0.5
*** TOTAL ON-ROAD MOTOR VEHICLES**	**296.5**	**184.1**	**157.9**	**142.5**	**129.5**	**119.6**	**111.4**	**104.9**
OTHER MOBILE SOURCES								
AIRCRAFT	2.6	2.7	2.7	2.7	2.7	2.7	2.7	5.0
TRAINS	21.7	16.4	17.0	17.1	17.0	16.9	16.7	16.5
SHIPS AND COMMERCIAL BOATS	1.1	0.9	0.9	0.8	0.8	0.8	0.8	0.8
RECREATIONAL BOATS	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.6
OFF-ROAD RECREATIONAL VEHICLES	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
OFF-ROAD EQUIPMENT	40.2	27.2	25.8	25.3	24.4	23.7	22.2	21.2
FARM EQUIPMENT	37.7	28.7	24.7	22.8	21.0	19.5	17.9	16.4
FUEL STORAGE AND HANDLING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL OTHER MOBILE SOURCES**	**103.9**	**76.6**	**71.7**	**69.4**	**66.7**	**64.3**	**61.0**	**60.6**
**** TOTAL MOBILE SOURCES**	**400.5**	**260.7**	**229.6**	**211.9**	**196.3**	**183.9**	**172.4**	**165.5**
GRAND TOTAL FOR SAN JOAQUIN VALLEY	**465.1**	**309.4**	**275.7**	**255.9**	**239.3**	**226.9**	**215.4**	**208.5**

Table B-3 SOx (Winter Daily Averages in tons per day)

SOx (tpd)								
SUMMARY CATEGORY NAME	WINTER AVERAGE							
	2007	2012	2014	2015	2016	2017	2018	2019
STATIONARY SOURCES								
FUEL COMBUSTION								
ELECTRIC UTILITIES	1.4	1.3	1.3	1.3	1.3	1.3	1.4	1.4
COGENERATION	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2
OIL AND GAS PRODUCTION (COMBUSTION)	2.0	1.1	0.5	0.4	0.4	0.4	0.4	0.4
PETROLEUM REFINING (COMBUSTION)	0.3	0.2	0.1	0.1	0.1	0.1	0.1	0.1
MANUFACTURING AND INDUSTRIAL	1.1	1.0	1.0	1.0	1.0	1.0	1.0	1.0
FOOD AND AGRICULTURAL PROCESSING	0.3	0.1	0.1	0.1	0.1	0.1	0.1	0.1
SERVICE AND COMMERCIAL	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3
OTHER (FUEL COMBUSTION)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL FUEL COMBUSTION**	**5.6**	**4.3**	**3.4**	**3.4**	**3.4**	**3.4**	**3.4**	**3.4**
WASTE DISPOSAL								
SEWAGE TREATMENT	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1
LANDFILLS	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
INCINERATORS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SOIL REMEDIATION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER (WASTE DISPOSAL)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL WASTE DISPOSAL**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**
CLEANING AND SURFACE COATINGS								
LAUNDERING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DEGREASING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COATINGS AND RELATED PROCESS SOLVENTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PRINTING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ADHESIVES AND SEALANTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER (CLEANING AND SURFACE COATINGS)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL CLEANING AND SURFACE COATINGS**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
PETROLEUM PRODUCTION AND MARKETING								
OIL AND GAS PRODUCTION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PETROLEUM REFINING	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
PETROLEUM MARKETING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER (PETROLEUM PRODUCTION AND MARKETING)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

SOx (tpd)								
SUMMARY CATEGORY NAME	WINTER AVERAGE							
	2007	2012	2014	2015	2016	2017	2018	2019
*** TOTAL PETROLEUM PRODUCTION AND MARKETING**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**
INDUSTRIAL PROCESSES								
CHEMICAL	1.0	0.8	0.8	0.8	0.8	0.8	0.8	0.9
FOOD AND AGRICULTURE	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3
MINERAL PROCESSES	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4
METAL PROCESSES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WOOD AND PAPER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GLASS AND RELATED PRODUCTS	3.0	1.9	1.8	1.8	1.8	1.9	1.9	1.9
ELECTRONICS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER (INDUSTRIAL PROCESSES)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL INDUSTRIAL PROCESSES**	**4.6**	**3.2**	**3.2**	**3.3**	**3.3**	**3.3**	**3.4**	**3.4**
**** TOTAL STATIONARY SOURCES**	**10.4**	**7.7**	**6.8**	**6.9**	**7.0**	**7.0**	**7.1**	**7.1**
AREA-WIDE SOURCES								
SOLVENT EVAPORATION								
CONSUMER PRODUCTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ARCHITECTURAL COATINGS AND RELATED PROCESS SOLVENTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PESTICIDES/FERTILIZERS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ASPHALT PAVING / ROOFING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL SOLVENT EVAPORATION**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
MISCELLANEOUS PROCESSES								
RESIDENTIAL FUEL COMBUSTION	0.6	0.3	0.3	0.3	0.3	0.3	0.3	0.3
FARMING OPERATIONS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONSTRUCTION AND DEMOLITION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PAVED ROAD DUST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
UNPAVED ROAD DUST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FUGITIVE WINDBLOWN DUST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FIRES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MANAGED BURNING AND DISPOSAL	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
COOKING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER (MISCELLANEOUS PROCESSES)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL MISCELLANEOUS PROCESSES**	**0.8**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**
**** TOTAL AREA-WIDE SOURCES**	**0.8**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**
MOBILE SOURCES								
ON-ROAD MOTOR VEHICLES								
LIGHT DUTY PASSENGER (LDA)	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2
LIGHT DUTY TRUCKS - 1 (LDT1)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

SOx (tpd)								
SUMMARY CATEGORY NAME	WINTER AVERAGE							
	2007	2012	2014	2015	2016	2017	2018	2019
LIGHT DUTY TRUCKS - 2 (LDT2)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
MEDIUM DUTY TRUCKS (MDV)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
LIGHT HEAVY DUTY GAS TRUCKS - 1 (LHDV1)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LIGHT HEAVY DUTY GAS TRUCKS - 2 (LHDV2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MEDIUM HEAVY DUTY GAS TRUCKS (MHDV)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HEAVY HEAVY DUTY GAS TRUCKS (HHDV)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LIGHT HEAVY DUTY DIESEL TRUCKS - 1 (LHDV1)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LIGHT HEAVY DUTY DIESEL TRUCKS - 2 (LHDV2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MEDIUM HEAVY DUTY DIESEL TRUCKS (MHDV)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HEAVY HEAVY DUTY DIESEL TRUCKS (HHDV)	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
MOTORCYCLES (MCY)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HEAVY DUTY DIESEL URBAN BUSES (UB)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HEAVY DUTY GAS URBAN BUSES (UB)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SCHOOL BUSES (SB)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER BUSES (OB)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MOTOR HOMES (MH)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL ON-ROAD MOTOR VEHICLES**	**0.6**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.8**	**0.8**
OTHER MOBILE SOURCES								
AIRCRAFT	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.5
TRAINS	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SHIPS AND COMMERCIAL BOATS	0.5	0.1	0.1	0.1	0.1	0.1	0.1	0.1
RECREATIONAL BOATS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OFF-ROAD RECREATIONAL VEHICLES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OFF-ROAD EQUIPMENT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FARM EQUIPMENT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FUEL STORAGE AND HANDLING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL OTHER MOBILE SOURCES**	**1.0**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.6**	**0.6**
**** TOTAL MOBILE SOURCES**	**1.6**	**1.2**	**1.2**	**1.2**	**1.3**	**1.3**	**1.3**	**1.4**
GRAND TOTAL FOR SAN JOAQUIN VALLEY	**12.8**	**9.4**	**8.6**	**8.6**	**8.7**	**8.8**	**8.9**	**9.0**

Table B-4 VOC (Winter Daily Averages in tons per day)

VOC (tpd)								
SUMMARY CATEGORY NAME	WINTER AVERAGE							
	2007	2012	2014	2015	2016	2017	2018	2019
STATIONARY SOURCES								
FUEL COMBUSTION								
ELECTRIC UTILITIES	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
COGENERATION	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
OIL AND GAS PRODUCTION (COMBUSTION)	1.5	1.3	1.2	1.2	1.2	1.2	1.1	1.1
PETROLEUM REFINING (COMBUSTION)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
MANUFACTURING AND INDUSTRIAL	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
FOOD AND AGRICULTURAL PROCESSING	1.2	0.7	0.7	0.6	0.4	0.4	0.4	0.4
SERVICE AND COMMERCIAL	0.6	0.5	0.6	0.6	0.6	0.6	0.6	0.6
OTHER (FUEL COMBUSTION)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
*** TOTAL FUEL COMBUSTION**	**4.0**	**3.3**	**3.2**	**3.1**	**3.0**	**2.9**	**2.9**	**2.9**
WASTE DISPOSAL								
SEWAGE TREATMENT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LANDFILLS	1.3	1.4	1.4	1.4	1.5	1.5	1.5	1.5
INCINERATORS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SOIL REMEDIATION	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
OTHER (WASTE DISPOSAL)	23.1	19.3	20.1	20.5	20.9	20.6	21.0	21.4
*** TOTAL WASTE DISPOSAL**	**24.6**	**21.0**	**21.8**	**22.2**	**22.7**	**22.3**	**22.7**	**23.2**
CLEANING AND SURFACE COATINGS								
LAUNDERING	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
DEGREASING	1.5	1.5	1.5	1.6	1.6	1.6	1.6	1.6
COATINGS AND RELATED PROCESS SOLVENTS	7.3	7.8	8.2	8.4	8.5	8.7	8.9	9.1
PRINTING	4.4	4.9	5.1	5.2	5.3	5.4	5.5	5.6
ADHESIVES AND SEALANTS	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.6
OTHER (CLEANING AND SURFACE COATINGS)	3.6	4.2	4.4	4.5	4.6	4.7	4.8	4.9
*** TOTAL CLEANING AND SURFACE COATINGS**	**17.6**	**19.1**	**20.0**	**20.4**	**20.7**	**21.1**	**21.5**	**21.8**
PETROLEUM PRODUCTION AND MARKETING								
OIL AND GAS PRODUCTION	28.5	25.2	24.1	23.5	23.0	22.5	22.0	21.5
PETROLEUM REFINING	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
PETROLEUM MARKETING	6.7	7.3	7.5	7.7	7.8	8.0	8.1	8.3
OTHER (PETROLEUM PRODUCTION AND MARKETING)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

VOC (tpd)								
SUMMARY CATEGORY NAME	WINTER AVERAGE							
	2007	2012	2014	2015	2016	2017	2018	2019
*** TOTAL PETROLEUM PRODUCTION AND MARKETING**	**36.3**	**33.6**	**32.7**	**32.4**	**32.0**	**31.6**	**31.3**	**31.0**
INDUSTRIAL PROCESSES								
CHEMICAL	3.4	2.7	2.8	2.8	2.9	2.9	2.9	3.0
FOOD AND AGRICULTURE	9.5	10.4	10.8	11.0	11.2	11.4	11.6	11.9
MINERAL PROCESSES	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4
METAL PROCESSES	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
WOOD AND PAPER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GLASS AND RELATED PRODUCTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ELECTRONICS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER (INDUSTRIAL PROCESSES)	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4
*** TOTAL INDUSTRIAL PROCESSES**	**13.7**	**14.0**	**14.5**	**14.8**	**15.0**	**15.3**	**15.5**	**15.9**
**** TOTAL STATIONARY SOURCES**	**96.2**	**91.0**	**92.3**	**92.8**	**93.4**	**93.2**	**94.0**	**94.7**
AREA-WIDE SOURCES								
SOLVENT EVAPORATION								
CONSUMER PRODUCTS	22.8	21.0	20.6	20.8	21.2	21.5	21.9	22.2
ARCHITECTURAL COATINGS AND RELATED PROCESS SOLVENTS	9.8	7.7	7.8	7.9	8.0	8.0	8.1	8.2
PESTICIDES/FERTILIZERS	18.1	16.5	16.3	16.3	16.2	16.1	16.1	16.0
ASPHALT PAVING / ROOFING	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9
*** TOTAL SOLVENT EVAPORATION**	**51.5**	**46.0**	**45.6**	**45.9**	**46.2**	**46.5**	**46.9**	**47.2**
MISCELLANEOUS PROCESSES								
RESIDENTIAL FUEL COMBUSTION	21.9	10.7	10.2	10.2	10.2	10.2	10.2	10.2
FARMING OPERATIONS	130.6	103.5	105.8	107.0	108.1	109.2	110.4	111.5
CONSTRUCTION AND DEMOLITION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PAVED ROAD DUST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
UNPAVED ROAD DUST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FUGITIVE WINDBLOWN DUST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FIRES	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
MANAGED BURNING AND DISPOSAL	8.5	6.5	6.4	6.4	6.4	6.4	6.4	6.3
COOKING	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.6
OTHER (MISCELLANEOUS PROCESSES)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL MISCELLANEOUS PROCESSES**	**161.7**	**121.4**	**123.1**	**124.2**	**125.4**	**126.5**	**127.6**	**128.8**
**** TOTAL AREA-WIDE SOURCES**	**213.2**	**167.4**	**168.7**	**170.1**	**171.6**	**173.1**	**174.5**	**176.0**
MOBILE SOURCES								
ON-ROAD MOTOR VEHICLES								
LIGHT DUTY PASSENGER (LDA)	20.2	13.2	8.8	7.7	6.8	5.9	5.2	4.7

VOC (tpd)								
SUMMARY CATEGORY NAME	**WINTER AVERAGE**							
	2007	**2012**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
LIGHT DUTY TRUCKS - 1 (LDT1)	7.0	4.9	3.6	3.3	3.0	2.8	2.5	2.4
LIGHT DUTY TRUCKS - 2 (LDT2)	8.9	6.8	4.9	4.4	4.0	3.5	3.2	3.0
MEDIUM DUTY TRUCKS (MDV)	8.5	8.4	7.0	6.8	6.6	6.3	6.1	6.0
LIGHT HEAVY DUTY GAS TRUCKS - 1 (LHDV1)	3.8	3.4	2.7	2.6	2.5	2.4	2.3	2.3
LIGHT HEAVY DUTY GAS TRUCKS - 2 (LHDV2)	0.5	0.3	0.2	0.2	0.2	0.2	0.1	0.1
MEDIUM HEAVY DUTY GAS TRUCKS (MHDV)	1.4	1.0	0.6	0.5	0.5	0.4	0.3	0.3
HEAVY HEAVY DUTY GAS TRUCKS (HHDV)	0.3	0.2	0.1	0.1	0.1	0.1	0.1	0.1
LIGHT HEAVY DUTY DIESEL TRUCKS - 1 (LHDV1)	0.6	0.6	0.6	0.6	0.5	0.5	0.5	0.5
LIGHT HEAVY DUTY DIESEL TRUCKS - 2 (LHDV2)	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1
MEDIUM HEAVY DUTY DIESEL TRUCKS (MHDV)	1.1	0.8	0.6	0.5	0.5	0.4	0.4	0.4
HEAVY HEAVY DUTY DIESEL TRUCKS (HHDV)	9.8	6.4	4.5	4.2	4.1	4.2	4.3	4.4
MOTORCYCLES (MCY)	4.2	3.7	3.1	3.1	3.0	3.0	3.0	3.1
HEAVY DUTY DIESEL URBAN BUSES (UB)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
HEAVY DUTY GAS URBAN BUSES	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
SCHOOL BUSES (SB)	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1
OTHER BUSES (OB)	0.3	0.2	0.2	0.2	0.2	0.1	0.1	0.1
MOTOR HOMES (MH)	0.2	0.1	0.1	0.1	0.1	0.0	0.0	0.0
*** TOTAL ON-ROAD MOTOR VEHICLES**	**67.3**	**50.5**	**37.5**	**34.7**	**32.4**	**30.4**	**28.8**	**27.7**
OTHER MOBILE SOURCES								
AIRCRAFT	4.1	4.2	4.2	4.2	4.2	4.3	4.3	6.0
TRAINS	1.6	1.1	1.0	1.0	0.9	0.9	0.8	0.8
SHIPS AND COMMERCIAL BOATS	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
RECREATIONAL BOATS	3.6	2.9	2.6	2.5	2.4	2.3	2.3	2.2
OFF-ROAD RECREATIONAL VEHICLES	3.7	2.9	2.8	2.8	2.8	2.7	2.7	2.7
OFF-ROAD EQUIPMENT	13.8	10.2	9.3	9.1	8.8	8.5	8.3	8.1
FARM EQUIPMENT	8.0	5.9	4.9	4.5	4.1	3.7	3.4	3.1
FUEL STORAGE AND HANDLING	3.1	1.7	1.5	1.4	1.4	1.3	1.3	1.3
*** TOTAL OTHER MOBILE SOURCES**	**38.0**	**28.9**	**26.5**	**25.6**	**24.7**	**23.9**	**23.1**	**24.2**
**** TOTAL MOBILE SOURCES**	**105.3**	**79.4**	**64.0**	**60.3**	**57.1**	**54.3**	**52.0**	**51.9**
GRAND TOTAL FOR SAN JOAQUIN VALLEY	**414.8**	**337.8**	**324.9**	**323.2**	**322.0**	**320.6**	**320.5**	**322.6**

Table B-5 Ammonia (Winter Daily Averages in tons per day)

AMMONIA (tpd)								
SUMMARY CATEGORY NAME	WINTER AVERAGE							
	2007	2012	2014	2015	2016	2017	2018	2019
STATIONARY SOURCES								
FUEL COMBUSTION								
ELECTRIC UTILITIES	0.8	0.7	0.7	0.6	0.6	0.7	0.7	0.7
COGENERATION	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
OIL AND GAS PRODUCTION (COMBUSTION)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PETROLEUM REFINING (COMBUSTION)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MANUFACTURING AND INDUSTRIAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FOOD AND AGRICULTURAL PROCESSING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SERVICE AND COMMERCIAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER (FUEL COMBUSTION)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL FUEL COMBUSTION**	**0.9**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**
WASTE DISPOSAL								
SEWAGE TREATMENT	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1
LANDFILLS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INCINERATORS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SOIL REMEDIATION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER (WASTE DISPOSAL)	17.9	19.3	20.1	20.5	20.9	21.3	21.7	22.1
*** TOTAL WASTE DISPOSAL**	**17.9**	**19.3**	**20.1**	**20.5**	**20.9**	**21.3**	**21.8**	**22.2**
CLEANING AND SURFACE COATINGS								
LAUNDERING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DEGREASING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COATINGS AND RELATED PROCESS SOLVENTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PRINTING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ADHESIVES AND SEALANTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER (CLEANING AND SURFACE COATINGS)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL CLEANING AND SURFACE COATINGS**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
PETROLEUM PRODUCTION AND MARKETING								
OIL AND GAS PRODUCTION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PETROLEUM REFINING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PETROLEUM MARKETING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER (PETROLEUM PRODUCTION AND MARKETING)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

AMMONIA (tpd)								
SUMMARY CATEGORY NAME	WINTER AVERAGE							
	2007	2012	2014	2015	2016	2017	2018	2019
*** TOTAL PETROLEUM PRODUCTION AND MARKETING**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
INDUSTRIAL PROCESSES								
CHEMICAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FOOD AND AGRICULTURE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MINERAL PROCESSES	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.5
METAL PROCESSES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WOOD AND PAPER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GLASS AND RELATED PRODUCTS	0.5	0.3	0.4	0.4	0.4	0.4	0.4	0.4
ELECTRONICS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER (INDUSTRIAL PROCESSES)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL INDUSTRIAL PROCESSES**	**1.0**	**0.8**	**0.9**	**0.9**	**0.9**	**1.0**	**1.0**	**1.0**
**** TOTAL STATIONARY SOURCES**	**19.8**	**21.0**	**21.8**	**22.2**	**22.6**	**23.1**	**23.5**	**24.0**
AREA-WIDE SOURCES								
SOLVENT EVAPORATION								
CONSUMER PRODUCTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ARCHITECTURAL COATINGS AND RELATED PROCESS SOLVENTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PESTICIDES/FERTILIZERS	68.4	66.9	66.3	66.1	65.8	65.5	65.2	64.9
ASPHALT PAVING / ROOFING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL SOLVENT EVAPORATION**	**68.4**	**66.9**	**66.3**	**66.1**	**65.8**	**65.5**	**65.2**	**64.9**
MISCELLANEOUS PROCESSES								
RESIDENTIAL FUEL COMBUSTION	1.5	0.7	0.7	0.7	0.7	0.7	0.7	0.7
FARMING OPERATIONS	264.5	225.4	234.6	239.2	243.8	248.4	253.0	257.6
CONSTRUCTION AND DEMOLITION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PAVED ROAD DUST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
UNPAVED ROAD DUST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FUGITIVE WINDBLOWN DUST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FIRES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MANAGED BURNING AND DISPOSAL	1.4	1.1	1.0	1.0	1.0	1.0	1.0	1.0
COOKING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER (MISCELLANEOUS PROCESSES)	6.3	6.7	7.0	7.1	7.2	7.3	7.5	7.6
*** TOTAL MISCELLANEOUS PROCESSES**	**273.7**	**234.0**	**243.4**	**248.1**	**252.8**	**257.5**	**262.2**	**267.0**
**** TOTAL AREA-WIDE SOURCES**	**342.2**	**300.9**	**309.7**	**314.2**	**318.6**	**323.0**	**327.4**	**331.9**
MOBILE SOURCES								
ON-ROAD MOTOR VEHICLES								
LIGHT DUTY PASSENGER (LDA)	1.8	1.5	1.4	1.3	1.3	1.3	1.3	1.2

AMMONIA (tpd)								
SUMMARY CATEGORY NAME	WINTER AVERAGE							
	2007	2012	2014	2015	2016	2017	2018	2019
LIGHT DUTY TRUCKS - 1 (LDT1)	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2
LIGHT DUTY TRUCKS - 2 (LDT2)	1.0	0.8	0.8	0.7	0.7	0.7	0.7	0.7
MEDIUM DUTY TRUCKS (MDV)	1.6	1.4	1.3	1.3	1.3	1.3	1.3	1.2
LIGHT HEAVY DUTY GAS TRUCKS - 1 (LHDV1)	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3
LIGHT HEAVY DUTY GAS TRUCKS - 2 (LHDV2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MEDIUM HEAVY DUTY GAS TRUCKS (MHDV)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HEAVY HEAVY DUTY GAS TRUCKS (HHDV)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LIGHT HEAVY DUTY DIESEL TRUCKS - 1 (LHDV1)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LIGHT HEAVY DUTY DIESEL TRUCKS - 2 (LHDV2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MEDIUM HEAVY DUTY DIESEL TRUCKS (MHDV)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
HEAVY HEAVY DUTY DIESEL TRUCKS (HHDV)	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3
MOTORCYCLES (MCY)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HEAVY DUTY DIESEL URBAN BUSES (UB)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HEAVY DUTY GAS URBAN BUSES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SCHOOL BUSES (SB)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER BUSES (OB)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MOTOR HOMES (MH)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL ON-ROAD MOTOR VEHICLES**	**5.3**	**4.7**	**4.4**	**4.3**	**4.3**	**4.2**	**4.2**	**4.2**
OTHER MOBILE SOURCES								
AIRCRAFT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRAINS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SHIPS AND COMMERCIAL BOATS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RECREATIONAL BOATS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OFF-ROAD RECREATIONAL VEHICLES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OFF-ROAD EQUIPMENT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FARM EQUIPMENT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FUEL STORAGE AND HANDLING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL OTHER MOBILE SOURCES**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
**** TOTAL MOBILE SOURCES**	**5.4**	**4.7**	**4.5**	**4.4**	**4.3**	**4.3**	**4.2**	**4.2**
GRAND TOTAL FOR SAN JOAQUIN VALLEY	**367.3**	**326.6**	**336.0**	**340.7**	**345.5**	**350.4**	**355.2**	**360.1**

B.2 EMISSIONS INVENTORY CALCULATIONS AND REVISIONS

ARB and the District continually collect information and conduct research to improve the emission estimates. During development of this Plan, both agencies allocated substantial resources to the improvement of the emissions inventory. In the two-year span leading to the release of the draft Plan, ARB headed a workgroup that focused on updating the inventory data in ARB's database. ARB and District staff conducted a thorough review of the inventory to ensure that the emission estimates reflected accurate emission reports for point sources, and that estimates for mobile and area-wide sources were based on the most recent methodologies. In cases where area-wide source methodologies were deemed to be out-of date (*i.e.*, if new emission factors or more recent activity data were available), the methodologies were updated. The updates were prioritized based on the overall contribution of each emission category to the total inventory for key pollutants (directly emitted PM2.5, NOx, SOx, VOCs, and ammonia).

ARB also conducts periodic evaluations and updates of the growth profiles to ensure that the emission forecasts are based on data that reflect historical trends, current conditions, and recent forecasts. The most significant challenge for this Plan was to ensure that the growth projections reflected the economic recession. Staff conducted a category-by-category review and update of the growth profile data for all the categories that, in aggregate, comprise more than 95 percent of the NOx, SOx, or PM2.5 emissions. To capture the effects of the recession, staff ensured that the growth profiles included historical data through at least 2008 (data through 2009 or 2010 were included when available). Growth forecasts for the years 2009 and beyond were obtained primarily from government entities with expertise in developing forecasts for specific sectors, or in some cases, from econometric models.

In addition this comprehensive emissions inventory update process, modeling of the 24-hour PM2.5 standard requires detailed information on the timing and locations of emission sources on the most severe air quality days. This poses a unique challenge to translate regional, annual emission estimates into the temporal and spatial resolution needed for 24-hour modeling. An iterative process was used as a means to refine the modeling emission inputs to better reflect observed conditions expected at a local, 24-hour scale. Model-simulated concentrations were compared with chemical species present in the ambient monitoring data, maps of emission sources known to surround the monitoring stations, and temporal trends in the monitoring data. This led to further updates in the spatial and temporal emissions data used in the modeling.

ARB and District staff worked jointly to develop a comprehensive emissions inventory for the *2012 PM2.5 Plan*. The District worked closely with operators of major stationary facilities in their jurisdiction to develop the point source emission estimates. The District was also responsible for developing emission estimates for approximately one-third of the nonpoint (or area-wide) sources, such as commercial cooking and agricultural burning.

ARB staff developed the emission inventory for the mobile sources (both on-road and off-road) and the remaining two-thirds of the area-wide sources. ARB 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), the California Energy Commission (CEC), and local councils of government (COGs) to assemble activity information necessary to develop the mobile and area-wide source emission estimates.

B.2.1 Base Year Inventory

The base year inventory is an essential element of the Plan that 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 general guidelines for selecting an inventory base year. Based on those guidelines, ARB and the District selected 2007 as the base year for this Plan. The design values recorded in 2007 were some of the highest in recent years. In addition, analysis of the impacts of meteorology on PM2.5 levels in the Valley over the last ten years indicate that the 2007 meteorology was one of the most conducive to PM2.5 formation. Thus, the selection of 2007 represents a health protective approach to the attainment demonstration.

B.2.2 Emission Forecasts

In addition to a base year inventory, U.S. EPA regulations require future year inventories for specific milestone years. ARB develops emission forecasts for point and area-wide sources by applying growth and control factors to the base year inventory to account for year-to-year changes resulting from anticipated trends in economic conditions and population growth, and the effects of adopted emission control rules.

Growth factors are expressed as a ratio of the expected activity level in a future year relative to the base year. For point and area-wide sources, growth factors are derived from surrogates such as economic activity, fuel usage, population, dwelling-units, etc., that best reflect the expected growth or decline rates for each specific source category.

Control factors are percentages representing the extent to which a source category is controlled. These factors are derived from data provided by the regulatory agencies responsible for the affected emission categories. Developing control factors enables agencies to take appropriate credit for adopted rules and regulations that reduce emissions, remove exemptions, or improve compliance.

Mobile source projections are generated by emission models that employ sophisticated routines that predict 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.

B.2.3 Annual, Seasonal, and Modeling Inventories

Annual and seasonal emissions inventories, often referred to as planning inventories, are typically produced at a county or air basin level of resolution. Annual emissions inventories represent the total emissions over an entire year (tons per year), or a simple average of annual emissions divided by 365 days (tons per day).

Seasonal inventories (summer and winter) account for temporal activity variations throughout the year, as determined by actual data from point source facilities or by temporal profiles developed for area and mobile sources. Summer inventories include emissions from May to October, and winter inventories encompass November through April. Because PM2.5 concentrations in the Valley are at their highest during the winter, the Plan's attainment demonstration is based on the winter inventory.

Modeling inventories (also referred to as gridded inventories), are estimated at finer spatial and temporal scales than planning inventories. Modeling inventories are used to support hour-by-hour, grid-based calculations of ambient pollutant concentrations. As a result, these inventories must characterize hourly emissions from all sources (stationary point, area-wide, mobile, and biogenic) located within each grid cell for the region and time being simulated. Modeling inventories account for day-specific variations within grid cells (such as actual plant shut-downs or wildfires) and the effects of meteorological conditions on emission rates (*e.g.*, the hour-specific ambient temperature effects on biogenic or evaporative emission releases). A more in-depth discussion of the temporal and spatial adjustments made to the Valley's modeling inventory is presented in the Modeling Protocol.

B.2.4 Quality Assurance and Quality Control

ARB has established a quality assurance and quality control (QA/QC) process to ensure the integrity and accuracy of the emissions inventories used in the development of air quality plans. Emission inventory staff perform comprehensive QA/QC checks to confirm that inventory inputs have been reliably prepared and approved for use in photochemical modeling. This process involves collaboration among ARB and air district staff to develop base and future year emission estimates.

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). Inventory staff work with air districts, 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. Area-wide source emission estimates are developed by ARB staff as well as some air districts. The methodologies for estimating these are reviewed by ARB 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 Forecasting and Planning Inventory System (CEFS). 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- and off-road emission models (EMFAC and OFFROAD).

Prior to input into the air quality model, the spatial and temporal parameters applied to the emissions are checked. Monthly, weekly, and diurnal emission profiles are examined to ensure they appear reasonable for the category. Emissions are again summarized by region (county, air basin, and district), category, and pollutant to confirm their consistency with the overall inventory.

As modeling results become available, the results are used to further validate the inventory. The modeled concentrations in a particular grid cell are reviewed for consistency with the types of sources present nearby in the emission inventory. Additionally, the inclusion of air quality monitor data, when available, is used to reaffirm that the types and magnitude of upwind sources are accounted for in the inventory.

B.3 EMISSIONS INVENTORY IMPROVEMENTS

A summary of the major revisions that have been incorporated into the PM2.5 Plan emissions inventory is presented below.

B.3.1 Stationary Sources

Emission estimates from stationary sources (industrial point sources) are routinely updated on an annual basis by the District. District staff works with facility operators to ensure that emissions are reported accurately and in a timely manner. The point source emissions inventory for this PM2.5 Plan was compiled from emissions data reported by District staff for the year 2007.

Once the base year emissions are compiled by the District, ARB staff uses the base year inventory to forecast emissions into the future using relevant growth and control factors. Key updates to growth assumptions for stationary sources are discussed below.

Stationary Source Growth Assumptions and Methodology Updates

The growth profiles for key industrial categories were updated to reflect recent trends and growth forecasts in specific industrial sectors. To the extent feasible, these growth profile revisions capture the effects of the economic recession. Growth factors are derived from county-specific economic activity profiles, population forecasts, and other socio/demographic activity. These data are obtained from a number of sources such as local air districts, municipal planning agencies, economic studies sponsored by ARB, and other State and federal agencies. Growth assumptions for the following point source categories were updated as described below:

- **Cogeneration:** Growth projections for emissions from natural gas use in the Cogeneration sector are based on the California Energy Commission's (CEC) 2009 Integrated Energy Policy Report (2009 IEPR) forecasts. For other fuels used in cogeneration facilities, ARB used forecasts from the U.S. Energy Information Administration's Annual Energy Outlook (AEO).

- **Cotton Gins:** The particulate matter (PM) size profile for cotton gins was updated to reflect lower PM2.5 fractions (6.7% PM2.5/Total PM and 15% PM2.5/PM10) based on test data obtained from a study sponsored by the U.S. Department of Agriculture, the cotton industry, ARB and the District.

- **Electricity Generation:** Growth projections for emissions from natural gas use in the Electricity Generation sector are based on CEC data on electric utilities' contracts with operators of natural gas-fired power plants through 2020. Projections for power plant emissions driven by other fuels are based on AEO fuel use forecasts.

- **Glass and Related Products:** Growth projections for emissions from flat (architectural) glass manufacturing were adjusted to reflect the impact of the recession. The growth profile is based on ARB's growth curve for construction equipment, but it assumes no further growth once the curve returns to pre-recession levels. No growth was assumed for the Container and Cullet Glass manufacturing sectors.

- **Manufacturing and Industrial:** Growth projections for emissions from the Manufacturing and Industrial sector are based on the 2009 IEPR forecast for natural gas consumption and AEO forecasts for other fuels used by the manufacturing industry.

- **Mineral Processes:** Growth profiles for Mineral Processes associated with cement and concrete products manufacturing were derived from an econometric model run by Regional Economic Models Inc. (REMI). The profile for other mineral processes is based on an economic output forecast for non-metallic mineral product manufacturing, also from REMI.

- **Oil and Gas Production**: Growth projections for emissions from the Oil and Gas Production sector are based on a California Department of Conservation's Division of Oil, Gas and Geothermal Resources (DOGGR) forecast.

- **Petroleum Refining:** ARB assumes no growth for the Petroleum Refining sector based on assessments by District staff and DOGGR. While demand for petroleum based fuels and other products is expected to grow, District staff does not anticipate any expansion in capacity at the local facilities. The DOGGR assessment predicts that the increased demand will be satisfied by imports.

- **Service and Commercial:** Growth projections for emissions from the Service and Commercial sector are based on the 2009 IEPR forecast for natural gas consumption and AEO forecasts for other fuels used by the service and commercial industry.

B.3.2 Area-wide Sources

Area-wide sources include source categories associated with human activity where emissions take place over a wide geographic area. Consumer products and unpaved road dust are examples of area-wide sources. Area-wide sources also include smaller point sources or facilities, such as gasoline-dispensing facilities, and residential water heaters that are not inventoried individually, but are estimated as a group and reported as a single source category. Improvements made to the area-wide emission inventory categories are described below.

- **Agricultural Harvest Operations:** ARB staff updated the methodology for Agricultural Harvest Operations to reflect 2007 farmland acreage based on estimates from the California Department of Conservation Farmland Mapping and Monitoring Program (FMMP). ARB staff also applied a lower emission factor for almond harvesting (31.2 lbs PM10/acre compared to the prior emission factor of 40.77 lbs PM10/acre) based on recent field research. Growth for this category is based on a linear regression analysis of the 2000-2008 FMMP farmland acreage for the Valley counties, which results in a slight decline of about 0.3 percent per year.

- **Agricultural Land Preparation:** ARB staff updated the Agricultural Land Preparation methodology to reflect 2007 farmland acreage estimates based on FMMP data. Growth for this category is based on a linear regression analysis of the 2000-2008 FMMP farmland acreage for the Valley counties, which results in a slight decline of about 0.3 percent per year.

- **Ammonia Emissions from Publicly Owned Treatment Works, Landfills, Composting, Fertilizer Application, Domestic Activity, Native Animals, and Native Soils :** ARB staff updated the ammonia emissions inventory methodology for publicly owned treatment works, landfills, composting, fertilizer application, domestic activity, native animals, and native soils. Revisions for these categories consist primarily of updated activity data. Emission factors were revised only for fertilizer application. Ammonia emissions for other categories such as residential wood combustion, livestock husbandry, agricultural open burning, on-road motor vehicles, wildfires, and wildland fire use (WFU) were updated as part of the methodology updates for those specific area source categories.

- **Architectural Coatings:** The Architectural Coatings category was updated to reflect emission estimates based on the comprehensive survey for the 2004 calendar year. The emission estimates include benefits of the 2003 and 2007 ARB Suggested Control Measures.

- **Biogenic Emissions:** The Biogenic Emissions category was updated to incorporate year-specific 8-day Leaf Area Index data from the Moderate Resolution Imaging Spectroradiometer (MODIS) instrument aboard NASA's Terra and Aqua satellites. The use of MODIS data result in higher biogenic emissions estimates. In addition, the planning and modeling inventories are based on observed gridded temperatures rather than climatologically average temperatures. Finally, ARB staff is now generating biogenic emissions through the Model of Emissions of Gases and Aerosols from Nature (MEGAN) v2.04 model, a state-of-the-science canopy scale model, using California-specific emission factor and plant functional type datasets. MEGAN is widely used in the global research and earth system modeling community as well as the U.S. regulatory modeling community.

- **Commercial Cooking:** ARB staff updated the growth profile for the Commercial Cooking category to reflect more recent population growth projections(San Joaquin Valley Demographic Forecasts 2010-2050) developed by The Planning Center | Design, Community, and Environment (DC&E) on behalf of the regional planning organizations in the Valley.

- **Consumer Products:** The Consumer Products category was updated to reflect the three most recent surveys conducted by ARB staff for the years 2003, 2006, and 2008. Together these surveys collected updated product information and ingredient information for approximately 350 product categories. Based on the survey data, ARB staff determined the total product sales and total VOC emissions for the various product categories. Before the emissions inventory was updated, some of the existing categories were split out into more specific categories, others were combined, and new categories were added to better reflect changes in formulations of existing products. The result of this update was an overall reduction in emissions from this category. After establishing revised baseline emissions, growth projections for this category are based the

May 2012 DOF Interim Population Projections for California and its Counties 2010-2050.

- **Livestock Husbandry:** ARB staff updated the Livestock Husbandry methodology to reflect livestock population data based on the U.S. Department of Agriculture's 2007 Census of Agriculture, and ammonia emission factors for dairy support cattle using data provided by District staff. The ROG and NH3 emissions reflect updated control profiles to account for control requirements in District Rule 4570, Confined Animal Facilities, and a seasonal adjustment was added to account for the suppression of dust emissions in months in which rainfall occurs.

- **Managed Burning & Disposal:** ARB updated the Managed Burning and Disposal category with emissions data reported by District staff for the years 2005 to 2009. Growth for this category after 2009 is based on a linear regression analysis of the 2000-2008 FMMP farmland acreage for the Valley counties, which results in a slight decline of about 0.3 percent per year.

- **Paved Road Dust:** ARB updated the paved road dust methodology to be consistent with the current U.S. EPA AP-42 method (January 2011) to quantify dust emissions from paved roads. Revisions include reductions in silt loading values, updated vehicle miles traveled (VMT) data, and incorporation of precipitation correction factors. In addition, the revised method removed the vehicle exhaust, tire wear and brake wear PM, thereby avoiding double-counting of emissions which are already estimated in EMFAC. ARB assumes no growth for this category over the timeframe covered by the Plan.

- **Pesticides:** The Department of Pesticide Regulation (DPR) develops month-specific emission estimates for agricultural and structural pesticides. Each calendar year, DPR updates the inventory based on the Pesticides Use Report (PUR) that provides updated information from 1990 to the most current data year available. The inventory includes estimates through the 2009 calendar year. Emission forecasts for years beyond 2009 are based on the average of the most recent five years. Historical emissions estimates for the period 1990-2009 were retained exactly as provided by DPR (*i.e.*, emissions are not back casted).

- **Residential Wood Combustion:** ARB staff updated the Residential Wood Combustion methodology using U.S. EPA's National Emission Inventory emission factors and newer sales data for manufactured logs. The fireplace wood consumption rate for 2008 and previous years is based on a 1997 firewood usage survey sponsored by the District. Because of episodic wood burning curtailment requirements in District Rule 4901 that became fully effective in 2009, the fireplace wood consumption rate for 2009 and subsequent years is based on the values suggested in a report by U.S. EPA staff and others entitled "A Recommended Procedure for Compiling Emission Inventory National, Regional and County Level Activity Data for the Residential Wood Combustion Source Category." ARB assumed no growth for this category.

- **Unpaved Road Dust – Farm Roads:** ARB staff updated the methodology for Unpaved Road Dust (Farm Roads) to reflect 2007 farmland acreage estimates based on FMMP data. Growth for this category is based on a linear regression analysis of the 2000-2008 FMMP farmland acreage for the Valley counties, which results in a slight decline of about 0.3 percent per year.

- **Unpaved Road Dust – Nonfarm Roads:** ARB updated the Unpaved Nonfarm Roads methodology with a lower emission factor of 2.00 lbs PM10/ VMT based on studies sponsored by ARB and the District. The previously used emission factor of 2.27 lbs PM10/VMT was based on preliminary data from these same studies. Other revisions include updated road mile data and the addition of a rainfall correction factor. ARB assumed no growth for this category over the timeframe covered in the Plan.

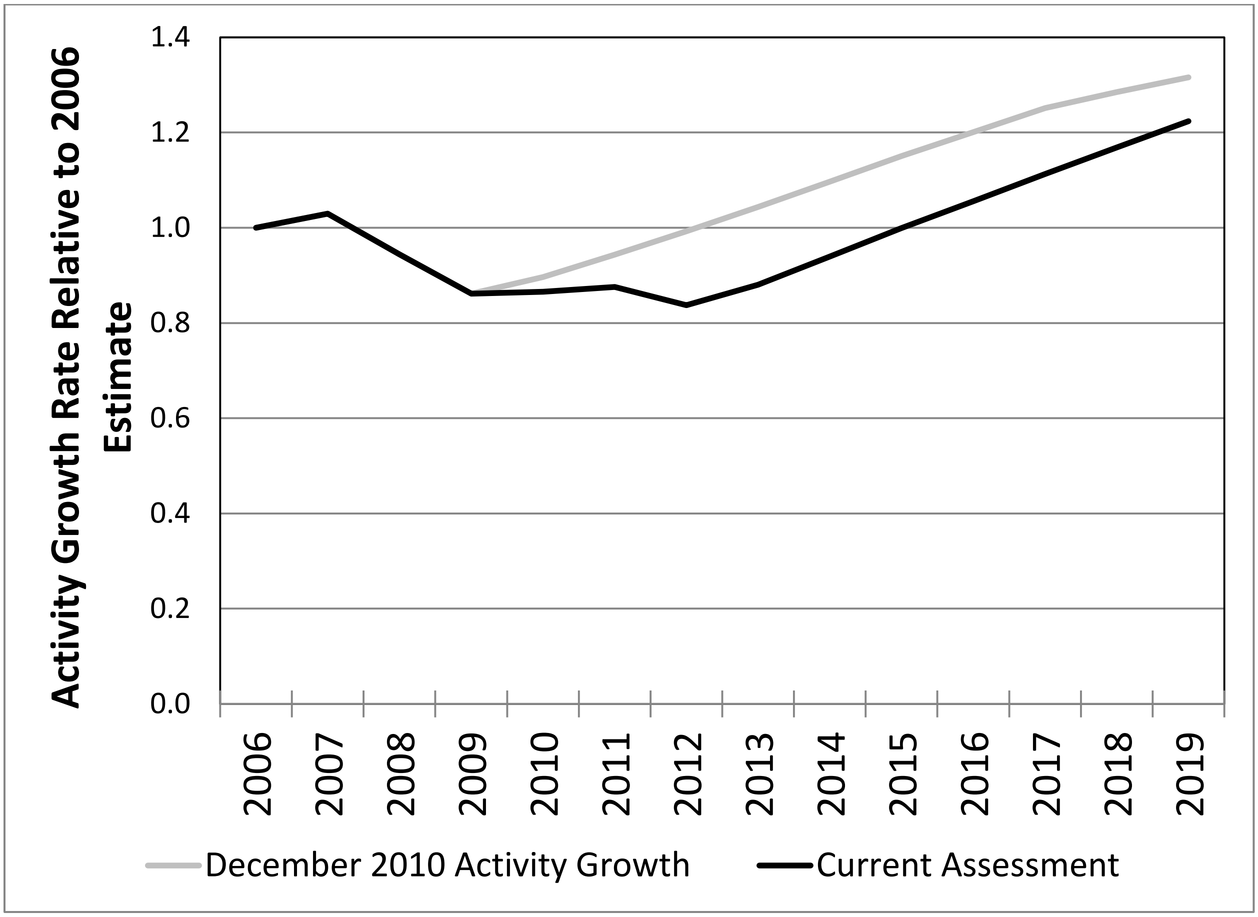
B.3.3 Mobile Sources

Mobile source emissions are estimated using computer models that are designed to estimate emissions on a category-specific basis. ARB 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. The emissions inventories for on-road heavy-duty diesel vehicles and the off-road construction sector were also adjusted to reflect revised estimates of the impact of the economic recession on emissions. These adjustments reflect the latest forecasts and statistics for population growth, fuel sales, and construction employment in the Valley, which indicate that the pace of the economic recovery continues to lag previous forecasts.

- **On-Road Mobile Sources:** EMFAC2011 was released in October 2011 and reflects current mobile source emissions inventory methods used by the ARB. The EMFAC model is comprised of several modules; EMFAC2011-HD is used to estimate emissions from heavy-duty diesel truck operations. Truck activity estimates in EMFAC2011-HD reflect the emissions inventory presented to the Board in December 2010. Since that time, new information has become available on statewide diesel fuel usage as well as updated economic forecasts. Truck activity estimates were updated using the same methods and data sources as in the December 2010 inventory.

  Figure B-1 compares the EMFAC2011 forecast to the updated forecast. Data suggest that truck emissions will be roughly 6 percent lower in 2019 in the San Joaquin Valley than previously estimated in EMFAC2011. For the PM2.5 plan, EMFAC2011 emissions estimates for heavy-duty trucks were adjusted to reflect this new information. This adjustment also resulted in a redistribution of VMT between heavy duty and light duty vehicle classes, to maintain the total county VMT in EMFAC2011.

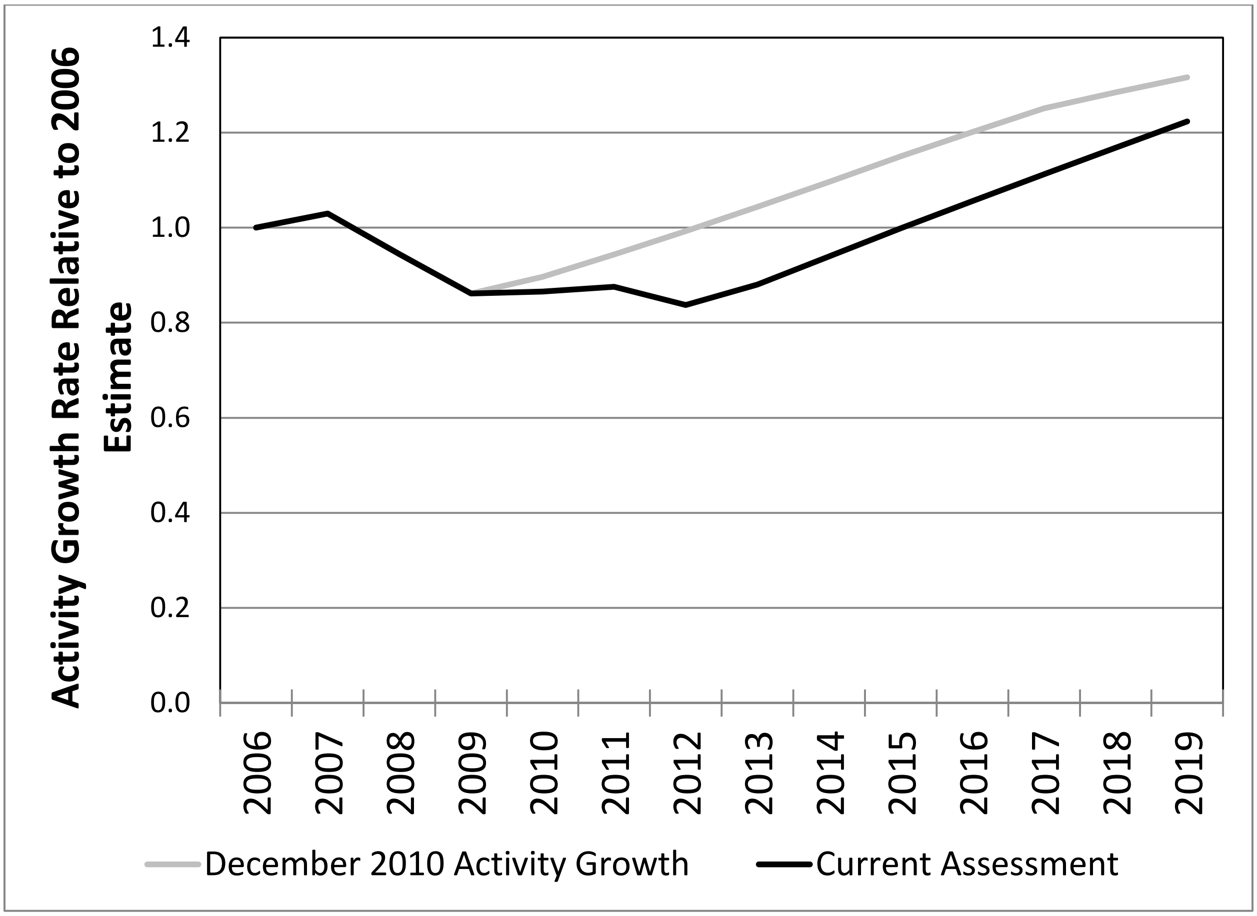
Figure B-1. Heavy Heavy-Duty Diesel Truck Emissions Forecast: EMFAC2011 vs. Current Assessment



- **Off-Road Mobile Sources:** Off-Road emissions are generated by many different types of equipment including equipment used in construction and at industrial sites; airport ground support equipment; cargo handling equipment used at California's Ports and Railyards; locomotives; pleasurecraft; recreational vehicles; commercial harborcraft and ocean-going vessels. Emissions from these equipment are estimated using a suite of models that provide inventory estimates specific to different categories of vehicles. Many of these category-specific models were developed to support recent ARB Rulemaking and are available through the ARB website. Emissions estimates for pleasurecraft and recreational vehicles were developed using new models. Category-specific models have not yet been created for remaining categories and in those cases OFFROAD2007 was used.

  The In-Use Off-Road equipment inventory was developed in 2009 and 2010, and was presented to the Board in December 2010. Since that time updated economic forecasts have become available. This new information was used to update the in-use construction equipment inventory forecast. Staff evaluated these economic forecasts to estimate the impact on construction equipment. Results indicated that in 2019 that construction employment would be roughly 10 percent lower than previously anticipated. Figure B-2 compares the December 2010 and updated growth estimate.

Figure B-2. In-Use Construction Equipment Revised Activity Growth Estimate



B.4 FUTURE POPULATION ESTIMATES

Future population estimates play a key role in emissions inventory projections. Population increases and decreases are directly linked to emissions categories such as residential fuel combustion, commercial cooking, consumer products, mobile sources, and more. There are often competing population projection models that can be used for inclusion in the emissions inventory. The following is a discussion of two such models.

The Valley's population increases make it one of the fastest growing regions in the state. Population growth estimates for the Valley and for California as a whole have been under review in 2012. The Population Research Unit of the Department of

Finance (DOF) released interim revised population growth projections in May 2012[1]. For the 2012 data, DOF used currently available 2010 census data and demographic trends showing slower growth than projected in DOF's 2007 series projections. The DOF developed these interim projections per its duties under California Government Code Sections 13073 and 13073.5 to provide sound and current population data for use in developing state, regional, and local agency policies. The DOF's final projections will be completed by January 2013.

The Valley's Metropolitan Planning Organizations (MPOs) released their revised population growth projections on March 27, 2012[2]. The MPOs use their forecasts to analyze potential development densities, run MPO traffic models, formulate Sustainable Community Strategies for SB375, and more.

Population data is factored into air quality planning in a few ways. For example, a county's population is one factor in determining the minimum number of air monitoring stations required for that county, and data from these air monitoring stations are used to determine attainment status and show the extent of a region's attainment challenges. Population also affects the emissions inventory, with emissions growth projections from categories like consumer products, architectural coatings, commercial cooking, and light duty vehicles linked to anticipated growth in population. Increasing population generally increases air pollutant emissions from these categories, offsetting some of the emissions reductions progress made by control measures and improved pollution control technologies.

The population data displayed in Table B-6 and Figure B-3 show that although newer estimates show less population growth in the Valley than was previously estimated, the population of the Valley is still growing over the 2010-2020 time period covered by this plan. Population growth is a component of the Valley's air quality challenges.

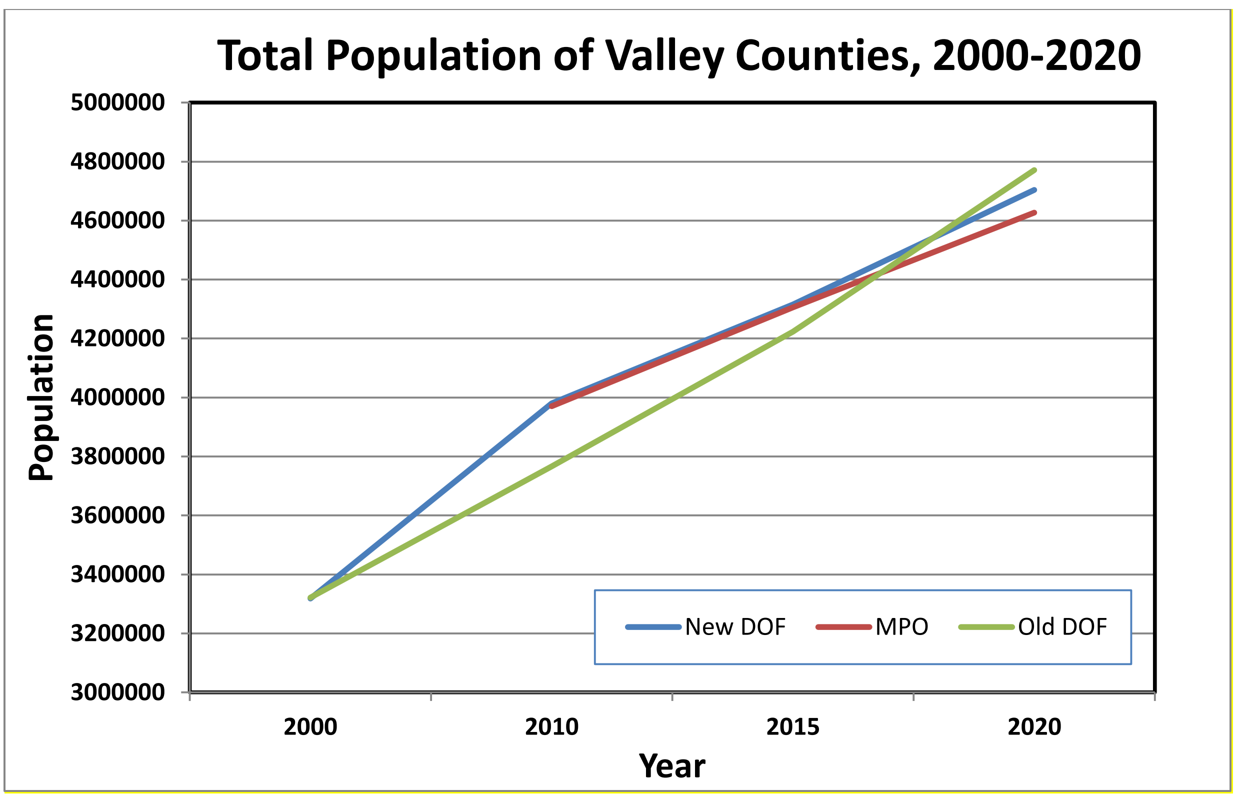
[1] DOF Interim Population Projections for California and its Counties, 2010-2050. http://www.dof.ca.gov/research/demographic/reports/projections/interim/view.php

[2] San Joaquin Valley Demographic Forecasts, 2010-2015 (March 27, 2012) http://www.valleyblueprint.org/files/San%20Joaquin%20Valley%20Demographic%20Forecasts%20-%20Final%2027%20Mar%202012_0.pdf

Table B-6 Comparison between DOF and MPO Population Projections

County	Old DOF (2007 Series)			New DOF			MPO		
	2010	2020	% change	2010	2020	% change	2010	2020	% change
Fresno	983,478	1,201,792	22%	932,926	1,083,889	16%	930,000	1,082,000	16%
Kern*	871,728	1,086,113	25%	841,609	1,041,469	24%	840,000	1,004,000	20%
Kings	164,535	205,707	25%	152,996	179,722	17%	153,000	181,000	18%
Madera	162,114	212,874	31%	151,136	183,176	21%	150,900	154,500	2%
Merced	273,935	348,690	27%	256,345	301,449	18%	256,000	303,000	18%
San Joaquin	741,417	965,094	30%	686,651	795,631	16%	685,000	807,000	18%
Stanislaus	559,708	699,144	25%	515,229	582,746	13%	514,000	594,000	16%
Tulare	466,893	599,117	28%	443,567	536,429	21%	442,000	501,000	13%
Total	4,223,808	5,318,531	26%	3,980,459	4,704,511	18%	3,970,900	4,626,500	17%
California Total	39.1 million	44.1 million	12.8%	37.3 million	40.8 million	9%	*NA*	*NA*	*NA*
% Calif. pop. in Valley	10.8%	12.1%		10.7%	11.5%		*NA*	*NA*	*NA*

Figure B-3 Temporal Comparison of Population Projections



Appendix C

Mobile Source Control Strategies

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Appendix C: Mobile Source Control Strategies

Mobile sources—on-road and off-road combined—account for over 80% of the San Joaquin Valley's total NOx emissions in the 2012 to 2019 timeframe (see Appendix B). Mobile source emissions will decrease about 40% over this time period under already-adopted regulations and associated engine, fuel, and fleet improvements. However, the Valley's total vehicle miles traveled (VMT) are predicted to increase about 18% over the 2012-2019 time period, as the Valley continues to be the fastest growing population in the state and continues to serve as one of the state's major goods movement corridors.[1] VMT growth can offset some of regulations' full emissions reductions potential. Considering all of this in conjunction with the magnitude of the Valley's attainment challenges, it is clear that mobile source emissions reductions must be a key component of the District's strategies to attain EPA's health-based air quality standards. Additionally, mobile sources contribute significant diesel particulate matter and other toxic and ultra-fine emissions, particularly in urban and environmental justice communities. As such, mobile sources will be important sources to the District's Risk-based Strategy.

However, the District does not have the authority to directly regulate the engines themselves. The state of California and the federal government—but not regional agencies like the District—can directly regulate tailpipe emissions from mobile sources. Under Clean Air Act (CAA) Section 209, states cannot generally adopt motor vehicle engine standards. The State of California is a noted exception, since California starting adopting engine standards before the federal government. The state codifies this authority in California Health and Safety Code Section 43013, then utilizes this authority through several iterations of its mobile source regulations. The California Air Resources Board (ARB) has adopted tough regulations for heavy duty trucks, off-road equipment, and other mobile sources. This appendix includes a discussion of ARB's mobile source regulations satisfying the Reasonably Available Control Measure (RACM) requirement. In addition to ARB regulations, the District has adopted innovative regulations such as Indirect Source Review and Employer-based Trip Reduction to reduce emissions from mobile sources, within the District's limited jurisdiction over these sources.

The District is also prohibited from making land use decisions, although these decisions can impact the Valley's total VMT and, thus, mobile source emissions. Land use decisions are the jurisdiction of the Valley's cities and eight counties.

Though the District cannot directly regulate engines themselves, there are a number of approaches the District can use to reduce emissions from mobile sources in the Valley:

- **Encourage California and/or federal agencies** to adopt stronger regulations for the mobile sources under their jurisdictions.
- **Adopt regulations related to usage.** This can include regulations that indirectly reduce on-road mobile emissions by encouraging reductions in VMT, or

[1] CEPAM: 2009 Almanac – Population and Vehicle Trends Tool. www.arb.ca.gov/app/emsinv/trends/ems_trends.php

regulations on how certain off-road engines are used in the Valley ("in-use" regulations).

- **Develop and implement voluntary monetary incentive programs for mobile sources.** These programs may accelerate fleet turnover to achieve reductions beyond or in advance of regulations.
- **Support technology advancement.** The District can fund projects that demonstrate the effectiveness of new engine technologies. The District can also help establish infrastructure needed for alternative fuel vehicles, thus making these vehicles a more viable option for the Valley.
- **Pursue policy initiatives.** The District can use its legislative platform to pursue additional funding and federal actions related to mobile sources. The District is also a partner in the *Vision for Clean Air: A Framework for Air Quality and Climate Planning*, an interagency policy collaboration outlining a common ARB, South Coast, and Valley vision for strategies to meet federal air quality standards for ozone and PM2.5, the State's greenhouse gas goals, and reduced public exposure to toxics (such as diesel particulates). Meeting these long-term goals will depend on introduction and deployment of transformative measures and emerging technologies, including zero-emissions goods movement. Thus, the *Vision* document will evaluate potential policies, legislation, infrastructure, and efficiencies that might provide the groundwork for ensuring that South Coast, the Valley, and California as a whole are prepared to meet the demands of long-term goals. This is to be the starting point for identifying actions that need to begin in the short-term. These actions can also contribute to the more near-term air quality needs – including the *2012 PM2.5 Plan* – as well.
- **Outreach.** The District's *Healthy Air Living* outreach program encourages Valley residents and businesses to consider air quality as part of daily decision making. Reducing vehicle trips is a core component of this program. The District also addressed mobile sources in its *Fast Track* initiative.
- **Conformity.** For "transportation conformity," the District works with county Metropolitan Planning Organizations (MPOs) to establish transportation conformity budgets. The District also works with federal agencies under "general conformity" as these agencies mitigate certain construction, indirect, and operational emissions from their projects.
- **Other interagency cooperation.** The District's *Guidelines for General Plans, Guidelines for Assessing and Mitigating Air Quality Impacts*, and related guidance are designed to help cities, counties, developers, and others consider opportunities to reduce emissions from construction equipment, indirect emissions resulting from increased VMT, and more as part of their processes.

Though this landscape can be complex, there are in fact many options at the District's disposal for addressing the Valley's mobile source emissions, even though many options available to the District are not regulatory. In this Mobile Source Control Measures appendix, the District summarizes equipment categories, existing emissions reductions efforts, and some future opportunities for further emissions reductions. These concepts might be pursued through non-regulatory efforts as opportunities become available, and are thus incorporated into Chapters 5 through 8 as appropriate.

C.1 PASSENGER CARS, LIGHT-DUTY TRUCKS, MEDIUM-DUTY VEHICLES, AND MOTORCYCLES

Category Overview

This category includes classes of vehicles used primarily for personal transportation. When the light-duty truck and medium-duty vehicle categories were first established, the majority of vehicles in the medium-duty vehicle category were primarily used for work purposes. The popularity and high sales volumes of full size pick-up trucks and SUVs have altered the light- and medium-duty truck use patterns. It is now common for trucks and SUVs to be used primarily for personal transportation.[2]

Passenger cars are vehicles designed primarily for transportation of persons and having a capacity of twelve or less. Light-duty trucks are trucks with a gross vehicle weight rating (GVWR) less than 5,750 lbs. Medium-duty vehicles have a GVWR between 5,751 lbs. and 8,500 lbs.

Existing Efforts

- **District Rule 9410: Employer Based Trip Reduction**—The goal of the eTRIP Rule (Rule 9410, Employer Based Trip Reduction) is to reduce single-occupancy vehicle work commutes. Under the eTRIP Rule, the Valley's larger employers, representing a wide range of locales and sectors, select and implement workplace measures that make it easier for their employees to choose ridesharing and alternative transportation. Because of the diversity of employers covered by the eTRIP Rule, the rule was built with a flexible, menu-based approach. In the eTRIP, or "Employer Trip Reduction Implementation Plan," employers choose from a list of measures, each contributing to a workplace where it is easier for employees to reduce their dependence on single-occupancy vehicles. Each eTRIP measure has a point value, and employer eTRIPs must reach specified point targets for each strategy over a phased-in compliance schedule (2010 – 2015). The Valley Air District has continually provided employer assistance through training, guidance materials, promotional information, and online reporting options. Upon full implementation, the eTRIP Rule will reduce NOx and VOC emissions from passenger vehicle commute trips by approximately 1.2 ton per day. eTRIP Rule information and registration is available at www.valleyair.org/tripreduction.htm.
- **District Rule 9510: Indirect Source Review**—In adopting Rule 9510 (Indirect Source Review, or ISR) in 2005, the District was the first air agency in the nation to control emissions from indirect sources. Clean Air Act Section 110(a)(5)(C) defines an indirect source as a "facility, building, structure, installation, real property, road, or highway which attracts, or may attract, mobile sources of pollution." The District prevailed in all legal challenges to the ISR rule, which reduces mobile source emissions from new development projects. ISR's on-site

[2] California Air Resources Board [ARB]. (1999). *"Lev II" And "Cap 2000" Amendments To The California Exhaust And Evaporative Emission Standards And Test Procedures For Passenger Cars, Light-Duty Trucks And Medium-Duty Vehicles, And To The Evaporative Emission Requirements For Heavy-Duty Vehicles: Final Statement Of Reasons.* Retrieved from http://www.arb.ca.gov/msprog/levprog/levii/pstfrpt.pdf

mitigation component encourages beneficial changes in land development patterns and practices. The off-site mitigation option applies assessed ISR fees to the District's cost-effective emissions reductions incentive programs. The District conducted extensive outreach on ISR and prepares and annual report on ISR implementation. The District's 2010 5-year evaluation of ISR implementation noted that in spite of economic downtown in the construction industry, ISR has achieved emission reductions and has resulted in positive changes in land development practices and processes in the San Joaquin Valley. No other air district has a rule quite like the District's ISR rule. As such, the District's rule is the most stringent and effective ISR rule.

- **Plug-In Electric Vehicle Readiness Plans**—The District received state and federal grants to prepare the Valley for the mass adoption of plug-in electric vehicles (PEV) by developing plans for PEV infrastructure deployment, as well as using related incentive programs to leverage funding. PEV Readiness Plans represent unprecedented collaborations involving other California air districts, Clean Cities Coalitions, COGs, transportation agencies, city agencies, county agencies, public and private utility companies, universities, manufacturers, developers, investors, the California Energy Commission, the Department of Energy, the California Air Resources Board, and the Environmental Protection Agency. The District will continue to actively seek funding to expand existing PEV-related incentive programs and develop additional incentive programs.
- **Drive Clean! Rebate Program**—This District program provides rebates for the purchase of eligible new, clean-air vehicles for residents and businesses of the San Joaquin Valley.
- **REMOVE II Program**—A suite of incentive programs administered by the District to encourage vanpooling, telecommuting, bicycle commuting, and alternative fuel adoption.
- **Polluting Automobile Scrap and Salvage Program**—Incentives targeted for the reduction of emissions from older high polluting vehicles through identification, repair, and replacement.
- **Smoking Vehicle Complaint Program**—This program was established to reduce visible exhaust from vehicles traveling in the valley, residents can call the District's toll-free number with a complaint about a smoking vehicle they have seen traveling the valley's roads and freeways.
- **Healthy Air Living™**—A comprehensive outreach initiative that aims to improve the health and quality of life of all Valley residents by encouraging people and businesses to make lasting changes in the way we live our lives, so that our air quality is positively affected.
- **Advanced Clean Cars Program**—A single package of standards adopted by Air Resources Board combining the control of smog, soot, global warming gases, and requirements for greater numbers of zero-emission vehicles.
- **Low Emission Vehicle II (LEV II) Standards**—Emission standards phased in through 2010 for all new vehicles sold in California, setting the base from which the Advanced Clean Cars Program will phase in newer standards.
- **Vision for Clean Air: A Framework for Air Quality and Climate Planning**—The Air Resources Board, in collaboration with the Valley Air District and the

South Coast Air District, is developing the Vision for Clean Air document to frame the long-term goals for 2050 (greenhouse gasses) and 2035 (75 ppb ozone), with the needs for mid-term 2023 (85 ppb ozone) and 2019 (PM2.5) emission reductions in both the trucking as well as the transportation sectors.

- **Smog Check Program**—Smog Check inspections are designed to identify and either repair or retire high polluting vehicles. The program is administered by the California Department of Consumer Affairs, Bureau of Automotive Repair.
- **California Reformulated Gasoline**—Regulations adopted by Air Resources Board established a comprehensive set of specifications to provide reductions of ozone and particulate matter precursor emissions and toxic air pollutants.
- **Clean Vehicle Rebate Program**—A statewide program funded by the Air Resources Board to promote the production and use of zero-emission vehicles, including electric, plug-in electric, and fuel cell vehicles.
- **Clean Air Vehicle Decals (HOV Stickers)**—Clean Air Vehicle (CAV) Decals allows vehicles to use High Occupancy Vehicle Lanes regardless of vehicle occupancy until January 1, 2015. White CAV decals are available to an unlimited number of qualifying vehicles meeting the federal inherently low–emission vehicle (ILEV) and California super ultra-low emission vehicle standard requirements and certain Advanced Technology Partial Zero-Emission Vehicles, such as certified zero emission vehicles. Green CAV decals are available to a limited number of qualifying vehicles meeting California's Enhanced Advanced Technology Partial Zero Emission Vehicle requirements.
- **Federal Vehicle Tax Credits**—Tax credits available for the purchase or lease of a qualified new plug-in electric drive motor vehicle range between $2,500 and $7,500 with factors such as battery capacity determining how much owners are eligible to receive and with credits phasing out for a manufacture's vehicles based on cumulative sales.

New Opportunities

As described above, numerous efforts exist at the state and local level to reduce emissions from this category. New opportunities to reduce emissions from passenger vehicles can be grouped into three categories: cleaner driving, reduction in vehicle miles traveled, and new technology development and adoption. In the category of cleaner driving, new opportunities include programs for congestion mitigation, such as traffic signal coordination, and public education about cleaner driving habits, also called *eco-driving*. The reduction-of-vehicle-miles-traveled category includes increases in alternative commuting, additional transit-oriented planning, and enhanced commuter rail. Potential opportunities for new technology development and adoption include clean alternative fuels and improved accessibility to electrical infrastructure. The District has added Eco-driving as a potential non-regulatory strategy in Chapter 5 of this plan. While the District is not recommending any other specific program changes targeting passenger vehicles as part of this plan, the District will continue to consider these and similar measures for reducing passenger vehicle emissions whenever opportunities arise.

Emission Inventory

Pollutant	2007	2012	2014	2015	2016	2017	2018	2019
	Annual Average - Tons per day							
PM2.5	1.94	1.88	1.90	1.93	1.97	2.00	2.04	2.08
NOx	51.15	34.51	27.85	25.44	23.31	21.30	19.68	18.29
SOx	0.38	0.41	0.43	0.44	0.44	0.44	0.45	0.45
	Winter Average - Tons per day							
PM2.5	1.94	1.88	1.90	1.93	1.97	2.00	2.05	2.09
NOx	56.06	37.85	30.55	27.91	25.56	23.37	21.64	20.17
SOx	0.37	0.40	0.41	0.42	0.43	0.43	0.43	0.43

C.2 HEAVY-DUTY TRUCKS

Category Overview

This source category includes on-road, diesel-fueled trucks with a gross vehicle weight rating (GVWR) over 14,000 pounds. Trucks in this category are primarily used for goods movement throughout the state, between ports and rail yards (drayage trucks), as well as for interstate transport. Industries using heavy-duty trucks include for-hire transportation, construction, manufacturing, retail and wholesale trade, and vehicle leasing and rental. Buses, including school buses that meet the GVWR limit, also fall under the state's Truck and Bus Regulation; however, they are not included here for purposes of programs and inventories.

Existing Efforts

- **CARB Truck and Bus Regulation**—Regulation to significantly reduce PM and NOx emissions from existing diesel vehicles operating in California. The regulation applies to privately or federally owned, diesel-fueled trucks and buses with a gross vehicle weight rating (GVWR) greater than 14,000 pounds. Reductions are implemented through a compliance schedule based on the engine model year. By 2023, all trucks and buses must have engines certified to EPA's 2010 emission limits.
- **CARB Drayage Truck Regulation**—Regulation to significantly reduce PM and NOx emissions from existing diesel vehicles that transport cargo to and from California's ports and intermodal rail yards.
- **CARB Fleet Rule for Public Agencies and Utilities**—Regulation to reduce diesel PM from vehicle fleets operated by public agencies and utilities.
- **CARB Solid Waste Collection Vehicle Rule**—This 2003 regulation applies to model year 1960 to 2006 waste-collection vehicles weighing more than 14,000 pounds that collect waste for a fee. Such vehicles are required to install ARB-verified BACT devices to reduce diesel smoke emissions.
- **CARB Heavy-Duty Diesel Engine Software Upgrade Regulation (Chip Reflash)**— Low NOx software upgrade is computer programming which reduces excess emissions of oxides of nitrogen (NOx) in 1993-1998 model year heavy-duty trucks, school buses, and motor homes with engines manufactured by Caterpillar, Cummins, Detroit Diesel Corporation, Mack/Renault, Volvo and International. The software is required to be installed during rebuilds of the engines listed above; however, ARB encourages voluntary efforts to have the software installed prior to engine rebuild.
- **CARB Diesel-Fueled Commercial Motor Vehicle Idling Regulation**—Regulation to limit the time and location of diesel engine idling.
- **CARB Transport Refrigeration Unit (Reefer) Airborne Toxic Control Measure (ATCM)**—ARB requires all transport refrigeration units (TRU) and TRU gensets that operate in California, regardless of where they are based, to meet in-use performance standards for particulate matter for model year 2001 and older units, beginning December 31, 2009.
- **CARB Heavy-Duty Diesel Emission Control Labeling Program**—Requires that all diesel engines have legible emission control labels.

- **CARB Heavy-Duty Greenhouse Gas Regulation**—Adopted in 2008, this regulation requires heavy-duty trucks to improve fuel efficiency through improvements in tractor and trailer aerodynamics and the use of low-rolling resistance tires.
- **Vision for Clean Air: A Framework for Air Quality and Climate Planning**—The Air Resources Board, in collaboration with the Valley Air District and the South Coast Air District, is developing the Vision for Clean Air document to frame the long-term goals for 2050 (greenhouse gasses) and 2035 (75 ppb ozone), with the needs for mid-term 2023 (85 ppb ozone) and 2019 (PM2.5) emission reductions in both the trucking as well as the transportation sectors.
- **District's Proposition 1B Goods Movement Emission Reduction Program**—Grant program to replace, retrofit, or repower on-road heavy-duty trucks.
- **District's On-Road Voucher Incentive Program**—Voucher program to replace or retrofit on-road medium-duty and heavy-duty trucks.
- **District's Heavy-Duty Truck Voucher Program**—Voucher program to replace or retrofit on-road heavy-duty trucks.
- **District's Short-Sea Shipping**—Incentives for moving shipping containers by barge, thus eliminating the need for heavy-duty trucks transporting containers from ports and intermodal rail yards.

New Opportunities

As described above, numerous efforts exist at the state and local level to reduce emissions from this category. The District's review of opportunities for this source category includes continuation of the Proposition 1B Goods Movement Emission Reduction Program, the District's Truck Replacement Program, and the Heavy-Duty Truck Voucher Program.

Advancing the turnover of heavy duty trucks to cleaner vehicles that operate on alternative fuels (CNG, LNG, electricity, etc.) is a critical component of reducing emissions. ARB's adopted fleet rules, together with ARB's and the District's incentive programs have greatly reduced emissions from public fleet vehicles. South Coast Air Quality Management District currently has a fleet rule that requires that solid waste collection vehicle fleets transition to operating entirely on alternative fuel beginning in 2011. This is different than ARB's Solid Waste Collection Vehicles Rule, which gives fleet operators several options to meet Best Available Control Technology requirements for fine particulate matter by the end of 2010. One of those options is the use of alternative fuel. Given the stringent particulate matter requirements under ARB's rule, there is little potential emissions benefit available from requiring a transition to alternative fuels.

Many of the District's SWCV fleets have already converted to alternative fuels. For example, the city of Fresno's fleet is nearly 100% CNG. However, currently there is not an established database of alternative fuel solid waste collection vehicles in the District. ARB staff indicated that they are working to compile data received from fleet managers and this information will be available in 2013.

Transitioning a fleet from diesel to alternative fuel can be costly and may not be economically feasible. Additionally, the emissions benefit associated with such a transition is minimal given the stringent particulate matter requirements under ARB's rule, and the relatively small difference in NOx emissions, if any, between diesel and alternative fuel vehicles. Establishing new alternative fuel infrastructure can cost millions of dollars and alternative fuel SWCVs generally cost $25,000 more than diesel. Therefore, more information is needed about the District-wide SWCV fleet to understand how adopting a more stringent fleet rule would impact the Valley's municipalities.

For these reasons, the District will continue to advance the turnover of SWCVs through the use of incentive funds rather than adopting a fleet rule. The District's Heavy-Duty Engine Program has already funded 115 natural gas fired refuse trucks, and the Public Benefits Grant Program will soon provide funds for alternative fuel infrastructure. ARB can also aid municipalities through their Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project.

While the District is not recommending any specific program changes targeting heavy-duty trucks as part of this plan, the District will continue to consider these and similar measures for reducing emissions whenever opportunities arise.

Emission Inventory

Pollutant	2007	2012	2014	2015	2016	2017	2018	2019
	Annual Average - Tons per day							
PM2.5	6.91	4.65	2.73	2.33	2.15	2.04	2.04	2.04
NOx	229.67	137.71	119.66	107.44	97.23	89.80	83.47	78.48
SOx	0.26	0.25	0.27	0.28	0.30	0.31	0.31	0.32
	Winter Average - Tons per day							
PM2.5	6.95	4.66	2.74	2.33	2.16	2.05	2.05	2.05
NOx	233.38	140.43	121.97	109.47	99.02	91.41	85.18	80.29
SOx	0.26	0.25	0.27	0.28	0.29	0.31	0.31	0.32

C.3 BUSES

Category Overview

This source category includes diesel-fueled buses, including public or privately owned school buses, with a gross vehicle weight rating (GVWR) over 14,000 pounds. The number of buses that are in this source category is relatively small (less than 4,000 in 2011, EMFAC2011) compared to the number of heavy-duty trucks also meeting the 14,000 GVWR limit and covered by the State Truck and Bus Regulation. However, as the primary means of public transportation, including transportation of the Valley's children, minimizing emissions from this category is of high importance.

Existing Efforts

- **Small School District and County Office of Education Bus Replacement Program**—The California Department of Education administers this grant program, in which small school districts and county offices of education with an average daily attendance of fewer than 2,501 students may apply for funding to purchase new school buses to replace pre-1992 school buses.
- **Lower-Emission School Bus Program**—Local air districts administered the state-funded Lower-Emission School Bus grant program. This program provided funding to public school districts and joint powers authorities (JPAs) to replace model-year 1986, and older, school buses, or to retrofit school buses with a 1987 or newer model-year engine. While the state funding for this program has been expended, the District continues to secure additional funding to support the goals of this program and needs of Valley school districts.
- **Statewide School Bus Retrofit Program**—The District administers the Statewide School Bus Retrofit program to provide funding to public school districts, joint powers authorities, and private transportation providers, which contract with public school districts, to retrofit 1987-model year and newer school buses with an ARB-verified level-3 diesel retrofit.
- **Hybrid Truck and Bus Voucher Incentive Program (HVIP)**—The ARB provides vouchers to California fleets for the purchase of hybrid and zero-emission trucks and buses. The vouchers range from $10,000 to $30,000 and are awarded on a first-come-first-served basis.
- **Measure C School Bus Replacement Program**—Fresno County administers the Measure C School Bus Replacement program, which uses a local retail-transaction-and-use tax to fund school bus replacements for Fresno County school districts.
- **Vision for Clean Air: A Framework for Air Quality and Climate Planning**—The Air Resources Board, in collaboration with the Valley Air District and the South Coast Air District, is developing the Vision for Clean Air document to frame the long-term goals for 2050 (greenhouse gasses) and 2035 (75 ppb ozone), with the needs for mid-term 2023 (85 ppb ozone) and 2019 (PM2.5) emission reductions in both the trucking as well as the transportation sectors.
- **District Rule 9310 (School Bus Fleets)**—The District approved Rule 9310 (School Bus Fleets) on September 21, 2006. The rule applies to diesel-fueled school buses with a gross vehicle weight rating of greater than 8,500 pounds.

Per the rule, all school buses manufactured prior to January 1, 1978, shall be replaced by January 1, 2016. School buses manufactured after January 1, 1978, shall either be replaced with a bus meeting emissions current emissions standards, or retrofitted or repowered with an engine manufactured on or after October 1, 2002.

- **State Truck and Bus Regulation**—The ARB approved the California Truck and Bus Regulation on December 12, 2008. This rule requires diesel-fueled school buses with a gross vehicle weight rating of greater than 14,000 pounds to meet specific particulate matter reductions. School buses manufactured prior to April 1, 1977, are to be taken out of service by January 1, 2012 and all other school buses are to have a retrofit device installed by specific compliance deadlines, with a final compliance deadline of January 1, 2014.
- **Airborne Toxic Control Measure**—The ARB approved the Airborne Toxic Control Measure to limit school bus idling and idling of all buses at or near schools. Idling is restricted within 100 feet of a school and operators are to turn off engines upon arrival and start the engine within 30 seconds of leaving. Operators are to limit idling to 5 minutes at all other locations. Exemptions apply for specific circumstances.
- **Fleet Rule for Transit Agencies**—The ARB adopted the Fleet Rule for Transit Agencies in 2000 in an effort to reduce both criteria pollutant emissions and exposure to toxic air contaminants from urban buses and transit fleet vehicles. The rule requires more stringent exhaust emission standards for new urban bus engines and transit fleet vehicles. The rule also encourages the operation and use of zero-emission buses (ZEB) in California urban bus fleets, with the goal of gradually developing a California transit fleet composed of 15% zero-emission buses.

New Opportunities

As described above, numerous efforts exist at the state and local level to reduce emissions from this category. Opportunities to reduce emissions from buses include continued funding for the replacement and retrofit of older school buses through local funding sources, additional voucher funding for hybrid and zero-emission buses that will be combined with the Hybrid Truck and Bus Voucher Incentive program, and funding for the replacement of expiring compressed natural gas (CNG) tanks in school buses. While the District is not recommending any specific program changes targeting buses as part of this plan, the District will continue to consider these and similar measures for reducing emissions whenever opportunities arise.

Emission Inventory

Pollutant	2007	2012	2014	2015	2016	2017	2018	2019
	Annual Average - Tons per day							
PM2.5	0.23	0.18	0.15	0.14	0.14	0.14	0.14	0.14
NOx	6.06	5.13	4.83	4.63	4.49	4.37	4.13	3.98
SOx	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	Winter Average - Tons per day							
PM2.5	0.23	0.18	0.15	0.14	0.14	0.14	0.14	0.14
NOx	6.20	5.25	4.95	4.74	4.59	4.48	4.23	4.08
SOx	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

C.4 AIRCRAFT AND AIRPORT GROUND SUPPORT EQUIPMENT

Category Overview

This category consists of the variety of aircraft and airport ground support equipment (GSE) utilized in their service. Aircraft can be powered by jet turbines or piston engines, and are categorized as commercial, civil, agricultural, or military. Emissions from GSE primarily come from baggage tugs, cargo tractors, or systems that provide power or air-conditioning to aircraft while on the ground.

Existing Efforts

- **Proposed Emissions standards by EPA for Aircraft Engines**—New emission standards and other regulatory requirements for aircraft turbofan and turbojet engines with rated thrusts greater than 26.7 kilonewtons.[3] These proposed emission standards will replace existing emission standards adopted in 2005.
- **CARB Off-Road Diesel Vehicle Regulation**—This regulation, as it applies to airport ground support equipment, imposes limits on idling, buying older off-road diesel vehicles, and the sale of off-road diesel vehicles. The regulation also stipulates the gradual requirement for fleet operators to progressively clean up their fleets by replacing older engines with newer engines and installing exhaust retrofits.
- **Federal Emission Standards for Nonroad Engines**—In response to environmental and public health concerns, the U.S. Environmental Protection Agency (EPA) has established emission standards for most categories of nonroad engines. These engines operate in a wide variety of applications, including airport ground support equipment.

New Opportunities

Potential emissions reduction opportunities identified thus far include electrification of ground support equipment. While the District is not recommending any specific program changes targeting aircraft and airport ground support equipment as part of this plan, the District will continue to consider this and similar measures for reducing emissions whenever opportunities arise.

[3] Control of Air Pollution From Aircraft and Aircraft Engines; Proposed Emission Standards and Test Procedures, 76 Fed. Reg. 144, pp. 45012–45052. (2011, July 27). (to be codified at 40 CFR Parts 87 and 1068)

Emission Inventory

Pollutant	2007	2012	2014	2015	2016	2017	2018	2019
	Annual Average - Tons per day							
PM2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.58
NOx	2.64	2.71	2.73	2.74	2.75	2.76	2.76	5.06
SOx	0.36	0.39	0.40	0.41	0.41	0.41	0.42	0.47
	Winter Average - Tons per day							
PM2.5	1.00	0.99	0.99	1.00	1.00	1.00	1.00	1.58
NOx	2.65	2.71	2.73	2.74	2.75	2.76	2.76	5.06
SOx	0.36	0.39	0.40	0.40	0.41	0.41	0.42	0.47

C.5 LOCOMOTIVES AND OFF-ROAD RAIL OPERATIONS

Category Overview

Locomotives can be divided into three groups: interstate line haul locomotives; medium horsepower locomotives that are mostly in California or regional service; and switch locomotives. This category also includes emissions from off-road equipment operated at rail yards. This type of equipment includes cranes, yard tractors, and material handling equipment such as forklifts.

Interstate Line Haul Locomotive are generally newer (built 1995 and later) and high horsepower (greater than 4,000 hp) locomotives that typically operate over long distances and many states. Medium Horsepower (MHP) Locomotives are typically, older locomotives that may have once served in interstate line haul service, but are now used in regional service. Switch (Yard) Locomotives are typically used to push railcars together to form trains within rail yards, but can also be used to power local and regional service trains.[4]

Existing Efforts

- **District Incentive Programs**—To date, the District has provided over $21.5 million in grant incentives to install idle limiting devices (ILD) on 16 locomotives and for the purchase of 17 clean technology switch locomotives. A new program with $2 million in funding to repower line-haul, medium horsepower or switch locomotives was opened April 2012.
- **2005 ARB statewide pollution reduction agreement with BNSF and UP**—the railroads have agreed to reduce locomotive idling time, install idle-limiting technology, repair excessively smoking locomotives, maximize use of ultra-low sulfur (15ppm) diesel fuel, conduct health risk assessments at major railyards and prepare a report on feasible mitigation plans.
- **2004 ARB Diesel Fuel Standards pertaining to intrastate locomotives**—adoption of new standards regulating the quality of diesel fuel used in intrastate locomotives, beginning 1/1/2007.
- **Measuring locomotive emissions using remote sensing**—AB 1222 implemented a pilot program to use remote sensing devices (RSD) to measure diesel emissions from in-use locomotives, in order to compare the results to applicable federal certification standards.
- **2008 U.S.EPA Locomotive Regulation**—outlined new emission standards pertaining to line haul, passenger and switch locomotives resulting in Tier 4 emission levels by 2015.
- **2009 ARB locomotive and railyard emission reduction recommendation plan**—ideas to further implement emission reductions by repowering older switch and medium horsepower (MHP) locomotives, retrofiting older switch and medium horsepower (MHP) locomotives with diesel particulate filters and selective catalytic reduction technology, and accelerating the introduction of Tier 4 line haul and switch locomotives.

[4] California Air Resources Board [ARB]. (2009). Recommendations to Implement Further Locomotive and Railyard Emission Reductions. Retrieved from http://www.arb.ca.gov/railyard/ted/drftrec090909.pdf

- **2005 ARB Mobile Cargo Handling Equipment regulation**—requires emission reductions from diesel powered mobile equipment operating in ports and intermodal railyards. Pertains to intermodal container handling equipment, yard trucks and forklifts.
- **Vision for Clean Air: A Framework for Air Quality and Climate Planning**—The Air Resources Board, in collaboration with the Valley Air District and the South Coast Air District, is developing the Vision for Clean Air document to frame the long-term goals for 2050 (greenhouse gasses) and 2035 (75 ppb ozone), with the needs for mid-term 2023 (85 ppb ozone) and 2019 (PM2.5) emission reductions in both the trucking as well as the transportation sectors.
- **Federal Emission Standards for Nonroad Engines**—In response to environmental and public health concerns, the U.S. Environmental Protection Agency (EPA) has established emission standards for most categories of nonroad engines. These engines operate in a wide variety of applications, including locomotives and cargo handling equipment.

New Opportunities

As described above, numerous efforts exist at the state and local level to reduce emissions from this category. Potential emissions reduction opportunities identified include providing grant funding toward the purchase of idle-limiting devices, diesel particulate filters (DPF) and selective catalytic reduction (SCR) technology (retrofit technology), and certified engine remanufacture or repower for both locomotives and head end power (HEP) units, as well as the purchase of new alternative technology locomotives. There are also opportunities to replace, repower, retrofit, and electrify cargo handling equipment such as cranes, yard trucks and forklifts operating in rail switch yards and intermodal facilities. These potential incentive-based opportunities are currently eligible under existing District incentive programs. While the District is not recommending any specific program changes targeting locomotives as part of this plan, the District will continue to consider these and similar measures for reducing emissions whenever opportunities arise.

Emission Inventory

Pollutant	**2007**	**2012**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
	Annual Average - Tons per day							
PM2.5	0.57	0.40	0.40	0.40	0.39	0.38	0.37	0.36
NOx	21.68	16.41	16.97	17.10	17.04	16.93	16.69	16.48
SOx	0.06	0.01	0.01	0.01	0.01	0.01	0.02	0.02
	Winter Average - Tons per day							
PM2.5	0.57	0.40	0.40	0.40	0.39	0.38	0.37	0.36
NOx	21.68	16.41	16.97	17.10	17.04	16.93	16.69	16.48
SOx	0.06	0.01	0.01	0.01	0.01	0.01	0.02	0.02

C.6 SHIPS, COMMERCIAL BOATS, AND OFF-ROAD PORT OPERATIONS

Category Overview

This category includes oceangoing chips, harbor craft such as tugboats, and the off-road equipment associated with port operations. The primary source of these emissions in the San Joaquin Valley is at the Port of Stockton, a bulk and break bulk cargo port with berthing space for 17 vessels, 1.1 million square feet of dockside transit sheds and shipside rail trackage, 7.7 million square feet of warehousing for both dry bulk and general cargoes, including steel. Each warehouse is also served by rail. The port operates three traveling, multi-purpose, 30-ton Bridge Cranes; a fleet of 30,000 to 60,000 lb. fork lift trucks; slings; spreader bars; coil rams; front-end loaders; hoppers and conveyor belts and other equipment are maintained for handling and storing steel products, other general cargoes and bulk materials.[5]

Existing Efforts

- **District Incentive Programs**—The District is currently working with the Port of Stockton to provide grant funding to repower and retrofit six diesel powered forklifts and retrofit one diesel powered wheel loader.
- **Commercial Harbor Craft Regulation**—Adopted by the California air Resources Board (ARB) in 2007 the regulation establishes in-use emission limits for both auxiliary and propulsion diesel engines on ferries, excursion vessels, tugboats, and towboats consistent with the United States Environmental Protection Agency (U.S. EPA) marine engine emission standards.
- **Ocean-Going Vessels Fuel Rule**—Adopted by ARB in 2008 this regulation is designed reduce particulate matter, oxides of nitrogen, and sulfur oxide emissions from ocean-going vessels by requiring the use of cleaner marine distillate fuels in any of the regulated California waters.
- **Equipment Electrification**—The Port of Stockton replaced four older gasoline powered trucks with electric vehicles, and utilizes an electric rather than diesel-powered dredge.
- **Federal Emission Standards for Nonroad Engines—**In response to environmental and public health concerns, the U.S. Environmental Protection Agency (EPA) has established emission standards for most categories of nonroad engines. These engines operate in a wide variety of applications, including marine and cargo handling equipment.

New Opportunities

Potential emissions reduction opportunities identified thus far include further electrification and additional grants funding for port related off-road equipment. While the District is not recommending any specific program changes targeting ships, commercial boats, and off-road port operations as part of this plan, the District will continue to consider these and similar measures for reducing emissions whenever opportunities arise.

[5] Port of Stockton. (2012) Retrieved April 11, 2012, http://www.portofstockton.com/

Emission Inventory

Pollutant	2007	2012	2014	2015	2016	2017	2018	2019
	Annual Average - Tons per day							
PM2.5	0.06	0.03	0.03	0.02	0.02	0.02	0.02	0.02
NOx	1.02	0.84	0.83	0.76	0.78	0.74	0.72	0.71
SOx	0.47	0.06	0.05	0.05	0.06	0.06	0.06	0.07
	Winter Average - Tons per day							
PM2.5	0.06	0.03	0.03	0.02	0.02	0.02	0.02	0.02
NOx	1.02	0.84	0.83	0.76	0.78	0.74	0.72	0.71
SOx	0.47	0.06	0.05	0.05	0.06	0.06	0.06	0.07

C.7 RECREATIONAL: BOATS, MOTOR HOMES, AND OFF-HIGHWAY VEHICLES

Category Overview

This category includes vehicles intended for consumer recreational activities. Major subcategories include boats and spark-ignition auxiliary marine engines (power generators, winches, or auxiliary propulsion engines for sail boats); Motor homes and associated auxiliary engines; and off-road motorcycles (dirt bikes) and all-terrain vehicles (ATVs); engines used in specialty vehicles and go-karts; Sand Cars (i.e., dune buggies, sand rails, etc.); and golf carts.

Existing Efforts

- **California Air Resources Board (ARB) Engine Regulations**—Engines for this category are regulated by ARB's Small Off Road Engine, Tier 4 Off-Road Compression Engine, Off-Road Spark-Ignition Engines, Equipment, and Vehicles regulations.
- **"Red Sticker" Registration**—2003 and newer off-highway vehicles with Engines that do not meet California engine standards may be registered as a special class with limits placed on their use during the summer months.
- **On-road Engine Regulations**—Motor homes must meet ARB on-road engine standards for their size class as medium- or heavy-duty vehicles.
- **Golf Cart Zero Emission Requirement**—Since January 1, 1997, new golf carts purchased for operation within federal ozone non-attainment areas must be zero-emission golf carts (e.g., electric).

New Opportunities

While the District is not recommending any specific program changes targeting recreational vehicles as part of this plan, the District will continue to consider measures for reducing emissions whenever opportunities arise.

Emission Inventory

Pollutant	2007	2012	2014	2015	2016	2017	2018	2019
	Annual Average - Tons per day							
PM2.5	0.55	0.45	0.41	0.40	0.39	0.37	0.36	0.35
NOx	2.88	2.51	2.43	2.40	2.37	2.35	2.33	2.31
SOx	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Winter Average - Tons per day							
PM2.5	0.24	0.20	0.18	0.18	0.17	0.17	0.16	0.16
NOx	1.66	1.44	1.35	1.33	1.30	1.28	1.26	1.24
SOx	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

C.8 OTHER OFF-ROAD VEHICLES AND EQUIPMENT

Category Overview

This category includes all self-propelled off-road diesel vehicles over 25 horsepower and all two-engine vehicles, except two-engine sweepers. Examples of such vehicles are single-engine oil drilling and workover rigs; backhoes, excavators, loaders, forklifts, and other construction and mining equipment; and two-engine cranes or water-well drilling rigs. Diesel agricultural vehicles, locomotives, marine vehicles, and recreational vehicles are not included in this category.

Existing Efforts

- **In-Use Off-Road Diesel Vehicle Regulation**—CARB adopted the In-Use Off-Road Diesel Vehicle Regulation on July 26, 2007 to reduce diesel PM and NOx emissions from existing off-road heavy-duty diesel vehicles. This regulation imposes limits on idling, the buying of older off-road diesel vehicles, and the sale of off-road diesel vehicles. The regulation also stipulates the gradual requirement for fleet operators to progressively clean up their fleets by replacing older engines with newer engines and installing exhaust retrofits.
- **Heavy-Duty Engine Program**—The District's Heavy-Duty Engine program provides incentive funds for new reduced-emission technology for non-agricultural forklifts and other off-road vehicles such as non-agricultural tractors, backhoes, and excavators.
- **Federal Emission Standards for Nonroad Engines**—In response to environmental and public health concerns, the U.S. Environmental Protection Agency (EPA) has established emission standards for most categories of nonroad engines. These engines operate in a wide variety of applications, including construction and mining equipment.

New Opportunities

As described above, numerous efforts exist at the state and local level to reduce emissions from this category. Opportunities to reduce emissions from off-road vehicles and off-road equipment include incentives for zero-emission forklifts; incentives electric-hybrid construction equipment, such as loaders; and incentives for re-powering specialized equipment, such as road-paving equipment. These potential incentive-based opportunities are currently eligible under existing District incentive programs. While the District is not recommending any specific program changes targeting off-road vehicles and off-road equipment as part of this plan, the District will continue to consider these and similar measures for reducing emissions whenever opportunities arise.

Emission Inventory

Pollutant	2007	2012	2014	2015	2016	2017	2018	2019
	Annual Average - Tons per day							
PM2.5	2.18	1.49	1.31	1.25	1.18	1.13	1.03	0.96
NOx	44.14	31.63	30.07	29.57	28.58	27.80	26.13	25.09
SOx	0.03	0.02	0.02	0.02	0.03	0.03	0.03	0.03
	Winter Average - Tons per day							
PM2.5	2.17	1.47	1.29	1.23	1.17	1.12	1.02	0.95
NOx	44.17	31.62	30.06	29.57	28.58	27.80	26.14	25.10
SOx	0.03	0.02	0.02	0.02	0.03	0.03	0.03	0.03

C.9 FARM EQUIPMENT

Category Overview

The Farm Equipment category includes wheel tractors, agricultural mowers, agricultural tractors, balers, combines, hydro-power units, sprayers, swathers, tillers, and other agricultural equipment. It includes equipment fueled by gas and diesel. It is also bifurcated by exhaust and evaporative emissions for each applicable piece of equipment.

There is some overlap of farm equipment with equipment used for construction. The California Air Resources Board (ARB) allows farm equipment to be used for construction up to 50% of its usage; if used for 51% or more then it must be registered with ARB's Diesel Off-Road On-Line Reporting System (DOORS). Farm equipment can be used for crop demolition; therefore as long as the equipment is considered to be used in an agricultural setting it is considered Farm Equipment. Many farmers use their equipment for more than one specific type of crop or service in their business; the NRCS does not assist custom farmers within their program because they require the replaced vehicle to be tied to a piece of property.

The largest contributor to the farm equipment category is tractors. The District's current tractor program focuses on diesel tractors and does not include gasoline equipment. The new tractor equipment can be up to 125% of the existing tractor's horsepower to be considered for funding in our program. The District also currently accepting diesel ag forklifts in the tractor program to be replaced. While tractors may be the largest contributor from this category, every option needs to be evaluated for additional potential opportunities.

Existing Efforts

- **District Tractor Replacement Program**—Provides incentive funds for replacement of older, high-emitting tractors with newer, cleaner tractors.
- **Environmental Quality Incentives Program (EQIP)**—administered by the USDA Natural Resources Conservation Service, EQIP is a voluntary program authorized through the Farm Bill that offers technical and financial assistance to agricultural producers. Contracts with eligible farmers and ranchers provide incentive payments to implement conservation practices that address natural resource concerns with improving soil, water, air, plant, animal, and energy resources. Under the Air Quality Initiative, EQIP payments have improved air quality resources within the Valley by repowering and replacing old, higher-polluting stationary irrigation pump engines and mobile off-road agricultural engines with newer, cleaner engines or electric technology; chipping agricultural orchard debris instead of open burning; promoting Conservation Tillage by reducing tillage and vehicle passes to limit PM emissions and fuel consumption; treating unpaved agricultural road surfaces to limit fugitive dust emissions; promoting Integrated Pest Management practices and precision spray application to limit VOC emissions and pesticide usage; installing windbreaks and shelter breaks around Confined Animal Facility Headquarters to help capture fugitive

dust; injecting manure into the soil to help control dairy odors and limit VOC emissions; and properly disposing chemically-treated wooden grape stakes to prevent accidental burning or leaching of toxic substances.

- **Heavy Duty Engine Program—Off-Road Vehicle Repower and Ag Pump Repower**
    - **Off-Road Vehicle Repower**—This component provides incentives for engine replacement (repower) or retrofit of off-road self-propelled vehicles such as tractors, backhoes, and excavators.
    - **Ag Pump Repower**—This component provides incentives for engine replacement (repower) or new electric motor purchase of engines and/or electric motors used to power agricultural irrigation pumps.
- **Agricultural Electric Utility Terrain Vehicle (UTV)** —Provided rebate for electric UTVs used for farming purposes.
- **SJVAPCD Rule 4702 (Internal Combustion Engines)** —Limits the emissions of nitrogen oxides (NO_X), carbon monoxide (CO), volatile organic compounds (VOC), and sulfur oxides (SO_X) from internal combustion engines.
- **SJVAPCD Rule 4550 (Conservation Management Practices)** —Limits particulate emissions from agricultural operation sites using work practices.
- **Federal Emission Standards for Nonroad Engines**—In response to environmental and public health concerns, the U.S. Environmental Protection Agency (EPA) has established emission standards for most categories of nonroad engines. These engines operate in a wide variety of applications, including ag pumps and tractors.
- **In-Use Off-Road Mobile Agricultural Equipment Regulation –** ARB is currently in the process of developing and ultimately adopting a regulation to reduce emissions from in-use agricultural off-road equipment. While the emission reductions that will be achieved from this new regulation have not been quantified or accounted for in this plan, any reductions achieved through this rule will further contribute to attainment of the standard.

New Opportunities

As described above, numerous efforts exist at the state, federal, and local level to reduce emissions from this category. The District's analysis of additional potential opportunities to reduce emissions from this category has yielded the following recommendations:

- Ag Electric UTV—Reinstate with a greater amount of funding for replacements.
- Ag pump electric motors—Fund utility company line extensions for farmers who otherwise would not switch from diesel to electric due to high electrification costs.
- Replacement of gasoline fueled tractors

While the District is not recommending any specific program changes targeting farm equipment as part of this plan, the District will continue to consider these and similar measures for reducing emissions whenever opportunities arise.

Emission Inventory

Pollutant	2007	2012	2014	2015	2016	2017	2018	2019
	Annual Average - Tons per day							
PM2.5	2.65	2.00	1.65	1.51	1.37	1.25	1.12	0.99
NOx	48.13	36.63	31.52	29.16	26.89	24.92	22.89	20.95
SOx	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
	Winter Average - Tons per day							
PM2.5	2.07	1.56	1.29	1.18	1.07	0.97	0.87	0.77
NOx	37.66	28.66	24.67	22.82	21.04	19.50	17.91	16.40
SOx	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03

C.10 ARB MOBILE-SOURCE RACM

Given the significant emission reductions needed for attainment in California, ARB has adopted some of the most stringent control measures nationwide for on-road and off-road mobile sources and the fuels that power them. These measures target both new and in-use equipment. And while California first focused on cleaning up cars – new car emissions have been reduced by 99 percent – the scope of California's program is vast. The State has implemented regulations and programs to reduce emissions from freight transport equipment, including heavy-duty trucks, ocean going vessels, locomotives, harbor craft, and cargo handling equipment. In addition, the State has standards for lawn and garden equipment, recreational vehicles and boats, and other newly manufactured off-road equipment. California has also adopted many measures that focus on achieving reductions from in-use mobile sources that include accelerated replacement of older equipment with newer, less polluting equipment; more stringent inspection and maintenance requirements; and operational requirements such as truck and bus idling restrictions and speed reduction requirements for ocean going vessels.

California has unique authority under Clean Air Act section 209 to adopt and implement new emission standards for many categories of on-road vehicles and engines, and new and in-use off-road vehicles and engines. Use of this authority is subject to U.S. EPA waiving the applicable federal standard upon their finding that the standards adopted by California are, in the aggregate, at least as stringent as the comparable federal standard.

To support the attainment plans submitted to U.S. EPA in 2007 for 8-hour ozone and PM2.5, ARB undertook an extensive public consultation process to identify potential State Implementation Plan (SIP) measures. New measures developed by ARB as part of this 2007 State Strategy focused on cleaning up the in-use fleet, and increasing the stringency of emissions standards for a number of engine categories, fuels, and consumer products. These measures build on ARB's already comprehensive program that addresses emissions from all types of mobile sources.

In 2011, U.S. EPA approved the State mobile source control program as being RACM in the context of the 2007 and 2008 South Coast and San Joaquin Valley PM2.5 plans (76 FR 69896 at 69906). In its proposed approval of the 2008 San Joaquin Valley PM2.5 Plan, U.S. EPA recognized that the "State of California has been a leader in the development of some of the most stringent control measures nationwide for on-road and off-road mobile sources and the fuels that power them" (76 FR 41338 at 41345). In the 2007 State Strategy, ARB identified and committed to propose new defined measures for the sources under its jurisdiction. Of these new measures, U.S. EPA noted that "many, if not most, of these measures are being proposed for adoption for the first time anywhere in the nation" (76 FR 41562 at 41570).

California's comprehensive mobile source program continues to be RACM as it expands and further reduces emissions. The 2012 PM2.5 SIPs rely on additional regulations adopted since the State's last major SIP revision in 2007. In January 2012, ARB adopted the Advanced Clean Cars program, which combines the control of smog-causing pollutants and greenhouse gas emissions into a single coordinated package of requirements for model years 2017 through 2025. The program was developed in tandem with the federal government over several years, including a joint fact-finding process with shared engineering and technical studies. Benefits from this new program are reflected in emission inventories used in the 2012 PM2.5 attainment plans.

C.11 TRANSPORTATION CONFORMITY

Transportation conformity requirements are intended to ensure that transportation activities do not interfere with air quality progress. CAA Section 176 requires that transportation plans, programs, and projects conform to applicable air quality plans before being approved by a MPO. Conformity to an implementation plan means that proposed activities must not:

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

Motor vehicle emissions budgets are the mechanism for assuring that transportation planning activities conform with the SIP. A SIP analyzes the region's total emissions inventory from all sources for purposes of demonstrating Reasonable Further Progress (RFP) milestones, attainment, and/or maintenance. The portion of the total emissions inventory allocated to highway and transit vehicles in these analyses becomes the "motor vehicle emissions budget." [6] Budgets are set for each criteria pollutant or its precursors, and it is set for each RFP milestone or attainment year. Subsequent transportation plans and programs produced by local transportation planning processes are required to conform to the budget levels in the respective SIP.

C.11.1 PM2.5 Requirements

EPA issued a memorandum on March 2, 2012 regarding the "Implementation Guidance for the 2006 24-Hour Fine Particle (PM2.5) National Ambient Air Quality Standards (NAAQS). The memo indicates that transportation conformity is not discussed in detail and refers to previous regulations and guidance documents. In addition, the memo indicates that the "2007 PM2.5 Implementation rule continues to provide appropriate guidance for SIP development. The *Final Rule* implementing the 1997 PM2.5 NAAQS (72 *FR* 20586) addresses the types of motor vehicle emissions that must be addressed when setting transportation conformity budgets. In the *Final Rule*, EPA notes that "RFP

[6] 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.

plans, attainment demonstrations, and maintenance plans must include a budget for direct PM2.5 emissions, except for certain cases as described below. All PM2.5 SIP budgets would include directly emitted PM2.5 motor vehicle emissions from tailpipe, brake wear, and tire wear. States should also consider whether re-entrained road dust or highway and transit construction dust are significant contributors and should be included in the PM2.5 budget." (72 FR 20645). The rule goes on to state that 'Under certain circumstances, directly emitted PM2.5 from on-road mobile sources may be found an insignificant contributor to the air quality problem and NAAQS.'

The conformity rule applies for particles with aerodynamic diameter less than or equal to a nominal 2.5 micrometers (PM2.5). The precursor NOx must also be addressed unless there is a finding of insignificance.

Section 93.102(b)(2)(iv and v) of 40 CFR Part 51, subpart T identifies Volatile Organic Compounds (VOC), sulfur oxides (SOx) and/or ammonia as PM2.5 precursor pollutants that must also have a motor vehicle emissions budget if deemed significant. In addition, Section 93.102(b)(3) identifies reentrained road dust from paved and unpaved roads as PM2.5 emissions that must also have a motor vehicle emissions budget if deemed significant. While the applicability section of the rule does not address fugitive dust from road construction specifically, the rule does indicate that the consultation process should be used during the development of PM2.5 SIPs when construction emissions are a significant contributor, so that these emissions are included in the SIP's motor vehicle emissions budget for conformity purposes.

The rule also indicates that, as a practical matter, conformity for ammonia would not be required in California until there is an acceptable method for estimating such emissions, because a method would be needed to estimate current or future ammonia emissions for either a significance finding or SIP motor vehicle emissions budget. It is important to note that EMFAC 2011 does not estimate on-road mobile ammonia emissions. In addition, this plan indicates ammonia is abundant throughout the Valley and does not act as a limiting precursor, which means reducing ammonia is ineffective in reducing PM2.5 in the Valley. Consequently, ammonia emissions are NOT included in the motor vehicle emissions budgets for conformity purposes.

The conformity rule indicates that the following criteria will be considered in making significance or insignificance findings for PM2.5 precursors: the contribution of on-road emissions of the precursor to the total 2007 baseline SIP inventory; the current state of air quality for the area; the results of speciation monitoring for the area; the likelihood that future motor vehicle control measures will be implemented for a given precursor; and projections of future on-road emissions of the precursor.

In addition, significance findings for re-entrained road dust emissions will be based on a review of the following factors: the contribution of road dust to current and future PM2.5 nonattainment; an area's current design value for the PM2.5 standard; whether control of road dust appears necessary to reach attainment; and whether increases in re-entrained dust emissions may interfere with attainment. Such a review would include consideration of local air quality data and/or air quality or emissions modeling results.

C.11.2 Assessment of Significance

Six out of eight Valley counties are projected to attain the 24-hr PM2.5 standard by 2019 with adopted controls. The other two counties make significant progress towards attainment with these adopted, largely-NOx-focused controls, and additional reductions in directly emitted PM2.5 results in attainment of the 24-hour standard no later than 2019 in the other counties. Motor vehicle emissions budgets for NOx and directly-emitted PM2.5 emissions associated with on-road motor vehicle exhaust ARE being established.

VOC: On-road mobile emissions account for approximately 10% of the Valley's total VOC emissions in the budget years. The air quality modeling for this plan indicates that VOC is not a significant precursor to secondary PM2.5 formation in the Valley. Accordingly, motor vehicle emissions budgets for VOC are NOT being established.

SOx: Onroad mobile exhaust estimates are less than 1 ton per day Valley-wide in the budget years which equates to less than 10 percent of the total SOx emissions inventory. SOx controls are focused on industrial sources, which contribute almost 80 percent of the total inventory. As a result, onroad SOx emissions are NOT included in the motor vehicle emissions budgets for conformity purposes.

Paved Road Dust: For this *2012 PM2.5 Plan*, the paved road dust direct PM2.5 emission inventory is less than 10% of the Valley's total direct PM2.5 emissions in the budget years. As noted in Chapter 4 and Appendix A, all geologic and construction source categories combined represent no more than 6% of the peak PM2.5 concentrations measured in the Valley. While there are no "additional" fugitive dust controls included in the attainment demonstration for this plan, it is important to note that paved road dust is controlled via the PM10 Plan and is evaluated as continually as part of the PM10 conformity determinations. As a result, paved road dust emissions are NOT included in the motor vehicle emissions budgets for conformity purposes.

Unpaved Road Dust: Total unpaved road dust is less than 10% of the Valley's total direct PM2.5 emissions inventory in the budget years. Local roads are a sub-part (1 of 7) of this category and are therefore considered insignificant. While there are no "additional" fugitive dust controls included in the plan, it is important to note that unpaved road dust is controlled via the PM10 Plan, including the prohibition of any new local unpaved roads, and is evaluated as continually as part of the PM10 conformity determinations. As a result, unpaved road dust emissions are NOT included in the motor vehicle emissions budgets for conformity purposes.

Construction Dust: Total construction and demolition dust is less than 5% of the Valley's total direct PM2.5 emissions inventory in the budget years. Road construction is a sub-part (1 of 5) is therefore considered insignificant. While there are no "additional" fugitive dust controls included in the plan, it is important to note that road construction dust is controlled extensively via the PM10 Plan and is evaluated as continually as part of the PM10 conformity determinations. As a result, road construction emissions are NOT included in the motor vehicle emissions budgets for conformity purposes.

C.11.3 Conformity Budgets

This plan includes reasonable further progress demonstrations for 2014 and 2017, and attainment of the PM2.5 standard is projected by 2019. Winter annual day emissions are used in the plan, since the Valley's exceedance days relative to the 24-hour standard occur in the winter months. Consequently, conformity budgets have been set with EMFAC 2011 for winter averages in the analysis years 2014, 2017, and 2019.

Section 93.124(e) of the federal conformity rule indicates that nonattainment areas with more than one MPO may establish motor vehicle emission budgets for each MPO in the implementation plan. As a result, County-level emission budgets are provided in this plan.

In developing the attainment demonstration for the San Joaquin Valley 24-hour PM2.5 State Implementation Plan, it was critical to reflect the impacts of the economic recession on emissions. The air quality modeling for the attainment demonstration used motor vehicle emissions generated from ARB's emission factor model, EMFAC2011. An updated analysis of the rate of recovery from the economic recession was also incorporated for the trucking sector. The transportation conformity budgets being developed for this plan include more recent travel activity projections provided by the San Joaquin Valley MPOs for their 2013 Federal Transportation Improvement Plans (FTIPs). The emissions impact of this more recent activity data is reflected in the attainment demonstration.

Diesel Truck Activity: Truck activity estimates in EMFAC2011 reflect the emissions inventory presented to the ARB Board in December 2010. Since that time new information has become available on statewide diesel fuel usage as well as updated economic forecasts. The SJV truck activity estimates were updated using the same methods and data sources as in the December 2010 inventory. For example, data suggest that truck emissions will be roughly 6% lower in 2019 in the San Joaquin Valley than previously estimated in EMFAC2011. For this assessment, EMFAC2011 emissions estimates for heavy-duty trucks were adjusted to reflect this new information. This adjustment also resulted in a redistribution of VMT between heavy duty and light duty vehicle classes, to maintain the total county VMT in EMFAC2011.

In addition to changes to truck activity, staff also adjusted for decreased vehicle sales rates that are anticipated to occur given a slower truck VMT forecast. This adjustment is necessary because truck owners tend to hold on to their trucks longer during recessions and this will increase the fleet average emission rates even though total activity is decreasing. This affect is strongest in the trough of the recession and diminishes quickly as the economic recovery takes hold. The combined impact of reductions in activity and increases in emission rates are shown in Table C-1 below.

Table C-1 Proposed Adjustment Factors for Annual Emissions

Year	Adjustment Factor
2009	1.000
2010	1.000
2011	0.980
2012	0.940
2013	0.939
2014	0.926
2015	0.920
2016	0.912
2017	0.921
2018	0.922
2019	0.940
2020	0.952
2021	0.953
2022	0.954
2023	0.955
2024 -2035	0.956

For all portions of the eight San Joaquin Valley counties that fall within the San Joaquin Valley Air Basin, heavy duty VMT (which includes the medium heavy duty diesel, heavy heavy duty diesel, school bus, and other bus vehicle classes) was reduced by using the factors from Table C-1 above. To maintain the same total VMT, the reduction in VMT from the heavy duty vehicle classes was distributed proportionately among the remaining vehicle classes. EMFAC2011 was re-run using the revised VMT by vehicle class distribution to produce the recession-adjusted emissions.

Line Item Adjustments: District and ARB control measures which reduce on-road mobile source emissions but are not included in EMFAC 2011 are included in the Plan and have been included in the conformity emission budgets. The committed control measures are consistent with the 2008 PM2.5 Plan (as revised in 2011) as approved by EPA on November 9, 2011 (effective January 9, 2012). However, the emission reductions have been modified by ARB staff to be consistent with the use of EMFAC 2011. Two additional measures have been included: 1) Prop 1B Goods Movement Emission Reduction Program (GMRP) and 2) Advanced Clean Cars (ACC).

Table C-2 District and ARB Control Measures Reducing On-road Mobile Source Emissions

Measure Description	Pollutants
Rule 9410(ETR)	Winter PM2.5 Winter NOx
Carl Moyer Program	Winter PM2.5 Winter NOx
AB 1493 GHG Standards	Winter PM2.5
Smog Check	Winter NOx
Prop 1B (GMRP)	Winter PM2.5 Winter NOx
Advanced Clean Cars (ACC)	Winter PM2.5 Winter NOx

While Valley-wide emission reductions are presented throughout the Plan, by-County emission reduction estimates have been estimated for inclusion in the conformity emission budgets. In general, by-County emission estimates were calculated by combining the emission reduction factors with the EMFAC 2011 on-road motor vehicle emissions estimate by-County. Table C-3 and C-4 illustrate these emission reductions. Detailed documentation supporting the conformity emission budget development is contained as an attachment to this appendix. The following provides a sample budget calculation.

Table C-3 Example County Emission Budget Calculation (tons per winter season day)

	PM2.5	**NOx**
Emissions Baseline		
Baseline EMFAC 2011	1.03	31.74
Rule 9410 (ETR)	0.01	0.11
Carl Moyer Program	0.01	0.03
AB 1493 GHG Standards	0.00	0.00
Smog Check	0.00	0.16
Prop 1B (GMRP)	0.03	0.84
Advanced Clean Cars (ACC)	0.00	0.00
*Conformity Emissions Budgets**	1.0	30.7

* Rounded up to the nearest tenth.

The budgets have been constructed to more closely align with the emissions identified in the on-road inventory, as follows:

1) Sum the county-by-county emissions results to get a Valleywide total
2) Round the Valleywide totals up to:
   a. NOx- the nearest whole ton
   b. PM2.5 – the nearest tenth of a ton
3) Disaggregate the rounded values proportional to each county’s emissions

4) Calculate the budget by rounding each county's values to the nearest tenth ton (for both NOx and PM2.5). (i.e. use conventional rounding)

This plan update establishes subarea county emission budgets for PM2.5 and NOx for the horizon years 2014, 2017, and 2019. The conformity attachment to this appendix provides more detailed calculations.

Table C-4 Transportation Conformity Budgets
(tons per average annual day)

County	2014		2017		2019	
	PM2.5	NOx	PM2.5	NOx	PM2.5	NOx
Fresno	1.0	30.7	0.9	24.9	0.9	21.3
Kern (SJV)	1.1	41.5	1.0	34.1	1.0	29.0
Kings	0.2	8.5	0.2	7.1	0.2	5.9
Madera	0.2	8.5	0.2	6.9	0.2	6.1
Merced	0.5	16.7	0.4	13.6	0.4	11.7
San Joaquin	0.6	19.4	0.6	15.7	0.6	13.5
Stanislaus	0.5	14.7	0.4	11.9	0.4	10.2
Tulare	0.4	13.9	0.4	10.6	0.4	9.3

Section 93.124 of the federal conformity rule, in particular 93.124(b), allows for the SIP to establish trading mechanisms between budgets for pollutants or precursors, or among budgets allocated to mobile and other sources. The 2008 PM2.5 Plan (as revised in 2011) included a trading mechanism, which was approved by EPA effective January 9, 2012, to be used for analysis years after 2014. This SIP allows trading from the motor vehicle emissions budget for the PM2.5 precursor NOx to the motor vehicle emissions budget for primary PM2.5 using a 8 to 1 ratio (see Chapter 9, Section 9.4).

To ensure that the trading mechanism does not impact the ability to meet the NOx budget, the NOx emission reductions available to supplement the PM2.5 budget shall only be those remaining after the NOx budget has been met. Each agency responsible for demonstrating transportation conformity shall clearly document the calculations used in the trading, along with any additional reductions of NOx or PM2.5 emissions in the conformity analysis.

Demonstrating Transportation Conformity: The SJV MPOs should apply the updated diesel truck activity and the appropriate line item adjustments in future conformity demonstrations. For project level conformity, unless specific vehicle fleet mix or VMT data from observed traffic counts are used, then the default fleet VMT distribution should be adjusted in the same fashion as noted above. For conformity determinations, the MPOs would still use conventional rounding on a county-by-county basis for the conformity test.

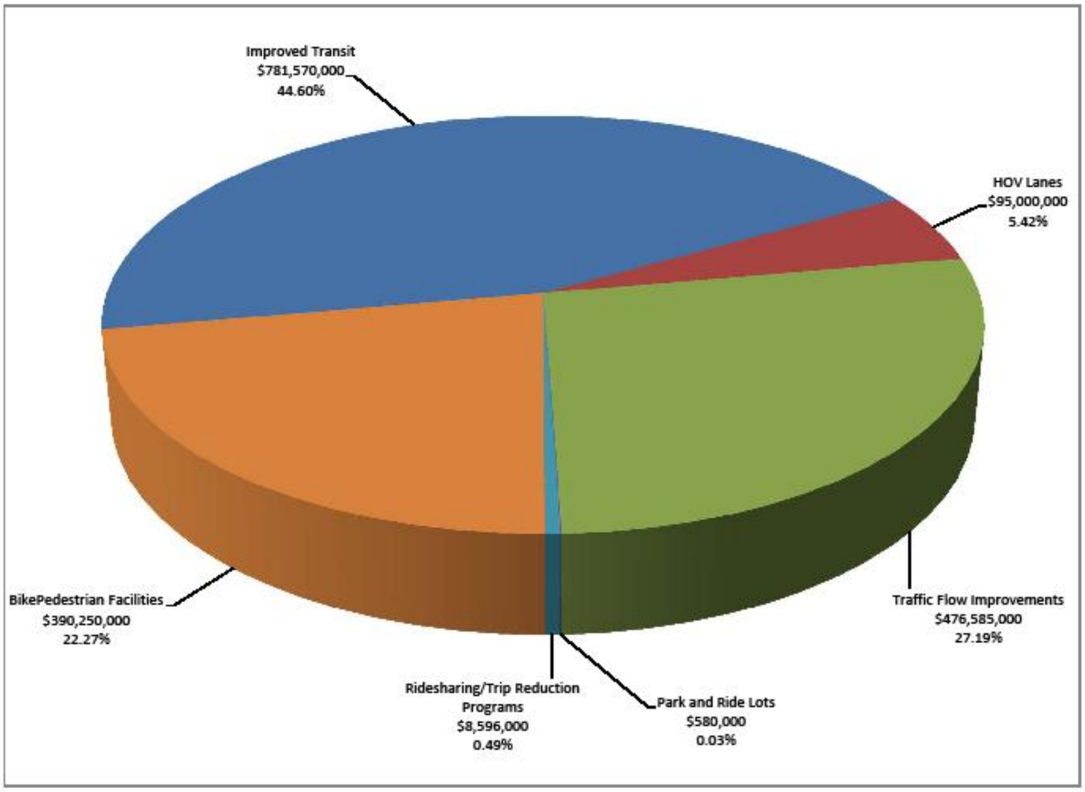
C.11.4 Local Reasonably Available Control Measures (RACM)

Clean Air Act Section 108(f) Transportation Control Measures are currently being implemented by the San Joaquin Valley MPOs as part of the adopted CMAQ cost effectiveness policy and the development of each Regional Transportation Plan (RTP). In addition, new transportation legislation (MAP-21) includes enhanced emphasis on funding PM2.5 projects.

The San Joaquin Valley MPOs continue to implement the adopted San Joaquin Valley CMAQ Policy which was included in the San Joaquin Valley *2007 8-Hour Ozone Plan* and *2008 PM2.5 Plan*. The CMAQ policy includes a standardized process for distributing 20 percent of the CMAQ funds to projects that meet a minimum cost-effectiveness beginning in FY2011. This policy focuses on achieving the most cost-effective emission reductions, while maintaining flexibility to meet local needs. The policy feasibility and minimum cost-effectiveness standard was revisited in 2009 as part of the 2011 FTIP development; the minimum cost-effectiveness standard was also revisited in 2012 as part of the 2013 FTIP development.

Figure C-1 provides an illustration of funding allocated valley-wide in the 2013 FTIPs for a sample of TCM categories: improved transit; high occupancy vehicle lanes; traffic flow improvements; park and ride lots; ridesharing/trip reduction programs; bicycle/pedestrian facilities. Please note these tables are not included as RACM, but are provided to demonstrate the eight SJV MPOs commitment to the implementation of TCMs throughout the Valley. As the San Joaquin Valley MPOs are implementing TCMs through the current policies, all reasonable transportation control measures are being implemented.

Figure C-1 Illustration of San Joaquin Valley MPO Funding for Sample TCM Categories



Each San Joaquin Valley MPO is required to update its RTP every four years. The RTP is a long range regional transportation plan that provides a vision for transportation investments throughout the San Joaquin Valley. The next RTP will also integrate land use and transportation planning to achieve regional greenhouse gas (GHG) targets set by ARB pursuant to SB 375.

The RTP contains a host of improvements to every component of the regional multimodal transportation system including:

- Active transportation (non-motorized transportation, such as biking and walking)
- Transportation demand management (TDM)
- Transportation system management (TSM)
- Transit
- Passenger rail
- Goods movement
- Aviation and airport ground access
- Highways
- Arterials
- Operations and maintenance

Included within these transportation system improvements are TCM projects that reduce vehicle use or change traffic flow or congestion conditions. TCMs include the following categories of transportation improvement projects and programs:

- Improved Transit
- High Occupancy Vehicle Lanes
- Traffic Flow Improvements
- Park and Ride Lots
- Ridesharing/Trip Reduction Programs
- Bicycle/Pedestrian Facilities

C.11.5 SB 375

The Sustainable Communities and Climate Protection Act of 2008 (Sustainable Communities, SB 375) enhances California's strategy to reduce California's Greenhouse gas emissions through the coordination of transportation and land-use to reduce vehicle miles traveled per person through the development of a Sustainable Community Strategy. SB-375 identifies specific reduction goals for each of California's Metropolitan Planning Organizations in 2020 and 2035 which the Sustainable Community Strategy must meet, if feasible. For the San Joaquin Valley the SB-375 target reductions are a 5% per capita greenhouse gas emission reduction from 2005 by 2020 and a 10% per capita greenhouse gas emission reduction from 2005 by 2035. The strategies contained in the next RTP/SCS will produce benefits for the region far beyond simply reducing GHG emissions. The SCS integrates the transportation network and related strategies with an overall land use pattern that responds to projected growth, housing needs, changing demographics, and transportation demands. As a result, Sustainable Community Strategy development is anticipated to complement the reduction strategies outlined in the *2012 PM2.5 Plan*.

Attachment: San Joaquin Valley Draft 24-hour PM2.5 Motor Vehicle Emissions Budgets (tons per winter season day, *established by conventional rounding)

2014 Motor Vehicle Emissions Budgets
2013 FTIP MPO new activity data adjusted for recession

County	Fresno		Kern		Kings		Madera		Merced		San Joaquin		Stanislaus		Tulare		SJV Air Basin	
	PM2.5	NOx	PM2.5	NOx	PM2.5	NOx	PM2.5	NOx	PM2.5	NOx	PM2.5	NOx	PM2.5	NOx	PM2.5	NOx	PM2.5	NOx
Baseline EMFAC2011	1.03	31.74	1.19	43.28	0.23	8.86	0.25	8.79	0.48	17.28	0.68	20.12	0.49	15.21	0.45	14.37		
Rule 9410	-0.01	-0.11	-0.01	-0.08	0.00	-0.02	0.00	-0.03	0.00	-0.04	-0.01	-0.08	0.00	-0.06	0.00	-0.06		
Prop 1B	-0.03	-0.84	-0.06	-1.65	-0.01	-0.31	-0.01	-0.22	-0.02	-0.56	-0.03	-0.60	-0.01	-0.37	-0.01	-0.34		
Moyer	-0.01	-0.03	-0.02	-0.05	0.00	-0.01	0.00	-0.01	-0.01	-0.02	-0.01	-0.02	0.00	-0.01	0.00	-0.01		
AB 1493	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Smog Check	0.00	-0.16	0.00	-0.14	0.00	-0.03	0.00	-0.05	0.00	-0.07	0.00	-0.12	0.00	-0.10	0.00	-0.09		
ACC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Total	0.97	30.59	1.11	41.35	0.21	8.49	0.24	8.48	0.44	16.59	0.64	19.30	0.47	14.67	0.43	13.87	4.51	153.35
Air Basin Total																	4.6	154
Disaggregated County Totals	0.992	30.724	1.127	41.520	0.217	8.523	0.245	8.519	0.453	16.663	0.650	19.387	0.475	14.737	0.441	13.927		
Budget*	1.0	30.7	1.1	41.5	0.2	8.5	0.2	8.5	0.5	16.7	0.6	19.4	0.5	14.7	0.4	13.9	4.5	153.9

2017 Motor Vehicle Emissions Budgets

2013 FTIP MPO new activity data adjusted for recession

County	Fresno		Kern		Kings		Madera		Merced		San Joaquin		Stanislaus		Tulare		SJV Air Basin	
	PM2.5	NOx	PM2.5	NOx	PM2.5	NOx	PM2.5	NOx	PM2.5	NOx	PM2.5	NOx	PM2.5	NOx	PM2.5	NOx	PM2.5	NOx
Baseline EMFAC2011	0.94	25.30	1.04	34.44	0.20	7.17	0.23	7.03	0.42	13.78	0.63	16.00	0.46	12.14	0.40	10.80		
Rule 9410	-0.01	-0.08	-0.01	-0.06	0.00	-0.02	0.00	-0.02	0.00	-0.03	-0.01	-0.06	0.00	-0.04	0.00	-0.04		
Prop 1B	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Moyer	-0.02	-0.09	-0.04	-0.11	-0.01	-0.02	-0.01	-0.02	-0.02	-0.04	-0.02	-0.07	-0.01	-0.04	-0.01	-0.04		
AB 1493	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Smog Check	0.00	-0.15	0.00	-0.14	0.00	-0.03	0.00	-0.05	0.00	-0.06	0.00	-0.11	0.00	-0.09	0.00	-0.08		
ACC	-0.01	-0.07	-0.01	-0.06	0.00	-0.01	0.00	-0.02	0.00	-0.03	-0.01	-0.05	-0.01	-0.05	-0.01	-0.04		
Total	0.89	24.91	0.98	34.07	0.19	7.09	0.22	6.91	0.40	13.60	0.60	15.71	0.44	11.92	0.38	10.60	4.09	124.82
Air Basin Total																	4.1	125
Disaggregated County Totals	0.895	24.944	0.980	34.124	0.190	7.099	0.218	6.925	0.400	13.624	0.598	15.732	0.437	11.934	0.382	10.619		
Budget*	0.9	24.9	1.0	34.1	0.2	7.1	0.2	6.9	0.4	13.6	0.6	15.7	0.4	11.9	0.4	10.6	4.1	124.8

2019 Motor Vehicle Emissions Budgets
2013 FTIP MPO new activity data adjusted for recession

County	Fresno		Kern		Kings		Madera		Merced		San Joaquin		Stanislaus		Tulare		SJV Air Basin	
	PM2.5	NOx	PM2.5	NOx	PM2.5	NOx	PM2.5	NOx	PM2.5	NOx	PM2.5	NOx	PM2.5	NOx	PM2.5	NOx	PM2.5	NOx
Baseline EMFAC2011	0.95	21.65	1.05	29.34	0.20	5.99	0.25	6.24	0.43	11.80	0.64	13.71	0.47	10.45	0.42	9.47		
Rule 9410	-0.01	-0.07	-0.01	-0.06	0.00	-0.01	0.00	-0.02	0.00	-0.03	-0.01	-0.05	0.00	-0.04	0.00	-0.04		
Prop 1B	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Moyer	0.00	-0.02	0.00	-0.03	0.00	-0.01	0.00	-0.01	0.00	-0.01	0.00	-0.02	0.00	-0.01	0.00	-0.01		
AB 1493	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.00		
Smog Check	0.00	-0.13	0.00	-0.11	0.00	-0.02	0.00	-0.04	0.00	-0.05	0.00	-0.09	0.00	-0.07	0.00	-0.07		
ACC	-0.04	-0.16	-0.03	-0.14	-0.01	-0.03	-0.01	-0.06	-0.01	-0.07	-0.03	-0.12	-0.02	-0.10	-0.02	-0.09		
Total	0.90	21.27	1.01	29.00	0.19	5.91	0.23	6.11	0.41	11.63	0.60	13.43	0.44	10.22	0.40	9.26	4.18	106.83
Air Basin Total																	4.2	107
Disaggregated County Totals	0.903	21.302	1.014	29.046	0.191	5.919	0.236	6.118	0.413	11.650	0.604	13.453	0.439	10.234	0.399	9.277		
Budget*	0.9	21.3	1.0	29.0	0.2	5.9	0.2	6.1	0.4	11.7	0.6	13.5	0.4	10.2	0.4	9.3	4.1	107.0

Appendix D

Stationary and Area Source Control Strategy Evaluation

2012 PM2.5 Plan
SJVUAPCD

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Appendix D: Stationary and Area Source Control Strategy Evaluation

The San Joaquin Valley air basin (Valley) faces significant challenges in meeting the National Ambient Air Quality Standards (NAAQS). The San Joaquin Valley Air Pollution Control District (District) has demonstrated leadership in developing and implementing groundbreaking regulatory strategies to reduce emissions. Tough and innovative rules, such as those for indirect source review, residential fireplaces, glass manufacturing, and agricultural burning, have set benchmarks for California and the nation.

The District has adopted many regulatory control measures under the District's air quality attainment plans, including but not limited to the *2007 Ozone Plan* and *2008 PM2.5 Plan,* which serve as control measures under the *2012 PM2.5 Plan*. Under the federal Environmental Protection Agency (EPA) policy, there is a preference for reliance on control measures that have already been adopted. The *2012 PM2.5 Plan* regulatory control measures that have already been adopted are achieving 247.8 tons per day (tpd) of NOx reductions and 15.7 tpd of PM2.5 reductions, and include both stationary and area source control measures as well as California Air Resources Board (ARB) rules for mobile sources. The stationary and area source control measures that the District has already adopted and are contributing to achieving attainment of the 2006 NAAQS as a part of this plan are displayed in Table D-1 below. Refer to Appendix C for the discussion on mobile sources and mobile source regulatory control measures. Also, refer to Chapter 5 for a detailed discussion about the regulatory control measures that have already been adopted and will continue to get emissions reductions.

While the District has adopted numerous rules to reduce emissions from stationary and area sources that will achieve significant emissions reductions in the coming years, the District has invested significant effort in investigating additional potential opportunities for reducing emissions and leaving "no stone unturned," as outlined in the following Guiding Principles adopted by the District's Governing Board:

- *Use sound science as the plan's foundation. This includes efforts to assess public health impacts, predict future air quality, determine the extent of emissions reductions needed, and evaluate the availability, effectiveness, and feasibility of emission control measures.*
- *Consider all opportunities for timely, innovative, and cost-effective emission reductions. Consider traditional regulations, but look beyond traditional regulations to incorporate monetary incentives, policy initiatives, guidance documents, and outreach, including working with cities and counties to incorporate 2012 PM2.5 Plan principles into their general plans.*

This appendix reflects the comprehensive evaluation performed by District staff to examine the Valley's various emissions sources, and identify additional potential emission reduction strategies for inclusion in this plan.

Table D-1 District Stationary and Area Source Regulations Contributing to Continued PM2.5 Improvement

Adopted District Rules	Emissions Reduced[1]
Rule 4103 Open Burning	0.12 tpd NOx 0.34 tpd PM2.5
Rule 4106 Prescribed Burning and Hazard Reduction Burning	NQ[2]
Rule 4204 Cotton Gins	0.79 tpd PM
Rule 4307 Boilers, Steam Generators, and Process Heaters 2 to 5 MMBtu/hr	3.36 tpd NOx
Rule 4308 Boilers, Steam Generators, and Process Heaters 0.075 to <2 MMBtu/hr	3.30 tpd NOx
Rule 4309 Dryers, Dehydrators, and Ovens	0.65 tpd NOx
Rule 4311 Flares	0.06 tpd SOx
Rules 4306 & 4320 Boilers, Steam Generators, and Process Heaters >5 MMBtu/hr	3.50 tpd NOx 3.60 tpd SOx
Rule 4352 Solid Fuel Fired Boilers, Steam Generators, and Process Heaters >5 MMBtu/hr	NQ[2]
Rule 4354 Glass Melting Furnaces	3.37 tpd NOx 1.70 tpd SOx 0.11 tpd PM2.5
Rule 4550 Conservation Management Practices	34.2 tpd PM
Rule 4692 Commercial Charbroiling	0.08 tpd PM2.5
Rule 4702 Internal Combustion Engines	22.43 tpd NOx
Rule 4703 Stationary Gas Turbines	2.20 tpd NOx
Rule 4901 Wood Burning Fireplaces and Wood Burning Heaters[3]	2.40 tpd PM2.5
Rule 4902 Residential Water Heaters	1.03 tpd NOx
Rule 4905 Natural Gas-Fired, Fan-Type Residential Central Furnaces	2.6 tpd NOx
Regulation VIII Rules Fugitive PM10 Prohibitions	20.4 tpd PM

1. Emissions reduced upon full implementation of rule amendments.
2. Not quantified.
3. As an average for November – April; the reductions on any given "No Burn" day are much higher.

Given the significant emissions reductions already achieved through stationary and area source regulatory strategies and the significant investment necessary to achieve emissions reductions, the Valley is at the point of diminishing returns from new regulatory controls on stationary and area sources. Keeping in line with the District Governing Board adopted *Guiding Principles*; staff broadens the search for emission reduction opportunities beyond traditional regulatory strategies and considers other opportunities for timely, innovative, and cost effective emissions reductions, including new incentive programs, policy initiatives, and enhanced education and outreach efforts. Also, where additional research is required to determine if potential opportunities to further reduce emissions of particulate matter and particulate precursors may be feasible for the Valley, the District recommends further study. Further study commitments are another example of the District's commitment to continuously pursue emission reduction opportunities, even after an air quality plan has been adopted. The District's long-standing, multi-faceted strategy for attaining air quality standards has produced positive results. The District recognizes that there is no "silver bullet" for attainment, and every sector – from the public through all levels of government, businesses, and industry – must continue to reduce emissions to meet more stringent air quality standards.

This appendix consists of a literature review and evaluation of emission reduction opportunities for a variety of stationary and area source categories. District staff in multiple departments with expertise in these various sectors contributed to this effort. The evaluations in this appendix are intended to capture relevant background information, examine emission reduction opportunities for technological and economic feasibility, make recommendations for appropriate District actions moving forward, and to solicit public input during the plan development process.

Appendix D Organization and Evaluation

The stationary and area source control measure source categories evaluated in this appendix are organized into the following groups: combustion devices, industrial processes, managed burning, agricultural processes, residential and commercial, fugitive particulate matter, and additional source categories. Each control measure source category group discussion includes a summary of incentive programs, policy initiatives, and District rules that are specific to that category. Each individual control measure analyzed in this appendix has its own discussion and source category analysis.

Source Category Analysis

Each control measure source category analysis includes regulatory evaluations including an assessment of Reasonably Available Control Technology (RACT); review of potential opportunities to reduce emissions; an assessment of each source category with respect to the District's Risk-based Strategy; and recommendations for commitments for future actions to be taken by the District.

Regulatory Evaluation

As part of the regulatory evaluation, District rules and source categories are compared to federal air quality regulations and standards, and the regulations and standards in other air districts. The following regulations and guidelines are referenced in the comparisons:

- **Federal Regulations –** Investigation of federal regulations includes literature review of the following regulations and guidance documents:

    - Control Techniques Guidelines (CTG)
    - Alternative Control Techniques (ACT)
    - National Emission Standards for Hazardous Air Pollutants (NESHAP)
    - New Source Performance Standards (NSPS)
    - Best Available Control Technology (BACT)

- Maximum Achievable Control Technology (MACT)

- **Other Air Districts' Rules –** As agreed to by EPA staff for the *2009 RACT SIP Ozone Demonstration*, the rules were also compared to analogous regulations adopted by California's most progressive air districts. Investigation of control strategies and measures in other air districts and agencies includes, but is not limited to the following air districts:

  - South Coast Air Quality Management District (SCAQMD)
  - Sacramento Metropolitan Air Quality Management District (SMAQMD)
  - Bay Area Air Quality Management District (BAAQMD)
  - Ventura County Air Pollution Control District (VCAPCD)

- **Reasonably Available Control Technology (RACT)** –EPA has defined RACT as "*the lowest emission limitation that a particular source is capable of meeting by the application of control technology that is reasonably available considering technological and economic feasibility"* (44 FR 53762; September 17, 1979). Per Sections 182(b)(2) and 182(f) of the federal Clean Air Act, ozone nonattainment areas are required to implement RACT for sources that are subject to CTG documents issued by EPA and for "major sources" of VOCs and oxides of nitrogen (NOx), which are ozone precursors. Each control measure source category subject to RACT is evaluated to determine if each is at least as stringent as established RACT requirements. All source categories subject to RACT requirements have been determined to currently satisfy RACT requirements. Any new prohibitory requirements for these source categories would be more stringent than RACT.

Potential Opportunities to Reduce Emissions
Each control measure source category analysis identifies potential emission reduction opportunities for PM2.5 and its precursors, such as NOx and SOx. The potential emission reduction opportunities are then thoroughly evaluated using the following key factors:

- **Technological Feasibility** – The technological feasibility analysis determines if a potential opportunity to reduce emissions will physically work for existing facilities and operators in the Valley. District analysis of technological feasibility includes a literature review of BACT guidelines; District permits; environmental and technological studies; EPA and ARB guideline documents; and other air districts' rules, regulations, and guidelines, to identify potential opportunities and determine the technological feasibility of any identified potential opportunities.

- **Cost Effectiveness** – The purpose of conducting a cost effectiveness analysis is to evaluate the economic reasonableness of a pollution control measure or technology as it applies to operators in the Valley. A cost effectiveness analysis examines the added cost, in dollars per year, of the control technology or technique, divided by the emissions reductions achieved, in tons per year.

$$\text{Cost Effectiveness}\left(\$/ton\right)=\frac{\text{Compliance cost}\,(\$/year)}{\text{Emission Reduction}\,(ton/year)}$$

Additionally, a literature review of previous staff reports from District rules, staff reports and studies from other air districts, EPA technical guidance documents, and applicable study data from the scientific community is conducted to determine if any technologically feasible opportunities that were previously not cost effective have changed to become cost effective since the last amendment.

Risk-Based Strategy

The District's Risk-based Strategy (RBS) fits within and effectively supplements EPA's current Clean Air Act (CAA) framework. Through the RBS, the District is maximizing public health improvements resulting from the District's attainment strategies and related initiatives. The District is integrating the RBS into various aspects of the *2012 PM2.5 Plan*, including control measure review and strategy prioritization. As described in Chapter 2 of this plan, the District uses a five-factor exposure assessment methodology to evaluate the PM2.5 attainment strategy under the RBS:

1. Relevance to attainment
2. Toxicity of chemical species
3. Particle size and deposition
4. Proximity to PM 0.1
5. Population intake fraction

Based on this assessment, the District prioritizes regulatory control measures and other strategies that maximize public health. EPA policy directly acknowledges the importance of a Risk-based Strategy to maximize public health benefits within a region's attainment efforts, noting in the March 2012 PM2.5 implementation guidance memo, "…it is likely that SIPs for the 2006 24-hour PM2.5 NAAQS may need to include *greater emphasis on reducing emissions from local sources* [emphasis added] as compared to plans to attain the 1997 PM2.5 NAAQS."[1] EPA's memo further encourages that states consider evidence from published literature indicating that reductions of direct PM2.5 have a greater health benefit per ton than reductions of other criteria pollutants, such as SO2 and NOx,[2] and that providing methods local air quality plans can use to maximize health benefits and minimize risk inequality.[3]

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[1] U.S. Environmental Protection Agency (2012, March 2). Memorandum from the Office of Air Quality Planning and Standards: Implementation Guidance for the 2006 24-Hour Fine Particle (PM2.5) National Ambient Air Quality Standards (NAAQS). Retrieved from http://www.epa.gov/ttn/naaqs/pm/pdfs/20120302_implement_guidance_24-hr_pm2.5_naaqs.pdf

[2] Fann, N., Fulcher, C.M., & Hubbell, B.J. (2009). The Influence of Location, Source, and Emission Type in Estimates of the Human Health Benefits of Reducing a Ton of Air Pollution. *Air Quality, Atmosphere & Health, 2(3)*, 169–176. doi: 10.1007/s11869-009-0044-0

[3] Fann, N., Roman, H.A., Fulcher, C.M., Gentile, M.A., Hubbell, B.J., Wesson, K., & Levy, J.I. (2011). Maximizing Health Benefits and Minimizing Inequality: Incorporating Local-Scale Data in the Design and Evaluation of Air Quality Policies. *Risk Analysis, 31(6)*, 908–922. doi: 10.1111/j.1539-6924.2011.01629.x

Control Measure Commitment Recommendations

District's analysis of all applicable criteria discussed above will result in recommendations for commitments for the District to take to attain the standard as expeditiously as practicable. After the public has had opportunities to contribute to and comment on the evaluations and analyses, the District will determine which control strategies should be included in the plan. Commitments for future control strategies are in the form of the following types of actions:

- Regulatory Action
    - Rule amendments or adoption of new rules
    - Further study for additional opportunities to reduce emissions
- Incentive programs
- Technology advancement programs
- Policy initiatives
- Increased public outreach and education

Regulatory action commitments are summarized in Chapter 5 (Regulatory Control Measures), and all commitments are summarized in Chapter 9 (Progress Toward Attainment of the 2006 PM2.5 Standard).

D.1 COMBUSTION DEVICES

Combustion devices are equipment that burn fuel to create power, heat, or other forms of energy. The process of burning fuel via internal or external combustion creates multiple pollutants, including oxides of nitrogen (NOx), the primary PM2.5 precursor, volatile organic compounds (VOC), and oxides of sulfur (SOx). Establishing effective emission reduction strategies for combustion devices continues to be a key component of the San Joaquin Valley Air Pollution Control District's (District) strategy to reduce emissions and achieve federal air quality standards.

Combustion devices are utilized in numerous applications throughout the private and public sectors. The control measure source categories discussed affect several industries in the San Joaquin Valley air basin (Valley) including, but not limited to: electrical utilities, cogeneration, oil and gas production, petroleum refining, manufacturing processes, industrial activities, and food and agricultural processing.

Existing Control Strategies

Due to the degree of difficulty and enormity of the challenge that the Valley faces in meeting the National Ambient Air Quality Standards (NAAQS), the District recognizes that prohibitory rules alone are not enough to reduce emissions to meet attainment requirements and protect public health. The District's longstanding, progressive strategy for reducing emissions is a multifaceted effort that includes incentive programs and policy initiatives in addition to prohibitory rules. The following discussion summarizes both the existing District efforts to reduce emissions from this source category, and evaluations for potential opportunities for further emissions reductions.

Incentive Programs

Incentive programs are an integral part of the emission reduction efforts of the District, especially where the District lacks direct jurisdiction in establishing emission control requirements. Since the emission units within the Combustion Devices category are typically located at stationary sources and have been subject to several generations of regulations, the opportunities for incentive programs have been minimal. The District currently funds the following incentive programs that directly apply to stationary combustion units.

The stationary agricultural irrigation pump engine program component of the District's *Heavy-Duty Engine Program* was created to assist agricultural stakeholders in replacing old polluting internal combustion engines with new more efficient and less polluting units or with electric units with zero emissions. To date, the program has distributed over $100 million in grant money and has funded the replacement and/or purchase of 6,094 new engines and electric motors, reducing 47,059 tons of NOx and 1,738 tons of particulate emissions. Similarly, the District partnered with the Natural Resources Conservation Service (NRCS) Environmental Quality Incentives Program (EQIP) to replace 15 agricultural pump engines in the Valley. Between 2003 and 2011, NRCS also replaced an additional 547 diesel irrigation engines in the Valley.[1]

Incentives have also been available for biomass facilities through state and Federal funded programs independent from the District. Funding or tax credits are available through some short-term programs such as the Existing Renewable Facilities Program through the California Energy Commission (CEC) and federal corporate tax credits from a federal program called the Renewable Electricity Program Tax Credit. In addition to these programs, incentives and funding through Assembly Bill 118 (Núñez Statutes of 2007, Chapter 750), which directs the CEC to develop the *Alternative and Renewable Fuel and Vehicle Technology Program*, are available to identify and promote alternative biomass-based feedstocks, including agricultural waste, for the production of alternative fuels.

Policy Initiatives

The District's policies and Legislative Platform are important components to the District's strategy to attain federal ambient air quality standards. The District utilizes policies and the legislative platform to bring attention to major issues that have a direct impact on the Valley's air quality.

The District supports legislation for the continued operation of biomass facilities, including subsidies and/or preferential utility rates for power produced from biomass to enhance the economic feasibility of this alternative. Adoption of Senate Bill 705 (2003, codified as Health and Safety Code Sections 41855.5 and 41855.6), which phases out the ability to burn certain agricultural material in the field, has underlined the importance of biomass facilities in providing a mechanism to dispose of this agricultural material.

The District also supports legislation that calls for the increased development and use of cleaner-burning fuels. This platform was developed in an effort to accelerate the reduction of NOx emissions from combustion devices and the ability of Valley sources to achieve lower emission limits.

The District has made a diligent effort to support legislation that provides funding for the Carl Moyer Program and other similar incentive programs. The District supports the continuation of air quality funding in the Farm Bill to accelerate the replacement of agricultural equipment. Incentive funds have resulted in the turnover of thousands of irrigation pumps thus far, generating significant emissions reductions for the Valley.

Rules and Regulations

The following is a list of District rules that apply to the Combustion Devices category. Units subject to these rules are subject to some of the most stringent regulations and standards in the nation and have been subject to several generations of rule amendments. Each of the following rules will be evaluated to examine potential opportunities for additional emissions reductions.

[1] The District has also participated in the replacement of various mobile source combustion units (i.e. tractors) through other incentives programs. Please see Chapter 6 for additional information.

Table D-2 District Combustion Devices Rules

Rule		Last Amended/ Adopted
Rule 4203	Particulate Matter Emissions from Incineration of Combustible Refuse	12/17/1992
Rule 4307	Boilers, Steam Generators and Process Heaters–2.0 MMBtu/hr to 5.0 MMBtu/hr	05/19/2011
Rule 4308	Boilers, Steam Generators and Process Heaters–0.075 MMBtu/hr to less than 2.0 MMBtu/hr	12/17/2009
Rule 4309	Dryers, Dehydrators, and Ovens	12/15/2005
Rule 4320	Advanced Emission Reduction Options for Boilers, Steam Generators, and Process Heaters Greater than 5.0 MMBtu/hr	10/16/2008
Rule 4352	Solid Fuel Fired Boilers, Steam Generators, and Process Heaters	12/15/2011
Rule 4702	Internal Combustion Engines	08/18/2011
Rule 4703	Stationary Gas Turbines	09/20/2007

D.1.1 Rule 4203 Particulate Matter Emissions from the Incineration of Combustible Refuse

Source Category

Rule 4203 is applicable to incinerators or other equipment used to dispose of or process combustible refuse by incineration. The rule limits the concentration of particulate matter emissions based on process weight rates, and prohibits the discharge of visible emissions. Rule 4203 was adopted on May 21, 1992 and subsequently amended for District rule number reorganization on December 17, 1992. There are currently 3 facilities in the Valley subject to Rule 4203. These facilities currently implement Best Available Control Technology (BACT) requirements; the facilities are required to mitigate the discharge of air pollutants to the maximum degree achievable. For this source category, examples of emission control technologies include baghouses and lime scrubbers.

Emission Inventory

Pollutant	2007	2012	2014	2015	2016	2017	2018	2019
	Annual Average - Tons per day							
PM2.5	0.08	0.10	0.10	0.11	0.11	0.11	0.11	0.12
NOx	0.88	1.12	1.18	1.25	1.29	1.29	1.32	1.33
SOx	0.05	0.04	0.02	0.02	0.02	0.02	0.02	0.02
	Winter Average - Tons per day							
PM2.5	0.08	0.10	0.10	0.11	0.11	0.11	0.11	0.12
NOx	0.88	1.12	1.18	1.25	1.29	1.29	1.32	1.33
SOx	0.05	0.04	0.02	0.02	0.02	0.02	0.02	0.02

Regulatory Evaluation

How does District Rule 4203 compare with federal rules and regulations?

There are no specific federal guidelines for particulate matter concentration in terms of New Source Performance Standards (NSPS), Control Techniques Guidelines (CTG), Alternative Control Technology (ACT), Maximum Achievable Control Technology (MACT), and National Emission Standards for Hazardous Air Pollutants (NESHAP).

EPA BACT standards require the use of a fabric filter or baghouse. However, District BACT standards are just as stringent and require the use of natural gas supplemental fuel with a baghouse.

How does District Rule 4203 compare to rules in other air districts?

Rule 4203 was compared to similar rules at other air districts and is at least as stringent, if not more stringent, than other districts' rules. Comparisons to other air district rules included SCAMQD Rule 473 (Disposal of Solid and Liquid Wastes) and SMAQMD Rule 407 (Open Burn). BAAQMD and VCAPCD do not have comparable rules.

In addition to being one of the most stringent rules in the nation for this source category any new unit brought to the Valley, as well as any major modifications to existing units, would trigger BACT requirements. These new or modified units would be required to control emissions beyond that established as being RACT and implement the best available controls for NOx and PM2.5 emissions, as required by District Rule 2201 (New and Modified Stationary Source Review Rule). Additionally, all new or modified units are evaluated under the District's air toxics policy, and are required to not pose a significant health risk to Valley residents.

Emission Reduction Opportunities

Rule 4203 is one of the most stringent rules in the nation for this source category. As mentioned above, units subject to this rule already meet BACT level requirements, which require the mitigation of air pollution to the maximum degree achievable using control technology like baghouses and lime scrubbers. No technologies beyond those established as BACT were identified.

Risk-based Strategy Analysis

The emissions from units subject to Rule 4203 contribute 2.3% of average winter NOx emitted from stationary and area sources in the 2012 emission inventory. As illustrated in the emission inventory table above, the emissions from this source category are relatively small and consistent throughout the year, with no elevated emission levels in the winter months.

Control Measure Commitments

The following is a summary of recommended commitments for Rule 4203.

Regulatory Action

The District's analysis did not identify any additional technologically feasible and cost effective potential controls. Therefore, there are no recommendations for additional regulatory actions for Rule 4203.

Incentive Action

Units subject to Rule 4203 are regulated stationary sources, and already implement BACT level controls; as such, the opportunities for incentive programs are minimal. No incentive actions are recommended for furnaces and other units used for the incineration of combustible refuse at this time.

Technology Advancement Action
There is no recommendation for a new technology advancement project for units subject to Rule 4203. Through its Technology Advancement Program, the District will continue to seek potential feasible and low-cost technologies that may provide for additional emission reduction opportunities in this category.

Policy Initiatives
The District is not currently supporting any policy initiatives specific to furnaces and other units used for the incineration of combustible refuse. As regulated sources are already implementing BACT level controls, there are no recommendations for new policy initiatives for these sources.

Education and Outreach
The District currently provides a robust education and outreach program for regulated sources through the Small Business Assistance program, Permit Stakeholder Meetings, Compliance Assistance Bulletins, and public notices for public workshops and public hearings. No new education and outreach efforts are recommended for these sources at this time. The District will continue to work closely with affected sources to ensure successful compliance.

D.1.2 Rule 4307 Boilers, Steam Generators and Process Heaters– 2.0 MMBtu/hr to 5.0 MMBtu/hr

Source Category

This rule applies to any gaseous fuel or liquid fuel fired boiler, steam generator, or process heater with a total rated heat input of 2.0 million British thermal units per hour (MMBtu/hr) up to and including 5.0 MMBtu/hr. The purpose of this rule is to limit emissions of NOx, carbon monoxide (CO), sulfur dioxide (SO2), and particulates from units subject to this rule. Based on District permits information, there are currently 540 permitted and Permit-Exempt Equipment Registration (PEER) units subject to Rule 4307 requirements.

Rule 4307 was adopted on December 15, 2005 to establish emissions limits and control requirements for these units which were previously exempt because of their size. Since its adoption, the rule has been amended three times. The most recent amendments strengthened the rule by removing some exemptions, imposing NOx limits of 9 or 12 ppmv for new and replacement units, and adding a menu-approach for particulate matter control that also encompasses SOx controls. EPA finalized approval of Rule 4307 on January 13, 2010 and deemed this rule as being at least as stringent as established RACT requirements. As a result of this rule, NOx emissions have been controlled by over 84% for units in this source category.

Emission Inventory

Pollutant	2007	2012	2014	2015	2016	2017	2018	2019
	Annual Average - Tons per day							
PM2.5	0.37	0.33	0.32	0.31	0.31	0.30	0.30	0.29
NOx	0.70	0.38	0.34	0.31	0.30	0.30	0.29	0.28
SOx	0.39	0.22	0.09	0.09	0.09	0.08	0.08	0.08
	Winter Average - Tons per day							
PM2.5	0.36	0.32	0.31	0.31	0.30	0.30	0.29	0.29
NOx	0.67	0.36	0.33	0.30	0.29	0.29	0.28	0.27
SOx	0.38	0.21	0.09	0.08	0.08	0.08	0.08	0.08

Regulatory Evaluation

How does District Rule 4307 compare with federal rules and regulations?

Rule 4307 is equivalent to the applicable federal standards and guidelines. As confirmed by the June 2009 EPA Technical Support Document (TSD) for Rule 4307, the rule is as stringent as the federal Alternative Control Techniques (ACT) documents (EPA –453/R-94-022 "Alternative Control Techniques Document – NOx Emissions from Industrial/Commercial/Institutional Boilers", dated March 1994 and EPA – 452/R-93-008 "Alternative Control Techniques Document—NOx Emissions from Utility Boilers", dated March 1994), New Source Performance Standards (NSPS) (40 CFR 60 Subpart D (Standards of Performance for Fossil-Fuel Fired Steam Generators for Which Construction Commenced After August 17, 1971) and 40 CFR 60 Subpart Dc (Standards of Performance for Small Industrial-Commercial-Institutional Steam Generating Units)), and Maximum Achievable Control Technology (MACT) (40 CFR 63 Subpart DDDDD (NESHAP for Industrial, Commercial, and Institutional Boilers and Process Heaters)). Additionally, there are no EPA Control Technique Guidelines (CTG) or Best Available Control Technology (BACT) requirements listed for this category.

How does District Rule 4307 compare to rules in other air districts?

In comparison to other California air districts' rules for similar sources, Rule 4307 is at least as stringent as the analogous rules for SCAQMD (Rule 1146.1—Emissions of Oxides of Nitrogen from Small Industrial, Institutional, and Commercial Boilers, Steam Generators, and Process Heaters), BAAQMD (Regulation 9 Rule 7—Nitrogen Oxides and Carbon Monoxide from Industrial, Institutional and Commercial Boilers, Steam Generators and Process Heaters and Regulation 9 Rule 10—Nitrogen Oxides and Carbon Monoxide from Boilers, Steam Generators and Process Heaters in Petroleum Refineries), SMAQMD (Rule 411—NOx from Boilers, Process Heaters, and Steam Generators), and VCAPCD (Rule 74.15.1—Boilers, Steam Generators, and Process Heaters).

No BACT requirements exist for units of this small size. Generally, these smaller units have been exempt from permit requirements. However, the District does require these units to be registered through Rule 2250 (Permit-Exempt Equipment Registration) to ensure compliance with Rule 4307 requirements.

Emission Reduction Opportunities

The District has adopted numerous rule amendments over the years for boilers that have significantly reduced emissions from units subject to Rule 4307. Most units subject to Rule 4307 are fired on Public Utilities Commission (PUC) quality natural gas, and are inherently low-emitters of SOx and PM2.5 emissions. The NOx limits implemented through Rule 4307 and its amendments will reduce emissions from over 1,000 small (2-5 MMBtu/hr) boilers in the Valley when fully implemented, including from units that were previously exempt. As a result of these regulatory efforts, the emissions inventory for NOx from these boilers has dropped from 3.81 tpd in 2005 to 0.38 tpd in

2012. Additional emissions reductions are forthcoming with existing Rule 4307 as additional compliance dates are approaching in 2016. Given the significant efforts and investments already made to reduce emissions from this source category, there are little remaining opportunities for obtaining additional emissions reductions.

As discussed above, Rule 4307 is as stringent as or more stringent than federal regulations and requirements and other districts' rules and regulations. Any new or additional requirements would extend well beyond RACT requirements.

EMx as Potential Control
Post-combustion controls such as EMx, the second generation of the SCONOx technology that reduces NOx, SOx, CO, and volatile organic compound (VOC) emissions, were researched. This technology has not been achieved in practice (AIP) in the District and there is no available data that indicates that SCONOx or EMx has been installed on boilers, particularly in this size range, even though the manufacturer's website states that the technology is transferrable to industrial boilers. Based on research of the best available controls from EPA and other air districts, the SCONOx and EMx systems have only been utilized by power plants for the control of turbine emissions. In fact, cost effectiveness analyses conducted by the District for the installation of SCONOx/EMx units on large power plant turbine installations within the San Joaquin Valley have been found to not be cost effective. Given the high cost effectiveness demonstrated for turbines and lack of demonstrated practice with boilers, the District does not expect this technology to be feasible or cost effective for reducing emissions from this category.

PM2.5 Limits for Alternative Fuels
The majority of boilers (2-5 MMBtu/hr) in the Valley combust PUC-quality natural gas; PUC natural gas contains a very low sulfur content and inherently has low emissions. Few boilers in the Valley use alternative fuels for their combustion processes. Alternative fuels include digester gas, produced gas, and liquid fuel. Units fired on digester gas or produced gas are already required to use inlet gas scrubbers to meet District rule requirements. Current rule language requires that on and after July 1, 2015 liquid fuel shall be used only during a PUC quality natural gas curtailment period provided it contains no more than 15 ppm sulfur. While the currently limited use of liquid fuel will become even more strictly limited by July 2015, the feasibility of reducing PM emissions through adding PM2.5 limits for units using liquid fuel was explored as part of the District's comprehensive control measure evaluation.

There are 25 liquid fuel fired units in the Valley (2-5 MMBtu/hr) with a combined emissions inventory of approximately 0.08 tons per year of total PM. The low emissions inventory is attributed to the fact that these units either utilize liquid fuel as a backup if there is a natural gas curtailment or are minimally operated units. The following three technologies were evaluated as potential control options for reducing PM emissions: baghouses, electrostatic precipitators (ESPs), and wet scrubbers. Baghouses control total PM and PM2.5 emissions by 90-99%; ESPs control total PM and PM2.5 emissions by 90-99%; and wet scrubbers control large particulates (>PM5) by 99% and PM2.5

emissions by approximately 50%.[2] However, baghouses are typically not used with liquid-fired boilers due to the potential clogging of the baghouse and are therefore not a recommended technology due to infeasibility and safety issues.[3]

PM Potential Emissions Reductions for an ESP and Scrubber

For the purposes of these calculations, the following assumptions were made:

1. For simplicity, the analysis will evaluate the cost effectiveness of these technologies for total PM reductions from liquid fuel fired units.
2. The PM control efficiency of an ESP is 99%.
3. The PM control efficiency of a scrubber is 99%.

Potential Emissions Reductions$_{ESP}$ = (Total PM Emissions) x (Control Efficiency)
Potential Emissions Reductions$_{ESP}$ = 0.08 tons/year X 0.99
Potential Emissions Reductions$_{ESP}$ = 0.079 tons/ year (tpy)

Potential Emissions Reductions $_{scrubber}$ = (Total PM Emissions) x (Control Efficiency)
Potential Emissions Reductions $_{scrubber}$ = 0.08 tons/year X 0.99
Potential Emissions Reductions $_{scrubber}$ = 0.079 tons/ year (tpy)

Annualized Cost of an ESP and Wet Scrubber

The capital cost for the installation of an ESP for a 1-5 MMBtu/hr boiler ranges from \$90,000 - \$100,000 and the annual maintenance cost is \$1,000-\$2,000.[4] For the wet scrubber system, EPA estimated the annualized cost at \$5,300-\$102,000 per sm^3/sec at an average air flow rate of 0.7- 47 sm^3/sec.[5] The following assumptions were made for this cost effectiveness calculations:

1. The capital cost of an ESP is assumed to be the median of the range above (\$95,000).
2. The annual maintenance cost of an ESP is assumed to be the median of the range above (\$1,500).
3. The annualized cost of a wet scrubber system is assumed to be the median of the range above (\$53,650 per sm^3/sec).
4. The average air flow rate for a wet scrubber system is assumed to be the median of the range above (23.85 sm^3/sec).

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[2] Northeast States for Coordinated Air Use Management. (November 2008) *Applicability and Feasibility of NOx, SO2, and PM Emissions Control Technologies for Industrial, Commercial, and Institutional (ICI) Boilers.*
[3] Northeast States for Coordinated Air Use Management. (November 2008) *Applicability and Feasibility of NOx, SO2, and PM Emissions Control Technologies for Industrial, Commercial, and Institutional (ICI) Boilers.*
[4] Catherine Roberts. (March 2009) *Information on Air Pollution Control Technology for Woody Biomass Boilers.* Environmental Protection Agency Office of Air Quality Planning and Standards and Northeast States for Coordinated Air Use Management.
[5] Environmental Protection Agency. (2002). *Air Pollution Control Technology Fact Sheet: Spray-Chamber/Spray-Tower Wet Scrubber.*

5. The total capital and maintenance cost of an ESP will be calculated by multiplying the cost of 1 unit by the total number of units.
6. The total annualized cost of a wet scrubber will be calculated by multiplying the annualized cost of 1 unit by the total number of units.
7. Lifetime of the ESP is 10 years at 10% interest. To account for this, the annualized capital cost will be calculated by multiplying the total capital cost by the capital recovery factor of 0.1627 and adding the annual maintenance costs.

Annual $Cost_{ESP}$ = (Total Capital Cost) x (0.1627) + (Annual Maintenance Cost)
Annual $Cost_{ESP}$ = (\$95,000 x 25) x (0.1627) + (\$1,500 x 25)
Annual $Cost_{ESP}$ = \$423,913/year

Annual $Cost_{scrubber}$ = (Annualized Cost of 1 unit) x (Number of Units) x (Average Flow Rate)
Annual $Cost_{scrubber}$ = (\$53,650/ sm^3/sec) x (25) x (23.85 sm^3/sec)
Annual $Cost_{scrubber}$ = \$31,988,813 year

Cost Effectiveness of an ESP and Wet Scrubber

Cost Effectiveness = Annual Cost / Annual Emissions Reductions

Cost $Effectiveness_{ESP}$ = (\$423,913/year) / (0.079 tons/ year)
Cost $Effectiveness_{ESP}$ = \$5,365,987/ton of PM

Cost $Effectiveness_{scrubber}$ = (\$31,988,813/year) / (0.079 tons/ year)
Cost $Effectiveness_{scrubber}$ = \$404,921,684ton of PM

As illustrated above, neither PM control technology is a cost effective option for this source category. The cost of the ESP technology does not include costs of retrofitting equipment and/or the facility or compliance monitoring costs, which would drive the cost effectiveness up even more. In addition, the annualized costs provided by EPA for the wet scrubber system are in 2002 dollars, which means the value above would be even greater if it were adjusted to 2012 dollars.

At this time, the District's analysis indicates that there are no feasible opportunities for additional emission reduction regulatory strategies for this source category.

Risk-based Strategy Analysis

The emissions from units subject to Rule 4307 contribute 0.7% of average winter NOx, 2.6% of average winter SOx, and 0.6% of average winter PM2.5 emitted from stationary and area sources in the 2012 emission inventory. These units are primarily fired on PUC-quality natural gas, which is generally considered a clean burning fuel with low SOx and PM emissions. Overall, Rule 4307 has significantly reduced NOx and SOx emissions from these units and has assisted in reducing PM2.5 concentrations through reductions of these key precursors.

Control Measure Commitments

The following is a summary of recommended commitments for Rule 4307.

Regulatory Action

The District's analysis did not identify any additional technologically feasible and cost effective potential controls. Therefore, there are no recommendations for additional regulatory actions for Rule 4307.

Incentive Action

Boilers subject to Rule 4307 are regulated units that have been subject to several generations of regulations; as such, the opportunities for incentive programs are minimal. There are no recommendations for incentive actions at this time.

Technology Advancement Action

There is no recommendation for a new technology advancement project for units subject to Rule 4307. Through its Technology Advancement Program, the District will continue to seek potential feasible and low-cost technologies that may provide for additional emission reduction opportunities in this category.

Policy Initiatives

The District's current legislative platform includes support for the increased development and use of cleaner-burning fuels. The recommendation is to continue supporting the current legislative platform. There are no recommendations for new policy initiatives at this time because the rule already requires the most effective emission control technologies.

Education and Outreach

The District currently provides a robust education and outreach program for regulated sources through the Small Business Assistance program, Permit Stakeholder Meetings, Compliance Assistance Bulletins, and public notices for public workshops and public hearings. The District does not have recommendations for new education and outreach efforts for these sources. The District will continue to work closely with affected sources to ensure successful compliance.

D.1.3 Rule 4308 Boilers, Steam Generators and Process Heaters– 0.075 MMBtu/hr to less than 2.0 MMBtu/hr

Source Category

This rule applies to any person who supplies, sells, offers for sale, installs, or solicits the installation of any boiler, steam generator, process heater or water heater with a rated heat input capacity greater than or equal to 0.075 MMBtu/hr and less than 2.0 MMBtu/hr. This rule is a point of sale rule and achieves reductions as units subject to the rule are replaced over time.

Rule 4308 was adopted on October 20, 2005 to establish NOx emissions limits for these units which were previously exempt because of their size. The rule has been amended once, in December 2009, to lower the NOx emissions limits to 20 ppmv for units fired on natural gas, with the exception of a few unit types. EPA finalized approval for Rule 4308 on January 31, 2011 and deemed this rule as being at least as stringent as established RACT requirements. This rule has resulted in approximately 93% control of emissions from this source category.

Emission Inventory

Pollutant	2007	2012	2014	2015	2016	2017	2018	2019
	Annual Average - Tons per day							
PM2.5	0.70	0.62	0.60	0.59	0.58	0.57	0.56	0.55
NOx	1.32	0.71	0.64	0.60	0.58	0.56	0.54	0.53
SOx	0.73	0.42	0.17	0.17	0.16	0.16	0.16	0.15
	Winter Average - Tons per day							
PM2.5	0.68	0.61	0.59	0.58	0.57	0.56	0.55	0.54
NOx	1.27	0.68	0.62	0.57	0.55	0.54	0.52	0.51
SOx	0.71	0.41	0.17	0.16	0.16	0.16	0.15	0.15

Regulatory Evaluation

How does District Rule 4308 compare with federal rules and regulations?

Rule 4308 is equivalent to the applicable federal standards and guidelines. As confirmed by the July 2010 EPA technical support document (TSD) for the approval of Rule 4308, the rule is as stringent as the federal Alternative Control Techniques (ACT) (EPA –453/R-94-022 "Alternative Control Techniques Document – NOx Emissions from Industrial/Commercial/ Institutional Boilers", dated March 1994 and EPA – 452/R-93-008 "Alternative Control Techniques Document—NOx Emissions from Utility Boilers", dated March 1994). Federal requirements such as New Source Performance Standards (NSPS), National Emission Standards for Hazardous Air Pollutants (NESHAP), and Maximum Achievable Control Technology (MACT) requirements are not applicable to boilers, steam generators, and process heaters of this size. Additionally, there are no EPA Control Techniques Guidelines (CTG) or Best Available

Control Technology (BACT) requirements listed for this category. The District, SCAQMD, BAAQMD, and EPA do not employ BACT requirements for this source category because BACT is required for new or modified permitted units and these units are exempt from the permitting process.

How does District Rule 4308 compare to rules in other air districts?

Air districts' rules that were evaluated as a part of this control measure effort include BAAQMD Regulation 9 Rule 6 (Nitrogen Oxides Emissions from Natural Gas-Fired Boilers and Water Heaters), SMAQMD Rule 411 (NOx from Boilers, Process Heaters and Steam Generators), SMAQMD Rule 414 (Water Heaters, Boilers and Process Heaters Rated Less Than 1,000,000 BTU Per Hour), VCAPCD Rule 74.11.1 (Large Water Heaters and Small Boilers), and SCAQMD Rule 1146.2 (Emissions of Oxides of Nitrogen From Large Water Heaters and Small Boilers and Process Heaters).

District Rule 4308 meets RACT standards, which includes a comparison to other air district rules, as confirmed by the previously mentioned 2010 EPA TSD. Rule 4308 was compared to other California air districts' rules for similar sources and cross-referenced with the exemptions in each rule. Multiple air districts do not exempt water heaters in mobile homes like Rule 4308; however, because those air districts have different rule structures with regards to the size of devices regulated, District Rule 4308 requirements are as stringent as the other Districts' rules.

For example, SCAQMD Rule 1146.2 does not regulate mobile home water heaters, per the definition for type 1 units, because they are subject to Rule 1121 (Control of Nitrogen Oxides from Residential Type, Natural Gas-Fired Water Heaters). SCAQMD Rule 1121 regulates units less than 0.075 MMBtu/hr, which is out of the size range of District Rule 4308. Similarly, in SMAQMD Rule 414, mobile home units are regulated in the size range of less than 0.075 MMBtu/hr. District Rule 4902 (Residential Water Heaters) applies to units less than 0.075 MMBtu/hr and currently regulates mobile home water heaters with the same emission limit in SCAQMD and SMAQMD rules. BAAQMD Rule 09-06 regulates all units less than 2 MMBtu/hr, essentially combining the requirements of District Rules 4308 and 4902.

Upon further comparison of District Rule 4308 to other air district rules, it was found that other air districts have more stringent limits for instantaneous water heaters. SCAQMD Rule 1146.2 (amended May 5, 2006) contains a limit of 20 ppmv NOx for natural gas-fired instantaneous water heaters in the size range of 0.075 – 0.4 MMBtu/hr, effective January 1, 2012 and BAAQMD Rule 09-06 (amended November 7, 2007) also contains a limit of 20 ppmv NOx effective January 2013. District Rule 4308 contains a limit of 55 ppmv for these same units. Refer to the Instantaneous Water Heaters discussion below for more details.

Emission Reduction Opportunities

The adoption of Rule 4308 and its subsequent amendment in 2009 have significantly reduced NOx and PM emissions from boilers of this size category, effectively reducing the emissions inventory for NOx from 3.66 tons per day (tpd) in 2005 to 0.71 tpd in 2012. It is estimated that the rule will effectively reduce emissions from over 17,000 units in the Valley upon full implementation. Additional emissions reductions are forthcoming as consumers continue to replace older units with newer and lower-emitting units. Given the significant regulatory efforts already made to reduce emissions from this source category, the only remaining potential opportunity for obtaining additional emissions reductions from currently regulated units would be to lower the NOx emission limit for instantaneous water heaters in the size range of 0.075 – 0.4 MMBtu/hr. For thoroughness, the possibility of further reducing emissions from currently exempt sources is also evaluated below.

Instantaneous Water Heaters

The emissions limits for units subject to Rule 4308 are separated based on two size categories: units 0.075-0.4 MMBtu/hr and units 0.4-2.0 MMBtu/hr. The larger category of instantaneous (tankless) water heaters 0.4-2.0MMBtu/hr are currently regulated with a NOx emissions limit of 20 ppmv, which is as stringent as the limit in the other air districts' rules. As a result, there is no opportunity to reduce emissions from the larger instantaneous water heaters. However, the emissions limit for instantaneous water heaters 0.075-0.4 MMBtu/hr in Rule 4308 is not equivalent to the other air districts' rules, which creates a potential opportunity for further emissions reductions from this category.

BAAQMD Rule 09-06 and SCAQMD Rule 1146.2 contain a more stringent NOx limit for instantaneous water heaters. When SCAQMD amended Rule 1146.2 to incorporate a 20 ppmv NOx limit for instantaneous water heaters, the technology had not been achieved in practice yet; however, manufacturers of instantaneous water heaters were reporting their progress of technology advancements quarterly to SCAQMD and indicated that they were on track to achieve a 20 ppmv NOx standard for instantaneous units by 2012[6]. Similarly, BAAQMD amended Rule 09-06 in 2007 to incorporate a 20 ppmv NOx limit for instantaneous water heaters after SCAQMD indicated that the technology was still set to be available in 2012. During that same time, BAAQMD received information that the additional cost of a 20 ppmv instantaneous water heater would be $100-$200, in comparison to a 55 ppmv instantaneous unit. Even though these units were not available at the time of the rule amendments, BAAQMD and SCAQMD amended their rules to include a 20 ppmv NOx limit for instantaneous units in this size range in anticipation of the technology being available by the compliance deadlines and because the cost differential for a 20 ppmv unit would be at most $200.

SCAQMD has obtained information that six manufacturers now produce instantaneous water heaters in this size range that meet the 20 ppmv limit. Five of the six manufacturers were contacted and four of them sell the identified models to Valley

[6] Gimlen, Guy A. (October 2007). *Staff Report for BAAQMD Regulation 9, Rule 6: Nitrogen Oxides from Natural Gas-Fired Water Heaters*. San Francisco, CA: Bay Area Air Quality Management District.

sources. Three of the manufacturers distribute their units through planning wholesalers who only sell to licensed contractors, with no direct retail sales. The fourth manufacturer sells units through online retailers.

After confirming the availability of this technology in the Valley, the feasibility of reducing current NOx limits for instantaneous water heaters to the 20 ppmv limit enforced in SCAQMD and BAAQMD was explored.

Potential Emissions Reductions by Reducing Instantaneous Water Heater NOx Limit

For purposes of these calculations, the following assumptions were made:

1. A 0.22 capacity factor was assumed based on South Coast Rule 1146.2 information.
2. An average rating was applied to the two size categories since the number of units is assumed to be distributed evenly. Therefore, the average rating is 0.238 MMBtu/hr for units in this size range.
3. The current emissions rate is based on the current rule requirement of 55 ppmv (0.068 lb NOx/MMBtu).
4. Since instantaneous water heaters heat water only when needed, it was assumed that each household would utilize the unit for an average of 3 hours per day.

Potential Emissions at 55 ppmv

Emissions_1 = (average rating) x (emission rate) x (capacity factor) x (hours/day) x (ton/lb)

Emissions_1 = (0.238 MMBtu/hr) x (0.068 lb NOx/MMBtu) x (0.22) x (3 hr/day) x (1 ton/2,000 lb)

Emissions_1 = 5.34×10^{-6} tons of NOx/day = 0.0019 tons of NOx/year

Potential Emissions at 20 ppmv

Emissions_2 = (average rating) x (emission rate) x (capacity factor) x (hours/day) x (ton/lb)

Emissions_2 = (0.238 MMBtu/hr) x (0.024 lb NOx/MMBtu) x (0.22) x (3 hr/day) x (1 ton/2,000 lb)

Emissions_2 = 1.88×10^{-6} tons NOx/day = 0.0007 tons of NOx/year

Emissions Reduction = 0.0019 – 0.0007
Emissions Reduction = 0.0012 tons NOx/year

Cost Effectiveness of Reducing the Instantaneous Water Heater Limit

BAAQMD found that water heaters in the size range of 0.075 through 0.4 MMBtu/hr vary in cost from $2,500 to $10,000 plus installation. The additional cost for low-NOx water heaters to achieve 20 ppmv was estimated to be $200 per unit. The following assumptions were made in the cost effectiveness calculations:

1. Cost differential between a 55 ppmv and 20 ppmv unit was assumed to be $200.
2. Lifetime of an instantaneous water heater is 10 years at 10% interest. To account for this, the annualized capital equipment cost will be calculated by multiplying the total capital cost by the capital recovery factor of 0.1627.

Annual Cost = (cost differential) x 0.1627
Annual Cost = ($200) x 0.1627
Annual Cost = $32.54/year

Cost Effectiveness = Annual Cost / Annual Emissions Reduction
Cost Effectiveness = ($32.54/year) / (0.0012 tons of NOx/year)
Cost Effectiveness = $27,117/ton of NOx

Although the cost effectiveness for a 20 ppmv instantaneous water heater is slightly above the BACT cost effectiveness threshold for NOx reductions ($24,500/ton of NOx), the cost of the low-NOx unit is at most an extra $200 per household. This cost would not be incurred by a specific facility or operator and it represents a small fraction of the total cost of the unit that is estimated to be $2,500-$10,000. Also, with an estimated lifetime of at least 10 years for these units, the extra $200 would be spread out over a 10 year period. Therefore, amending Rule 4308 to lower the limit for instantaneous water heaters is recommended.

Mobile Home Exemption

The possibility of removing the exemption for water heaters used in mobile homes from Rule 4308 was explored as a potential opportunity that could result in gradual emission reductions as existing higher emitting water heaters are replaced by newer low-NOx models. However, as discussed above, other air districts do not regulate mobile home water heaters within the size range of Rule 4308. In addition, after researching the size of mobile home water heaters, it was found that mobile home water heaters are not available in the 0.075-2.0 MMBtu/hr size range. Four mobile home retailers and three mobile home manufacturers were contacted to inquire about the size of mobile home water heaters. All seven contacts stated that the average size of a mobile home water heater is 30-40 gallons whereas a 0.075 MMBtu/hr water heater is approximately 80 gallons. One manufacturer and one retailer stated that 50 gallon mobile home water heaters are available but rarely used. If the exemption for mobile home water heaters in Rule 4308 were to be removed, it would not result in any additional emissions reductions since units do not exist in this size range.

Recreational Vehicle Exemption
The potential opportunity to reduce emissions by removing the exemption for recreational vehicles (RVs), per EPA's suggestion in the 2011 TSD for the approval of the 2009 amendments to this rule, was explored. While the EPA TSD for Rule 4308 included this recommendation, the recommendation is not a RACT requirement as demonstrated by EPA's approval of the rule into the State Implementation Plan (SIP) as RACT.

During the last rule-amending project, stakeholder input was received indicating that there are very few units in RVs that fall under the size category subject to this rule that also run on Public Utilities Commission (PUC) quality natural gas. As noted in the 2009 staff report, most units in RVs are 12 gallons, which is smaller than the 80 gallon size of a typical 0.075 MMBtu/hr unit[7]. Also, RV units are typically not used on a frequent basis and thus are small contributors to the NOx emissions of this source category. Air Districts such as SCAQMD and BAAQMD include this exemption in their rules. Removing this exemption would result in little to no emissions reductions because of the lack of availability of these units and the intermittent use of units in RVs. Due to the lack of potential emission reductions, there is no recommendation for amending this rule to remove this exemption.

Risk-based Strategy Analysis
The emissions from units subject to Rule 4308 contribute 1.4% of average winter NOx, 4.9% of average winter SOx, and 1.1% of average winter PM2.5 emitted from stationary and area sources in the 2012 emission inventory. These units are primarily fired on PUC-quality natural gas, which is generally considered a clean burning fuel with low SOx and PM emissions. Overall, Rule 4308 has significantly reduced NOx and SOx emissions from these units and has assisted in reducing PM2.5 concentrations through reductions of these key precursors.

Control Measure Commitments
The following is a summary of recommended commitments for Rule 4308.

Regulatory Action
District analysis identified low-NOx instantaneous water heaters between 0.075-0.4 MMBtu/hr as an opportunity to reduce emissions from this source category. Units between 0.075-0.4 MMBtu/hr that meet a NOx emissions limit of 20 ppmv are readily available in the Valley at an additional cost of $100-$200 per unit. The District recommends amending Rule 4308 to lower the emissions limit of these units from 55 ppmv to 20 ppmv of NOx.

[7] Linebach, Katy. (2009). *Final Staff Report for Amendments to Rule 4308 (Boilers, Steam Generators, and Process Heaters—0.075 MMBtu/hr to less than 2.0 MMBtu/hr)*. Fresno, CA: San Joaquin Valley Air Pollution Control District.

Incentive Action
Boilers, steam generators, and process heaters subject to Rule 4308 are regulated units that have already implemented controls to significantly reduce NOx emissions; as such, opportunities for incentive programs are minimal. There are no recommendations for incentive actions at this time.

Technology Advancement Action
There is no recommendation for a new technology advancement project for units subject to Rule 4308. Through its Technology Advancement Program, the District will continue to seek potential feasible and low-cost technologies that may provide for additional emission reduction opportunities in this category.

Policy Initiatives
The District's current legislative platform includes support for the increased development and use of cleaner-burning fuels. The recommendation is to continue supporting the current legislative platform but there are no recommendations for new policy initiatives at this time.

Education and Outreach
The District currently provides a robust education and outreach program for regulated sources through the Small Business Assistance program, Permit Stakeholder Meetings, Compliance Assistance Bulletins, and public notices for public workshops and public hearings. The District does not have recommendations for new education and outreach efforts for these sources. The District will continue to work closely with affected sources to ensure successful compliance.

D.1.4 Rule 4309 Dryers, Dehydrators, and Ovens

Source Category

Rule 4309 is applicable to any dryer, dehydrator, or oven that is fired on gaseous fuel, liquid fuel, or is fired on gaseous and liquid fuel sequentially, and the total rated heat input for the unit is 5.0 million British thermal units per hour (5.0 MMBtu/hr) or greater. The purpose of this rule is to limit NOx and carbon monoxide (CO) emissions from these units, which result from the combustion of fuel in the burners. The rule enforces NOx emission limits between 3.5-12 ppmv for four categories of equipment, achieving approximately 34% control of total NOx emissions.

Rule 4309 was adopted on December 15, 2005 and has not been amended. EPA finalized approval of Rule 4309 on May 30, 2007 and deemed this rule as being at least as stringent as established RACT requirements.

Emission Inventory

Pollutant	2007	2012	2014	2015	2016	2017	2018	2019
	Annual Average - Tons per day							
PM2.5	0.67	0.68	0.72	0.74	0.76	0.78	0.80	0.82
NOx	0.20	0.17	0.18	0.19	0.19	0.20	0.20	0.21
SOx	0.39	0.40	0.42	0.43	0.44	0.45	0.47	0.48
	Winter Average - Tons per day							
PM2.5	0.65	0.65	0.69	0.71	0.73	0.75	0.77	0.78
NOx	0.18	0.15	0.16	0.16	0.17	0.17	0.18	0.18
SOx	0.32	0.32	0.34	0.35	0.36	0.37	0.38	0.39

Regulatory Evaluation

How does District Rule 4309 compare with federal rules and regulations?

Rule 4309 is equivalent to the applicable federal standards and guidelines. Rule 4309 is as stringent as the federal Alternative Control Techniques (ACT) (EPA –453/R-94-004 “Emissions from Cement Manufacturing”, updated September 2000), as determined in the 2005 Rule Consistency Analysis for Rule 4309. Federal requirements such as New Source Performance Standards (NSPS), National Emission Standards for Hazardous Air Pollutants (NESHAP), and Maximum Achievable Control Technology (MACT) requirements are not applicable to this source category; additionally, there are no EPA Control Techniques Guidelines (CTG) or Best Available Control Technology (BACT) requirements listed for this category.

How does District Rule 4309 compare to rules in other air districts?

When comparing Rule 4309 to other California air districts' rules for similar sources, no other air district was found to contain a rule for dryers, dehydrators, and ovens. BAAQMD (Regulation 12 Rule 3—Asphalt Air Blowing), SCAQMD (Rule 470—Asphalt Air Blowing), and VCAPCD (Rule 69—Asphalt Air Blowing) only regulate asphalt plants and Rule 4309 is more stringent than the requirements in all three rules. SMAQMD does not have an analogous rule to Rule 4309.

Rule 4309 was also compared to SCAQMD and BAAQMD BACT requirements. Since SCAQMD and BAAQMD only regulate asphalt plants, the only differences between District rule requirements and other air districts' BACT requirements apply to requirements for asphalt facilities.

BACT comparisons revealed that the use of Public Utilities Commission (PUC) quality natural gas fuel was part of the NOx and SOx BACT requirements for asphalt plants in the District, BAAQMD, and SCAQMD. In addition, the NOx limit for asphalt plants in BAAQMD BACT guidelines is 3.9 ppmv at an oxygen correction factor of 19% by volume of O2 (19% O2), whereas Rule 4309 has a limit of 4.3 ppmv for gaseous fuel and 12 ppmv for liquid fuel @ 19% O2. These potential opportunities were evaluated and have been included in a discussion of the feasibility of both requirements in the Asphalt Plants section of the emission reduction opportunities discussion.

As previously stated, this rule satisfies RACT requirements; any additional requirements would be more stringent and go beyond RACT. In addition to being one of the most stringent rules in the nation for this source category, any new unit brought to the Valley, as well as any major modifications to existing units, would trigger Best Available Control Technology (BACT) requirements. Subsequently, these new or modified units would be required to use technology and control emissions beyond those established as RACT and implement the best available emission controls, as required by District Rule 2201 (New and Modified Stationary Source Review Rule).

Emission Reduction Opportunities

The adoption of Rule 4309 has considerably reduced NOx and PM emissions from this source category. The emissions inventory for NOx from dryers, dehydrators, and ovens has dropped from 1.93 tpd in 2005 to 0.17 tpd in 2012. Although this source category had a relatively small emissions inventory prior to the adoption of Rule 4309, stakeholders have installed control equipment and modified their operations considerably to reduce emissions to ultra-low levels. Given the significant effort already made to reduce emissions from this source category, there are little remaining opportunities for obtaining additional emissions reductions. For the sake of thoroughness, the possibility of further reducing emissions from these units is evaluated in the following discussion.

Asphalt Plants
As mentioned above, PUC-quality natural gas fuel is part of the BACT requirements for asphalt plants for the District, BAAQMD, and SCAQMD. There are currently 11 asphalt plants in the Valley that do not utilize PUC-quality natural gas because some facilities are physically too far removed from natural gas lines to use natural gas. Nine of these asphalt plants use LPG fuel or propane to comply with the same gaseous fuel fired limit as PUC-quality natural gas-fired facilities. The other two facilities utilize diesel gas; however, neither facility operates full time and their combined NOx emissions are less than 2 tons per year. Therefore, requiring natural gas for all asphalt facilities is not a feasible opportunity that would generate significant emission reduction benefit.

The potential opportunity for emission reductions by lowering the emissions limits for asphalt plants from the current NOx limits of 4.3 ppmv (gaseous fuel) and 12 ppmv (liquid fuel) to make them closer or equivalent to the BAAQMD BACT limit of 3.9 ppmv @ 19% O2 was also evaluated. To meet this limit, operators would need to install low-NOx burners or modify existing burners to comply with lower limits; however, all of the asphalt plants have already installed new low-NOx burners or modified their units to meet the 4.3 ppmv @ 19% O2 and 12 ppmv @ 19% O2 emissions limits in Rule 4309.

Based on District permit records, a good portion of the asphalt units fired on gaseous fuel would be in compliance with a 3.9 ppmv @ 19% O2 NOx limit. However, reducing the limit to 3.9 ppmv @ 19% O2 would reduce the margin of compliance the facility has, and would make it more difficult for the facility to show continued compliance. In addition, reducing the limit from 4.3 ppmv to 3.9 ppmv would be an administrative change in nature, since it would not require any additional control equipment or changes in operating techniques or practices to comply, and it would not generate additional emissions reductions from these units.

A higher NOx limit is required for the liquid fuel fired facilities due to the characteristics of liquid fuels. In BAAQMD's BACT guideline for hot mix asphalt facilities, there is a clause that states, *"For remote locations where natural gas is not available, liquefied petroleum gas may be permitted up to 38 ppmvd NOx @ 15% O2 and fuel oil < 0.05 wt. % sulfur may be permitted up to 55 ppmvd NOx @ 15% O2."* This equates to 12.24 ppmv @ 19% O2 for liquefied petroleum gas and 17.73 ppmv @ 19% O2 for fuel oil. The District's Permits department enforces a limit of 4.3 ppmv @ 19% O2 for liquefied petroleum gas and 12 ppmv for other liquid fuels. Therefore, the District's requirements are more stringent than both limits in the BAAQMD BACT guideline.

Dehydrators
Rule 4309 requires dehydrators be fired on PUC-quality natural gas. The potential opportunity to further reduce emissions by requiring the use of low-NOx burners during the 2005 rule adoption was evaluated; however, this option was deemed infeasible due to the potential negative effects on product quality. Additionally, enforcing the emissions limits was found to be potentially infeasible because monitoring and source testing of dehydrators is difficult to perform, if not impossible.

In the 2005 staff report for Rule 4309, a cost effectiveness analysis was conducted that compared the use of PUC-quality natural gas and the installation of low-NOx burners on dehydrators.

The costs in the staff report included not only replacements of all of the burners in the current units with low-NOx burners, but also an additional dryer that would need to be installed to keep a facility's throughput the same. This evaluation yielded the following results:

- Cost ($/year): $2,885,925
- Potential Emissions Reductions (tons per year): 58.57
- Cost Effectiveness ($/ton): $49,273

At a cost effectiveness of approximately $50,000/ton of NOx reduced, requiring low-NOx burners for dehydrators is not a cost effective option for dehydrators in the Valley. If the figure was adjusted to today's value, low-NOx burners would be even less cost effective.

Dryers

The potential opportunity to add a requirement for the use of dust collection devices, such as baghouses, was considered for the reduction of PM2.5. Through the District's New Source Review Rule (Rule 2201), dust collection devices are already in place in the permit requirements for units that create PM emissions from handling the products they are drying. These facilities install baghouses or cyclones because they do not want to blow their product out of their stack. While baghouses can foster PM2.5 reductions, cyclones are generally not as effective in removing fine particulate matter.[8]

The potential installation of baghouses on dryers was researched. However, it is technologically infeasible to install a baghouse for some of the dryers subject to Rule 4309. The purpose of a dryer is to remove moisture from a product, which means that the exhaust from dryers have a high humidity. Baghouses can have problems with high humidity exhaust streams because the bags become caked. The air stream would have to be dried somehow before entering the baghouse. As a result, this is not a feasible opportunity at this time.

The potential opportunity to reduce emissions by removing the exemption for column dryers and dryers with no stack and one or more sides open to the atmosphere was also considered. However, as was true during the 2005 rule adoption, compliance with the proposed limits would be difficult to determine reliably given the design of these units. Column dryers have large fans to move the warm air through the material and air escapes through screens that cover the side of the dryer. Similarly, dryers with no stack and at least one side open deal with air escape, which makes monitoring and testing emissions difficult, if not impossible. Since source testing of these types of dryers is

[8] Northeast States for Coordinated Air Use Management. (November 2008) *Applicability and Feasibility of NOx, SO2, and PM Emissions Control Technologies for Industrial, Commercial, and Institutional (ICI) Boilers.*

difficult due to the fact that there is not a stack where all emissions are exhausted, this is not a technologically feasible opportunity at this time.

At this time, the District's analysis indicates that there are no feasible opportunities for additional emission reduction regulatory strategies for this source category.

Risk-based Strategy Analysis

The emissions from units subject to Rule 4309 contribute 3.9% of average winter SOx and 1.2% of average winter PM2.5 emitted from stationary and area sources in the 2012 emission inventory. These units are primarily fired on PUC-quality natural gas, which is generally considered a clean burning fuel with low SOx and PM emissions. Overall, Rule 4309 has significantly reduced NOx and SOx emissions from these units and has assisted in reducing PM2.5 concentrations through reductions of these key precursors.

Control Measure Commitments

The following is a summary of recommended commitments for Rule 4309.

Regulatory Action

The District's analysis did not identify any additional technologically feasible and cost effective potential controls. Therefore, there are no recommendations for additional regulatory actions for Rule 4309.

Incentive Action

Dryers, dehydrators, and ovens subject to Rule 4309 are regulated units, which makes the opportunities for incentive programs minimal. There are no recommendations for incentive actions at this time.

Technology Advancement Action

There is no recommendation for a new technology advancement project for units subject to Rule 4309. Through its Technology Advancement Program, the District will continue to seek potential feasible and low-cost technologies that may provide for additional emission reduction opportunities in this category.

Policy Initiatives

The District's current legislative platform includes support for the increased development and use of cleaner-burning fuels. The recommendation is to continue supporting the current legislative platform but there are no recommendations for new policy initiatives at this time because the rule already requires effective emission control technologies.

Education and Outreach

The District currently provides a robust education and outreach program for regulated sources through the Small Business Assistance program, Permit Stakeholder Meetings, Compliance Assistance Bulletins, and public notices for public workshops and public hearings. There are no recommendations for new education and outreach efforts for these sources. The District will continue to work closely with affected sources to ensure successful compliance.

D.1.5 Rule 4320 Advanced Emission Reduction Options for Boilers, Steam Generators, and Process Heaters Greater than 5.0 MMBtu/hr

Source Category

This rule applies to any gaseous fuel or liquid fuel fired boiler, steam generator, or process heater with a total rated heat input greater than 5 million British thermal units per hour (MMBtu/hr). The purpose of Rule 4320 is to limit NOx and carbon monoxide (CO) emissions from boilers, steam generators, and process heaters of this size range.

Rule 4320 is the third generation rule for this source category. The first District rule for this source category, Rule 4305 (Boilers, Steam Generators, and Process Heaters) was adopted on December 16, 1993. Rule 4305 was superseded by Rule 4306 (Boilers, Steam Generators, and Process Heaters – Phase 3) on September 18, 2003 to implement a NOx control measure from the District's ozone and PM10 attainment plans lowering the NOx emissions limits in Rule 4305. Since adoption, Rule 4306 has been amended twice.

The most recent rule amendment in October 2008 was initially proposed to lower the NOx limit from 9 ppmv to 6 ppmv for units greater than 20 MMBtu/hr. It was determined that the proposed NOx limits could be accomplished by using selective catalytic reduction (SCR) or a combination of SCR and ultra-low NOx burners (ULNBs), thus making the lower limits technologically feasible. However, through the public workshop process and additional research it was also determined that most of the units subject to Rule 4306 have undergone several generations of NOx controls, and consequently, certain applications of SCR may not be feasible due cost effectiveness and/or technological infeasibility because of physical limitations. Therefore, the lower NOx limits were included in new Rule 4320 and an option was provided in the rule that allows for the payment of an annual emissions fee based on total actual emissions, rather than installation of additional NOx controls. These fees are used by the District to achieve cost effective NOx reductions through District incentive programs, the District's Technology Advancement Program, and other routes. The previous versions of Rule 4305 and 4306 combined with the implementation of Rule 4320 results in approximately 96% control of NOx emissions from this source category, once all of the compliance deadlines are in effect in 2014. EPA finalized approval for Rule 4320 on March 25, 2011 and deemed this rule as being at least as stringent as established RACT requirements.

Emission Inventory

Pollutant	2007	2012	2014	2015	2016	2017	2018	2019
	Annual Average - Tons per day							
PM2.5	1.46	1.31	1.26	1.24	1.22	1.20	1.18	1.16
NOx	2.76	1.49	1.34	1.25	1.21	1.17	1.14	1.10
SOx	1.53	0.87	0.35	0.35	0.34	0.34	0.33	0.32
	Winter Average - Tons per day							
PM2.5	1.43	1.28	1.24	1.22	1.20	1.18	1.16	1.14
NOx	2.66	1.43	1.29	1.20	1.16	1.13	1.09	1.06
SOx	1.49	0.85	0.35	0.34	0.34	0.33	0.32	0.32

Regulatory Evaluation

How does District Rule 4320 compare with federal rules and regulations?

Rule 4320 is equivalent to the applicable federal standards and guidelines. Rule 4320 is as stringent as the EPA Best Available Control Technology (BACT) requirements, Alternative Control Techniques (ACT) (EPA –453/R-94-022 “Alternative Control Techniques Document – NOx Emissions from Industrial/Commercial/Institutional Boilers”, dated March 1994 and EPA – 452/R-93-008 “Alternative Control Techniques Document—NOx Emissions from Utility Boilers”, dated March 1994), New Source Performance Standards (NSPS) (40 CFR 60 Subpart D (Standards of Performance for Fossil-Fuel Fired Steam Generators for Which Construction Commenced After August 17, 1971) and 40 CFR 60 Subpart Dc (Standards of Performance for Small Industrial-Commercial-Institutional Steam Generating Units)), and Maximum Achievable Control Technology (MACT) (40 CFR 63 Subpart DDDDD (NESHAP for Industrial, Commercial, and Institutional Boilers and Process Heaters)) requirements. There are no EPA Control Techniques Guidelines (CTGs) for this category.

How does District Rule 4320 compare to rules in other air districts?

Rule 4320 was compared to other California air districts’ rules for similar sources and was found to be at least as stringent as the analogous rules for SCAQMD (Rule 1146—Emissions of Nitrogen from Industrial, Institutional, and Commercial Boilers, Steam Generators, and Process Heaters), BAAQMD (Regulation 9 Rule 7—Nitrogen Oxides and Carbon Monoxide from Industrial, Institutional and Commercial Boilers, Steam Generators and Process Heaters and Regulation 9 Rule 10—Nitrogen Oxides and Carbon Monoxide from Boilers, Steam Generators and Process Heaters in Petroleum Refineries), SMAQMD (Rule 411—NOx from Boilers, Process Heaters and Steam Generators), and VCAPCD (Rule 74.15—Boilers, Steam Generators and Process Heaters). Rule 4320 also meets or exceeds the established BACT requirements for these units at BAAQMD and SCAQMD. Rule 4320 currently dictates SJVAPCD BACT requirements for Valley sources.

Emission Reduction Opportunities

Over the years, the District has adopted numerous generations of rules and rule amendments for boilers greater than 5 MMBtu/hr that have significantly reduced NOx and PM emissions from this source category. The emissions inventory for NOx from these boilers has dropped from 40.2 tpd in 1993 to 1.49 tpd in 2012. As part of these regulatory efforts, hundreds of boilers in the Valley have been equipped with the best available NOx and PM control technologies. Additional emissions reductions are forthcoming with existing Rule 4320 as more compliance dates approach in the next couple of years. Given the significant effort already made to reduce emissions from this source category, there are little remaining opportunities for obtaining additional emissions reductions. For thoroughness, the possibility of further reducing emissions from boilers greater than 5 MMBtu/hr is evaluated in the following discussion.

Low Temperature Oxidation

Emerging technologies that may have the potential to reduce emissions were researched. A Low Temperature Oxidation (LTO) System was installed at a dairy in the SCAQMD and was able to reach NOx limits between 1.0 - 3.2 ppmv for loads 4.1 - 13 MMBtu/hr. The LTO system utilizes ozone to oxidize and control various pollutants, including NOx. According to the SCAQMD BACT database information, capital and installation costs ranged from $360,000 - $400,000 for the LTO system when it was installed in 1997[9]. Installation within the South Coast region was heavily subsidized with government funding and the installation costs appear cost prohibitive for an installation that is not subsidized. In addition, the LTO system is classified as “Other Technologies” in the SCAQMD BACT guidelines, which means that the technology has not met the achieved in practice (AIP) criteria of six months of continuous operation at a minimum of 50% operating capacity and does not qualify as the lowest achievable emission rate (LAER). Since the technology has not been achieved in practice and cost prohibitive without significant subsidies, this is not a feasible opportunity at this time.

EMx

The potential for emissions reductions through EMx, the second generation of the SCONOx technology that is a post-combustion control that reduces NOx, SOx, CO, and volatile organic compound (VOC) emissions, was researched. This technology has not been AIP in the District and there is no available data that indicates that SCONOx or EMx has been installed on boilers even though the manufacturer’s website states that the technology is transferrable to industrial boilers. Based on research of the best available controls from EPA and other air districts, the SCONOx and EMx systems have only been utilized by power plants for control of turbine emissions. In fact, cost effectiveness analyses conducted by the District for the installation of SCONOx/EMx units on large power plant turbine installations within the San Joaquin Valley have been found to not be cost effective. Given the high cost effectiveness demonstrated for turbines and lack of demonstrated practice with boilers, the District does not expect this technology to be feasible or cost effective for reducing emissions from this category.

[9] (2012). *SCAQMD Best Available Control Technology (BACT) Database*. Diamond Bar, CA: South Coast Air Quality Management District.

PM2.5 Limits for Alternative Fuels
The majority of boilers (>5 MMBtu/hr) in the Valley combust Public Utilities Commission (PUC) quality natural gas, which contains a very low sulfur content and inherently has low emissions. Few boilers in the Valley use alternative fuels for their combustion processes. Alternative fuels include digester gas, produced gas, and liquid fuel. Units fired on digester gas or produced gas are already required to use inlet gas scrubbers to meet District rule requirements. Current rule language requires that liquid fuel shall be used only during a PUC-quality natural gas curtailment period provided it contains no more than 15 ppm sulfur. While the use of liquid fuel is strictly limited, the feasibility of reducing PM emissions through adding PM2.5 limits for units using liquid fuel was explored as part of the District's comprehensive control measure evaluation.

There are 62 units that utilize liquid fuel in the Valley (>5 MMBtu/hr) with a combined emissions inventory of approximately 0.02 tons per year of total PM. The low emissions inventory is attributed to the fact that these units either utilize liquid fuel as a backup if there is a natural gas curtailment or are minimally operated units. The following three technologies were researched as potential opportunities to reduce PM emissions: baghouses, electrostatic precipitators (ESPs), and wet scrubbers. Baghouses control total PM and PM2.5 emissions by 90-99%; ESPs control total PM and PM2.5 emissions by 90-99%; and wet scrubbers control large particulates (>PM5) by 99% and PM2.5 emissions by approximately 50%[10]. Currently, there are a few crude oil-fired or field gas-fired steam generators operating in crude oil production facilities that are required by their permits to operate SOx scrubbers and ESPs. However, baghouses are typically not used with liquid-fired boilers due to the potential clogging of the baghouse[11] and are therefore not a recommended technology due to infeasibility and safety issues.

PM Potential Emissions Reductions for an ESP and Scrubber

For the purposes of these calculations, the following assumptions were made:

1. For simplicity, the analysis will evaluate the cost effectiveness of these technologies for total PM reductions from liquid fuel fired units.
2. The PM control efficiency of an ESP is 99%.
3. The PM control efficiency of a scrubber is 99%.

Potential Emissions Reductions$_{ESP}$ = (Total PM Emissions) x (Control Efficiency)
Potential Emissions Reduction$_{ESP}$ = 0.02 tons/year X 0.99
Potential Emissions Reduction$_{ESP}$ = 0.0198 tons/ year (tpy)

Potential Emissions Reductions $_{scrubber}$ = (Total PM Emissions) x (Control Efficiency)
Potential Emissions Reduction $_{scrubber}$ = 0.02 tons/year X 0.99
Potential Emissions Reduction $_{scrubber}$ = 0.0198 tons/ year (tpy)

[10] Northeast States for Coordinated Air Use Management. (November 2008) *Applicability and Feasibility of NOx, SO2, and PM Emissions Control Technologies for Industrial, Commercial, and Institutional (ICI) Boilers.*
[11] Northeast States for Coordinated Air Use Management. (November 2008) *Applicability and Feasibility of NOx, SO2, and PM Emissions Control Technologies for Industrial, Commercial, and Institutional (ICI) Boilers.*

Annualized Cost of an ESP and Wet Scrubber

The capital cost for the installation of an ESP for a 1-5 MMBtu/hr boiler ranges from \$90,000 - \$100,000 and the annual maintenance cost is \$1,000-\$2,000.[12] For the wet scrubber system, EPA estimated the annualized cost at \$5,300-\$102,000 per sm^3/sec at an average air flow rate of 0.7- 47 sm^3/sec.[13] The following assumptions in the cost effectiveness calculations:

1. The capital cost of an ESP for a 5 MMBtu/hr boiler is assumed to be \$100,000.
2. The annual maintenance cost of an ESP for a 5 MMBtu/hr boiler is assumed to be \$2,000.
3. The annualized cost of a wet scrubber system is assumed to be the median of the range above (\$53,650 per sm^3/sec).
4. The average air flow rate for a wet scrubber system is assumed to be the median of the range above (23.85 sm^3/sec).
5. The total capital and maintenance cost of an ESP will be calculated by multiplying the cost of 1 unit by the total number of units.
6. The total annualized cost of a wet scrubber will be calculated by multiplying the annualized cost of 1 unit by the total number of units.
7. Lifetime of the ESP is 10 years at 10% interest. To account for this, the annualized capital cost will be calculated by multiplying the total capital cost by the capital recovery factor of 0.1627 and adding the annual maintenance costs.

Annual $Cost_{ESP}$ = (Total Capital Cost) x (0.1627) + (Annual Maintenance Cost x 62)
Annual $Cost_{ESP}$ = (\$100,000 x 62) x (0.1627) + (\$2,000 x 62)
Annual $Cost_{ESP}$ = \$1,132,740/year

Annual $Cost_{scrubber}$ = (Annualized Cost of 1 unit) x (Number of Units) x (Average Flow Rate)
Annual $Cost_{scrubber}$ = (\$53,650/ sm^3/sec) x (62) x (23.85 sm^3/sec)
Annual $Cost_{scrubber}$ = \$79,332,255 year

Cost Effectiveness of an ESP and Wet Scrubber

Cost Effectiveness = Annual Cost / Annual Emissions Reductions

$Cost Effectiveness_{ESP}$ = (\$1,132,740/year) / (0.0198 tons/ year)
$Cost Effectiveness_{ESP}$ = \$57,209,091/ton of PM

$Cost Effectiveness_{scrubber}$ = (\$79,332,255/year) / (0.0198 tons/ year)
$Cost Effectiveness_{scrubber}$ = \$4,006,679,545/ton of PM

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[12] Catherine Roberts. (March 2009) *Information on Air Pollution Control Technology for Woody Biomass Boilers.* Environmental Protection Agency Office of Air Quality Planning and Standards and Northeast States for Coordinated Air Use Management.
[13] (2002). *Air Pollution Control Technology Fact Sheet: Spray-Chamber/Spray-Tower Wet Scrubber.* Environmental Protection Agency.

As illustrated above, neither PM control technology is a cost effective option for this source category. The cost of the ESP technology does not include costs of retrofitting equipment and/or the facility or compliance monitoring costs, which would drive the cost effectiveness up even more. In addition, the annualized costs provided by EPA for the wet scrubber system are in 2002 dollars, which means the value above would be even greater if it were adjusted to 2012 dollars.

At this time, the District's analysis indicates that there are no feasible opportunities for additional emission reduction regulatory strategies for this source category.

Risk-based Strategy Analysis

The emissions from units subject to Rule 4320 contribute 3.0% of average winter NOx, 10.3% of average winter SOx, and 2.3% of average winter PM2.5 emitted from stationary and area sources in the 2012 emission inventory. These units are also fired on PUC-quality natural gas, which is generally considered a clean burning fuel with low SOx and PM emissions. Overall, Rule 4320 has significantly reduced NOx and SOx emissions from these units and has assisted in reducing PM2.5 concentrations through reductions of these key precursors.

Control Measure Commitments

The following is a summary of recommended commitments for Rule 4320.

Regulatory Action

The District's analysis did not identify any additional technologically feasible and cost effective potential controls. Therefore, there are no recommendations for additional regulatory actions for Rule 4320.

Incentive Action

Boilers subject to Rule 4320 are regulated units that have been subject to several generations of regulations; as such, the opportunities for incentive programs are minimal. There are no recommendations for incentive actions at this time.

Technology Advancement Action

There is no recommendation for a new technology advancement project for units subject to Rule 4320. Through its Technology Advancement Program, the District will continue to seek potential feasible and low-cost technologies that may provide for additional emission reduction opportunities in this category.

Policy Initiatives

The District's current legislative platform includes support for the increased development and use of cleaner-burning fuels. The recommendation is to continue supporting the current legislative platform but there are no recommendations for new policy initiatives at this time because the rule already requires the most effective emission control technologies.

Education and Outreach

The District currently provides a robust education and outreach program for regulated sources through the Small Business Assistance program, Permit Stakeholder Meetings, Compliance Assistance Bulletins, and public notices for public workshops and public hearings. The District does not have recommendations for new education and outreach efforts for these sources. The District will continue to work closely with affected sources to ensure successful compliance.

D.1.6 Rule 4352 Solid Fuel Fired Boilers, Steam Generators, and Process Heaters

Source Category

The purpose of Rule 4352 is to limit NOx and carbon monoxide (CO) emissions from any boiler, steam generator or process heater fired on solid fuel. Prior to September 14, 1994 solid fuel fired units were exempt from the requirements of District Rule 4305. The adoption of Rule 4352 established NOx limits of 200 parts per million volume (ppmv) for municipal solid waste facilities (MSW), 0.35 pounds per million British thermal units per hour (lb/MMBtu) for biomass facilities, and 0.20 lb/MMBtu for all other solid fuel fired units. Since its adoption, the rule has been amended three times. The recent December 2011 amendments strengthened the rule by lowering NOx emissions limits for all three source categories. However, no emissions reductions were quantified because the rule amendments were meant to satisfy EPA RACT requirements and all units were determined to be operating at the proposed emission limits. EPA finalized approval of Rule 4352 on November 6, 2012 and deemed this rule as being at least as stringent as established RACT requirements.

While previous rule-amending projects for Rule 4352 have not quantified specific emissions reductions, the increasing presence of biomass facilities in the Valley is fostering emissions reductions. As an energy source, biomass can either be used directly or converted into other energy products such as biofuel. Biomass facilities in the Valley reduce the amount of pollutants created by open burning practices and the landfilling of potential biofuels such as agricultural materials, and urban and forest wood waste products by utilizing these materials. To date, agricultural burning has been reduced by 70% and approximately 90% of agricultural burning is projected to be eliminated in the coming years.

Emission Inventory

Pollutant	2007	2012	2014	2015	2016	2017	2018	2019
	Annual Average - Tons per day							
PM2.5	0.54	0.64	0.69	0.74	0.79	0.81	0.85	0.87
NOx	3.98	4.38	4.59	4.77	4.97	5.07	5.18	5.26
SOx	1.34	1.25	1.25	1.28	1.32	1.36	1.38	1.40
	Winter Average - Tons per day							
PM2.5	0.56	0.67	0.72	0.76	0.81	0.84	0.87	0.90
NOx	4.05	4.46	4.67	4.86	5.06	5.16	5.28	5.35
SOx	1.35	1.26	1.27	1.29	1.34	1.37	1.40	1.41

Regulatory Evaluation

How does District Rule 4352 compare with federal rules and regulations?

Rule 4352 is equivalent to the applicable federal standards and guidelines. Rule 4352 is as stringent as the federal Alternative Control Techniques (ACT) (EPA –453/R-94-022 "Alternative Control Techniques Document – NOx Emissions from Industrial/Commercial/Institutional Boilers", dated March 1994 and EPA – 452/R-93-008 "Alternative Control Techniques Document—NOx Emissions from Utility Boilers", dated March 1994), New Source Performance Standards (NSPS) (40 CFR 60 Subpart D (Standards of Performance for Fossil-Fuel Fired Steam Generators for Which Construction Commenced After August 17, 1971) and 40 CFR 60 Subpart Db (Standards of Performance for Industrial-Commercial-Institutional Steam Generating Units)), and Maximum Achievable Control Technology (MACT) requirements (40 CFR 63 Subpart DDDDD (NESHAP for Industrial, Commercial, and Institutional Boilers and Process Heaters)). Additionally, there are no EPA Control Techniques Guidelines (CTG) listed for this category.

Rule 4352 was also compared to EPA Best Available Control Technology (BACT) standards and it was noted that Selective Catalytic Reduction (SCR) systems, scrubbers, electrostatic precipitators, and baghouses are amongst the technologies considered to be BACT for this source category. See the Emission Reduction Opportunities section for a discussion regarding these technologies.

How does District Rule 4352 compare to rules in other air districts?

Rule 4352 was compared to several other air districts' rules. Per the 2011 Staff Report[14], it was determined there are currently no solid fuel fired units subject to the NOx emission limits in the following rules in other air districts:

- BAAQMD Regulation 9 Rule 7 (Nitrogen Oxides and Carbon Monoxide from Industrial, Institutional and Commercial Boilers, Steam Generators and Process Heaters),
- BAAQMD Regulation 9 Rule 11 (Nitrogen Oxides and Carbon Monoxide from Electric Power Generating Steam Boilers),
- VCAPCD Rule 74.15 (Boilers, Steam Generators and Process Heaters),
- SCAQMD Rule 1146 (Emissions of Oxides of Nitrogen from Industrial, Institutional, and Commercial Boilers, Steam Generators and Process Heaters),
- SMAQMD Rule 411 (NOx from Boilers, Process Heaters and Steam Generators).

[14] Corless, N., DeMaris, F. (2011). *Revised Proposed Amendments to Rule 4352 (Solid Fuel Fired Boilers, Steam Generators and Process Heaters).* Fresno, CA: San Joaquin Valley Air Pollution Control District.

Units subject to District Rule 4352 would be exempt from the following rules in other air districts:

- VCAPCD Rule 59 (Electrical Power Generating Equipment—Oxides of Nitrogen Emissions),
- VCAPCD Rule 74.15 (Boilers, Steam Generators and Process Heaters), and
- SCAQMD Rule 1135 (Emissions of Oxide of Nitrogen from Electric Power Generating Systems) exempt sources burning solid fuels.

In addition to being one of the most stringent rules in the nation for this source category, any new unit brought to the Valley, as well as any major modifications to existing units, would trigger BACT requirements. Subsequently, these new or modified units would be required to use technology and control emissions beyond those established as RACT and implement the best available emission controls as required by District Rule 2201 (New and Modified Stationary Source Review Rule).

Emission Reduction Opportunities

Rule 4352 has been amended numerous times making it one of the most stringent rules in the country for this source category. Facilities subject to this rule have invested millions of dollars to implement innovative control technologies and have significantly reduced emissions from solid fuel fired boilers. The increased presence of biomass facilities in the Valley, from either new facilities or other solid fuel fired boilers that have converted to biomass, continues to significantly reduce NOx and PM emissions from open burning practices. Given the significant efforts and investments already made to reduce emissions from this source category, there are little remaining feasible opportunities for obtaining additional cost effective emissions reductions. For thoroughness, the possibility of further reducing emissions from these units was evaluated and cost effectiveness analyses were still performed as part of the District's comprehensive control measure evaluation.

Selective Catalytic Reduction

When comparing Rule 4352 to EPA and other air districts' BACT requirements, it was noted that SCR systems are considered BACT. A SCR system reduces NOx emissions by converting the emissions to water and elemental nitrogen. The staff report for the December 2011 amendment of this rule demonstrated that this technology is not cost effective as either a retrofit or new system. The following potential emissions reductions and cost effectiveness figures were included in the 2011 Staff Report:

Table D-3 Emissions Reductions and Cost Effectiveness of Solid Fuel Fired Boilers by Fuel Type

Fuel Type	Baseline Emissions (tons/yr)	Controlled Emissions (tons/yr)	Emissions Reduced (tons/yr)	Adjusted Annualized Cost ($/yr)	Cost Effectiveness ($/ton)
MSW	438	124	314	3,672,939	30,806
Biomass	337.26	67.46	269.8	14,661,434	54,342
Other	306.6	61.3	245.3	14,661,434	59,769

While these calculations were based off of a new installation of SCR, a retrofit system would include additional expenses and present even higher cost effectiveness figures.

Controls for Direct PM2.5 Emissions

The potential opportunity of specifying required controls for direct PM2.5 emissions, per EPA's suggestion in the 2009 and 2012 TSD for the rule, was researched. Three technologies were recognized as being able to potentially reduce direct PM2.5 emissions: electrostatic precipitators (ESPs), baghouses, and cyclones.

An ESP is a particulate collection device that removes particles from a flowing gas using the force of an electrostatic charge with a 90 - 99.9% control efficiency of PM2.5 for solid-fuel fired boilers within the 100-500 MMBtu/hr size range of District units[15]. A baghouse, on the other hand, is a technology in which particulates are removed from a stream of exhaust gases as the stream passes through a large cloth bag. Baghouses have a PM2.5 removal effectiveness of 90-99.9% for solid fuel fired boilers in the size range of District units[16]. Coal and coke-fired units generally use baghouses, but biomass boilers usually use ESPs because of the health and safety risk of the burning embers causing a fire in the baghouse. However, when cyclones are combined with the use of a baghouse, the burning embers are extinguished and allow for the use of a baghouse in a biomass facility[17]. This also reduces acid gases and some PM2.5 compared to the use of a baghouse alone.

All of the facilities subject to Rule 4352 have installed either a baghouse or ESP particulate matter removal system due to permitting requirements. Since the control efficiency ranges for both technologies are equivalent, there are currently no other PM controls more effective than current practices.

Controls for SOx Emissions

Potential opportunities to reduce SOx emissions from this source category were also researched. Most facilities subject to Rule 4352 currently inject limestone into the combustion chamber to react with fuel sulfur and produce various sulfate compounds, which can then be removed by the ESP or baghouse. This control technology typically achieves around 50% control of SOx emissions[18]; however, the emissions reduced are less for a low sulfuric fuel due to the lower concentration of sulfur dioxide (SO2) initially in the combustion products.

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[15] Senior, C., Afonso, R. (January 2009). *Applicability and Feasibility of NOx, SO2, and PM Emissions Control Technologies for Industrial, Commercial, and Institutional (ICI) Boilers.* Northeast States for Coordinated Air Use Management.

[16] Senior, C., Afonso, R. (January 2009). *Applicability and Feasibility of NOx, SO2, and PM Emissions Control Technologies for Industrial, Commercial, and Institutional (ICI) Boilers.* Northeast States for Coordinated Air Use Management.

[17] Roberts, C. (2009). *Information on Air Pollution Control Technology for Woody Biomass Boilers.* Northeast States for Coordinated Air Use Management and the EPA Office of Air Quality Planning and Standards.

[18] (2001). *Technical Advice on Air Pollution Control Technologies for Coal-fired Power Plants*. Edmonton, AB: Alberta Research Council Inc.

Scrubbers are an add-on control technology that can achieve 70-95% control of SOx emissions for solid fuel fired boilers[19]. The only MSW facility in the Valley currently utilizes a semi-dry scrubber system to control SOx emissions. Therefore, the District calculated the average cost effectiveness of a scrubber system for biomass and coal/coke facilities.

The District conducted a SOx BACT evaluation for a local power generation facility that was installing a biomass boiler and determined the capital costs for a wet scrubber system are approximately $5.8 million. The annualized capital equipment cost is calculated by multiplying the installed equipment cost by the capital recovery factor of 0.1627.

Annual Capital Costs ($AC_{capital}$)

$AC_{capital}$= $5,800,000 X 0.1627
$AC_{capital}$= $943,660/year

In addition, this system has additional costs for the sodium hydroxide reagent used in the scrubber which are estimated to be an additional $642,000 per year. Thus, the total annual cost would be:

Total Annual Costs (AC_{total})

AC_{total} = Capital Costs + Reagent Costs = ($943,660/year) + ($642,000/year)
AC_{total} = $1,585,660/year

Cost effectiveness is calculated by dividing the annual cost by the annual emissions reductions from District standard emissions. One cost effectiveness analysis was conducted for the biomass and coal/coke fired units in the Valley because the four coal/coke fired units are fired on biomass part of the time.

The average SOx emissions limit of these units, based on District Permits SOx emissions limits, is 0.044 lb/MMBtu and the average heat input is 341 MMBtu/hr. An emissions factor of 0.27 lb/MMbtu at 24 hours per year is assumed to reflect the time needed for the startup and shutdown period, when the exhaust temperature is not high enough for controls to be fully effective. Therefore, those numbers were utilized to calculate annual standard emissions as follows:

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[19] Senior, C., Afonso, R. (January 2009). *Applicability and Feasibility of NOx, SO2, and PM Emissions Control Technologies for Industrial, Commercial, and Institutional (ICI) Boilers.* Northeast States for Coordinated Air Use Management.

Annual Standard Emissions ($AE_{standard}$)

$AE_{standard}$ = [(0.044 lb/MMBtu) x (341 MMBtu/hour) x (8,760 hour/year)] + [(0.27 lb/MMBtu) x (24 hour/year) x (341 MMBtu/hr)]
$AE_{standard}$ = 133,644.7 lb/year

Potential emissions, using the technologically feasible emission limit of 0.012 lb/MMBtu that is achieved by the use of a wet scrubber system, can be calculated as follows:

Annual Emissions with Wet Scrubber System ($AE_{scrubber}$)

$AE_{scrubber}$ = [(0.012 lb/MMBtu) x (341 MMBtu/hour) x (8,760 hour/year)] + [(0.27 lb/MMBtu) x (24 hour/year) x (341 MMBtu/hour)]
$AE_{scrubber}$ = 38,055.6 lb/year

Therefore, the cost effectiveness would be:

Cost Effectiveness (CE)

CE= ($1,585,660/year) ÷ [(133,644.7 lb/year – 38,055.6 lb/year) x (1 ton/2,000 lb)]
CE = $33,177/ton

It is important to note that the cost effectiveness analysis above does not reflect the costs of additional electricity consumption, additional labor costs, additional solid waste disposal, and other operational changes or additions that would be required to comply with the lower limit. The option of scrubbers is not a cost effective option, and therefore, is not feasible.

There are no additional technologies available to reduce SOx emissions from solid fuel fired units.

Start-up Periods

The possibility of reducing the allowed start-up period of solid fuel fired boilers was considered, since facilities are exempt from emissions limits during this period. Facilities subject to Rule 4352 are currently subject to a start-up limit of 96 hours. Operators currently limit their start-up and shut-down times as much as possible since down time results in reduced productivity and profits. However, facilities periodically perform “cold repairs” on their solid fuel fired boilers for maintenance or trouble-shooting purposes. This requires operators to completely shut down the boilers, which in turn requires a longer start-up period to return to correct operating temperature. When the solid fuel fired boilers are starting up, the units are not operating with a full load which reduces emissions. Therefore, this is not a technologically feasible option for solid fuel fired facilities given the needs of current work practices.

At this time, the District’s analysis indicates that there are no feasible opportunities for additional emission reduction regulatory strategies for this source category.

Risk-based Strategy Analysis

The emissions from units subject to Rule 4352 contribute 9.2% of average winter NOx and 15.3% of average winter SOx emitted from stationary and area sources in the 2012 emission inventory. Overall, Rule 4352 has significantly reduced NOx and SOx emissions from these units and has assisted in reducing PM2.5 concentrations through reductions of these key precursors.

Control Measure Commitments

The following is a summary of recommended commitments for Rule 4352.

Regulatory Action

The District's analysis did not identify any additional technologically feasible and cost effective potential controls. Therefore, there are no recommendations for additional regulatory actions for Rule 4352.

Incentive Action

Boilers subject to Rule 4352 are regulated units that have been subject to several generations of regulations; as such, the opportunities for incentive programs are minimal. As discussed above, funding or tax credits aimed at reducing emissions from biomass facilities in the Valley are available through some short-term programs such as the Existing Renewable Facilities Program through the California Energy Commission (CEC) and federal corporate tax credits from a federal program called the Renewable Electricity Program Tax Credit. Although there are no recommendations for new incentive actions at this time, the recommendation is to support agencies to continue the funding of existing incentive programs.

Technology Advancement Action

There are no recommendations for any specific technology advancement actions to reduce emissions from solid fuel fired boilers at this time. Through its Technology Advancement Program, the District will continue to seek potential feasible and low-cost technologies that may provide for additional emission reduction opportunities in this category.

Policy Initiatives

The District's current legislative platform includes support for the continued operation of biomass facilities and increased development and use of cleaner-burning fuels. The recommendation is to continue supporting the current legislative platform but there are no recommendations for new policy initiatives at this time because the rule already requires the use of effective emission control technologies.

Education and Outreach
The District currently provides a robust education and outreach program for regulated sources through the Small Business Assistance program, Permit Stakeholder Meetings, Compliance Assistance Bulletins, and public notices for public workshops and public hearings. There are no recommendations for new education and outreach efforts for these sources. The District will continue to work closely with affected sources to ensure successful compliance.

D.1.7 Rule 4702 Internal Combustion Engines

Source Category

This rule applies to any internal combustion (IC) engine rated at 25 brake horsepower (bhp) or greater. The purpose of this rule is to limit NOx, carbon monoxide (CO), volatile organic compounds (VOC), and SOx emissions from units subject to this rule.

The District's original IC rule, Rule 4701 (Internal Combustion Engines – Phase 1), was adopted on May 21, 1992, superseded by newly adopted Rule 4702 on August 21, 2003, and has subsequently been amended four times. The rule established NOx limits between 25-50 ppmv with 90-96% control for non-agricultural operations rich-burn engines and 65-75 ppmv with 85-90% control for non-agricultural operations lean-burn engines. Amendments have strengthened the rule by regulating emissions from agricultural operations sources and achieving approximately 84% control of agricultural operations emissions from this source category. The most recent rule amendment in August 2011 added reporting and point-of-sale requirements for engines 25-50 bhp, which were previously unregulated, and implemented more stringent NOx limits for non-agricultural operations spark-ignited engines, further reducing emissions from this source category. EPA finalized approval for Rule 4702 on January 10, 2008 and deemed this rule as being at least as stringent as established RACT requirements.

Emission Inventory

Pollutant	2007	2012	2014	2015	2016	2017	2018	2019
	Annual Average - Tons per day							
PM2.5	0.81	0.53	0.51	0.44	0.34	0.33	0.32	0.31
NOx	20.18	12.53	11.93	8.63	6.67	6.24	5.99	5.80
SOx	0.19	0.15	0.15	0.13	0.12	0.11	0.11	0.11
	Winter Average - Tons per day							
PM2.5	0.58	0.39	0.38	0.33	0.27	0.26	0.26	0.25
NOx	14.03	8.85	8.41	6.18	4.87	4.61	4.45	4.32
SOx	0.15	0.13	0.13	0.11	0.10	0.10	0.10	0.10

Regulatory Evaluation

How does District Rule 4702 compare with federal rules and regulations?

Rule 4702 is equivalent to the applicable federal standards and guidelines. Rule 4702 is as stringent as the federal Alternative Control Techniques (ACT) documents (EPA – 453/R-93-032 "Alternative Control Techniques (ACT) Document – NOx Emissions from Stationary Reciprocating Internal Combustion Engines", dated July 1993), New Source Performance Standards (NSPS) (40 CFR 60 Subpart IIII (Standards of Performance for Stationary Compression Ignition Internal Combustion Engines) and 40 CFR 60 Subpart JJJJ (Standards of Performance for Stationary Spark Ignition Internal Combustion Engines)), Maximum Achievable Control Technology (MACT) NOx limits (40 CFR 63

Subpart ZZZZ (NESHAP for Stationary Reciprocating Internal Combustion Engines)), and EPA Best Available Control Technology (BACT) requirements. Additionally, there are no EPA Control Techniques Guidelines (CTG) listed for this category.

How does District Rule 4702 compare to rules in other air districts?

Upon comparing Rule 4702 to other California air districts' rules for similar sources, the rule was found to be at least as stringent as the analogous rules for BAAQMD (Regulation 9 Rule 8—Nitrogen Oxides and Carbon Monoxide from Stationary Internal Combustion Engines), SMAQMD (Rule 412—Stationary Internal Combustion Engines Located at Major Stationary Sources of NOx), and VCAPCD (Rule 74.9—Stationary Internal Combustion Engines). Rule 4702 also meets or exceeds the BACT requirements for BAAQMD.

SCAQMD Rule 1110.2 (Emissions from Gaseous and Liquid-Fueled Engines) specifies a NOx limit of 11 ppmv for all units. Due to the large inventory of agricultural engines in the Valley that have only recently been required to install emission control devices and the difficulties of implementing a lower NOx standard for agricultural engines, as discussed below in "Further NOx Limitations", an 11 ppmv NOx limit is not feasible for agricultural engines at this time. The SCAQMD 11 ppmv limit for non-agricultural operations engines fired on landfill gas or digester gas engines stated as being effective July 1, 2012, was based on a provision to complete a technology assessment by July 2010. The limit will only be implemented if the result of SCAQMD's technology assessment confirms that 11 ppmv is achievable. During a 2011 telephone conversation with SCAQMD during the rule development process of Rule 4702, District staff confirmed that the technology assessment would not be completed until 2012. Therefore, the District did not propose changes to the current limit for non-agricultural waste gas fueled rich-burn engines of Rule 4702 until such time that South Coast AQMD's technology assessment confirmed that it is technologically and economically feasible to achieve 11 ppmv for that category of non-agricultural units.

In addition to being one of the most stringent rules in the nation for this source category, any new unit brought to the Valley, except rare instances where the new unit has a low bhp rating or if the applicant agrees to limit the daily hours of operation, as well as any major modifications to existing units, would trigger District BACT requirements. Subsequently, these new or modified units would be required to use technology and control emissions beyond those established as RACT and implement the best available emission controls, as required by District Rule 2201 (New and Modified Stationary Source Review Rule).

Emission Reduction Opportunities

In its continuous effort to improve air quality in the Valley, the District has adopted numerous amendments to the IC engine rule that have significantly reduced NOx and PM emissions from this source category. The emissions inventory for NOx from IC engines will be reduced by 71% over from 20.18 tons of NOx per day in 2007, to 5.8 tons of NOx per day in 2019. . Significant emission reductions from agricultural IC engines have been achieved through a combination of regulatory efforts and incentive actions, including the replacement of over 2,000 diesel irrigation pumps with electric motors since 2007. Additional emissions reductions are forthcoming with the existing Rule 4702 as compliance dates approach over the next six years. Given the significant efforts and investments already made to reduce emissions from this source category, there are little remaining feasible opportunities for obtaining additional emissions reductions. While no significant additional opportunities have been identified, the District evaluated several potential additional areas based on comments received during development of this plan.

Further SOx and Particulate Matter Limitations

Most non-agricultural engines and many agricultural engines are fired on Public Utilities Commission (PUC) quality natural gas, and are inherently low-emitters of SOx and PM2.5 emissions. Current Rule 4702 contains stringent requirements requiring the combustion of PUC-quality natural gas, or other equivalent ultra-low sulfur fuels, and diesel engines subject to Rule 4702 are required to be EPA Tier 3 or Tier 4 certified, depending on the size of the engine and the annual operating hours. EPA Tier 3 and 4 certifications require the units to meet low PM limits and Tier 4 engines are required to meet even lower PM limited through the use of particulate filters. Given the low PM2.5 and SOx emissions from IC engines and existing rule requirements, no further requirements are needed to address PM2.5 and SOx emissions.

Further NOx Limitations

With regard to non-agricultural engines, new more stringent NOx limits were recently adopted in August 2011. The District conducted a thorough analysis in support of this recent rule amendment that considered all available control technologies, including their feasibility and cost effectiveness. The District subsequently adopted stringent limits with compliance dates ranging from 2014 through 2017. Based on this recent action and ongoing rule requirements, there are no additional emission reduction opportunities for non-agricultural engines at this time.

The District adopted requirements in 2005 that established stringent requirements for reducing emissions from PUC-quality natural gas (spark-ignited) and diesel-fired (compression-ignited) agricultural engines. These requirements were the first of their kind in the nation, and established a timetable for phasing in new engine and control technologies for a previously unregulated source category. Overall, these requirements reduce emissions from agricultural engines by 84% when fully implemented, with significant investments being made by the affected stakeholders to comply with the rule. Additionally, the District and United States Department of Agriculture – Natural Resources Conservation Service (USDA-NRCS) have also made significant investments to provide incentives to accelerate the transition to cleaner engine technologies. One prime example of this effort was the collaborative public/private partnership involving the District, USDA-NRCS, agricultural stakeholders, and public utilities to incentivize the replacement of diesel irrigation pump engines with electric motors. This effort resulted in the conversion of over 2,000 diesel irrigation engines to electric motors. Agricultural operations are still in the process of implementing the new standards or have only recently come into compliance with the stringent standards under Rule 4702. Compliance dates for agricultural operations engines range from 2009 to 2010 for spark-ignited engines and 2010 through 2018 for compression-ignited engines.

The District considered the possibility of reducing the NOx emissions limit for spark-ignited agricultural operations engines to 11 ppmv; however, as previously mentioned, these engines have only recently been required to install emission control devices and comply with the current NOx limits in Rule 4702. As discussed in the *2011 Final Staff Report for the Revised Proposed Amendments to Rule 4702*, the District is still evaluating the effectiveness and implementation issues associated with the control systems currently in place for agricultural spark-ignited engines, which include a 3-way catalytic converter, air/fuel ratio controller, and oxygen sensor. These systems have faced challenges due to the nature of agricultural engine installations, including remote locations, fluctuations in gas pressures, and unattended operations. While the technologies are capable of meeting the 150 ppmv and 90 ppmv NOx emissions limits currently in place for agricultural spark-ignited engines, additional time is needed to fully evaluate the effectiveness of these control devices and determine if it is technologically feasible to reach 11 ppmv with these controls.

Additionally, the current emissions limits are appropriate for agricultural spark-ignited engines considering the potential economic impacts that more stringent NOx limits could create for Valley agriculture. Agriculture is economically depressed as evidenced by continued economic assistance from the federal government in the form of subsidies/grants to even the economic playing field resulting from increased importation of cheaper cost products from foreign countries into the U.S. Unlike agricultural diesel (compression-ignited) engines, agricultural spark-ignited engines are not eligible for Moyer incentive funding which has helped reduce the economic impacts associated with compliance costs for diesel engines. Furthermore, agriculture's inability to pass the increased production costs on to consumers make it difficult for agriculture to absorb the compliance costs associated with more stringent limits for agricultural spark-ignited engines.

Another important consideration is that the NOx limits in place prevent operators from replacing agricultural spark-ignited engines with diesel engines. In light of the different requirements, and related compliance costs, for spark-ignited engines and diesel engines, the District was made aware during the 2005 amendment of Rule 4702 that operators would likely replace an agricultural spark-ignited engine with a diesel engine if the emission limits for spark-ignited engines were too stringent. To prevent, or minimize, these instances, the District made the requirements for spark-ignited engines and compression-ignited engines as comparable as reasonable; as supported by the rule limits and compliance dates. Agricultural spark-ignited engines with higher NOx emissions limits have sooner compliance dates (2009-2010) and agricultural diesel engines with more stringent NOx limits have a longer compliance timeline (2010-2018). Reducing the spark-ignited NOx emissions limits could potentially prompt agricultural operators to switch to diesel engines and thus increase PM2.5 emissions for this source category.

The potential for changing the exemption requirements for emergency standby engines and low-use engines was evaluated during the 2011 rule amendment process, it was determined that the existing requirements are consistent with ARB RACT/BARCT Determination for Spark-Ignited Engines and ARB Airborne Toxics Control Measures (ATCM). The emissions from these units are relatively minor, and controlling these emissions is subsequently cost ineffective.

The level of stringency associated with existing Rule 4702 requirements is further supported by EPA's full approval of Rule 4702. In the technical support document (TSD) published in August 2007 for the approval of Rule 4702, EPA determined that the requirements are, *"consistent with EPA regulations, and relevant policy and guidance regarding enforceability, BACM/BACT, RACM/RACT, and SIP relaxations."*[20] Additionally, EPA stated that, *"Submitted Rule 4702 continues to implement BACM/BACT and other SIP approval criteria for stationary internal combustion engines…Because the criteria for BACM/BACT are stricter than for RACT, by meeting BACT requirements submitted Rule 4702 also fulfills RACT."*[21]

Given the significant emissions reductions that have been achieved and will continue to be achieved under the existing rule, significant costs associated with these requirements, and the District's analysis and related EPA findings, there are no feasible opportunities for additional emission reduction regulatory strategies for this source category.

Risk-based Strategy Analysis

The emissions from units subject to Rule 4702 contribute 18.2% of average winter NOx emitted from stationary and area sources in the 2012 emission inventory. These units are primarily fired on PUC-quality natural gas, which is generally considered a clean burning fuel with low SOx and PM emissions. While many agricultural diesel engines have been replaced with electric motors over recent years, remaining engines have been replaced, or will soon be replaced, with new, certified, cleaner diesel engines. Given the rural nature of the emissions, District health risk assessments of these newer diesel engines have concluded that the toxic health risk associated with the new engines are generally not significant. Overall, Rule 4702 has significantly reduced NOx and SOx emissions from these units and has assisted in reducing PM2.5 concentrations through reductions of these key precursors.

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[20] (2008, January 10). *Revisions to the California State Implementation Plan, San Joaquin Valley Air Pollution Control District and*
Sacramento Metropolitan Air Quality management District. 73 Fed. Reg. 7, pp. 1818 – 1822.

[21] Donez, F. (August 2007).*Technical Support Document for EPA's Notice of Proposed Rulemaking and Direct Final Rule for the California State Implementation Plan San Joaquin Valley Unified Air Pollution Control District Rule 4702, Internal Combustion Engines – Phase 2*. San Francisco, CA: Environmental Protection Agency, Region IX Air Division.

Control Measure Commitments

The following is a summary of recommended commitments for Rule 4702.

Regulatory Action

The District's analysis did not identify any additional technologically feasible and cost effective potential controls. Therefore, there are no recommendations for additional regulatory actions for Rule 4702. Existing sources are in the process of complying with new standards in current rule language thus continuing to reduce emissions from these sources.

Incentive Action

As discussed above, the District implements the stationary agricultural irrigation pump engine program component of the *Heavy-Duty Engine Program*. This program provides incentives for both the conversion of Tier 1 and Tier 2 engines to lower NOx and PM-emitting Tier 4 engines and for the electrification of diesel engines, as the District highly prioritizes electrification efforts to achieve zero and near-zero emissions from engines. The following incentives are offered through this program:

- Prior to the January 1, 2015 (or 12 years from installation) Rule 4702 compliance deadline for the conversion of Tier 1 and Tier 2 engines to Tier 4 engines, the program will offer incentive funding for the replacement of Tier 1 and Tier 2 engines with the latest tier certified engine technology or electric motors.
- The District will continue to offer incentive funding for the replacement of Tier 3 certified engines with electric motors.
- The District will also continue to offer incentive funding for the installation of electric motors, rather than diesel engines, on new wells.

The District will consider the possibility of providing further incentives to further promote the replacement of agricultural IC engines with electric motors, including, but not limited to providing additional incentives for the high cost associated with utility line extensions to remote irrigation pump installations.

Technology Advancement Action

One of the 11 projects selected in 2011 for the District's Technology Advancement Program is aimed at demonstrating that a compact Selective Catalytic Reduction (SCR) device on a biogas-powered engine can reduce NOx emissions to ultra-low levels. This new technology has the potential of providing a low cost option for reducing emissions from biogas-powered engines, particularly for dairy and other digester applications. Through its Technology Advancement Program, the District will continue to seek potential feasible and low-cost technologies that may provide for additional emission reduction opportunities in this category.

Policy Initiatives

The District's current legislative platform includes support for the increased development and use of cleaner-burning fuels, incentive funding through the Carl Moyer Program, and the continuation of air quality funding in the Farm Bill. The District recommends continued support of these funding streams to continue providing incentives for accelerated reductions from engines in this category. The District will also consider pursuing a renewed public/private collaborative partnership similar to the previously discussed partnership to provide further incentives for replacing remaining agricultural IC engines with electric motors.

Education and Outreach

The District currently provides a robust education and outreach program for regulated sources through the Small Business Assistance program, Permit Stakeholder Meetings, Compliance Assistance Bulletins, and public notices for public workshops and public hearings. The District does not have recommendations for new education and outreach efforts for these sources. The District will continue to work closely with affected sources to ensure successful compliance.

D.1.8 Rule 4703 Stationary Gas Turbines

Source Category

The provisions of this rule are applicable to all stationary gas turbine systems, which are subject to District permitting requirements, and with electrical generation ratings equal to or greater than 0.3 megawatt (MW) or a maximum heat input rating of more than 3 million British Thermal Units per hour (MMBtu/hr), and that are used for the generation of electrical power. The purpose of this rule is to limit NOx emissions from these stationary gas turbines.

Rule 4703 was adopted on August 18, 1994. Since its adoption, the rule has been amended six times. The latest rule amendment in September 2007 strengthened the rule by establishing more stringent NOx limits for existing stationary gas turbines. EPA finalized approval for Rule 4703 on October 21, 2009 and deemed this rule as being at least as stringent as established RACT requirements. NOx emissions have been controlled by over 86% for this source category.

Emission Inventory

Pollutant	2007	2012	2014	2015	2016	2017	2018	2019
	Annual Average - Tons per day							
PM2.5	1.75	1.60	1.51	1.45	1.48	1.52	1.52	1.53
NOx	6.87	3.24	3.09	3.00	3.05	3.11	3.12	3.13
SOx	0.48	0.43	0.40	0.38	0.38	0.39	0.40	0.40
	Winter Average - Tons per day							
PM2.5	1.72	1.58	1.49	1.43	1.46	1.49	1.50	1.50
NOx	6.82	3.21	3.07	2.98	3.03	3.08	3.10	3.11
SOx	0.47	0.42	0.39	0.37	0.37	0.38	0.39	0.39

Regulatory Evaluation

How does District Rule 4703 compare with federal rules and regulations?

Rule 4703 is equivalent to the applicable federal standards and guidelines. Rule 4703 is as stringent as the federal Alternative Control Techniques (ACT) (EPA –453/R-93-007 "NOx Emissions from Stationary Combustion Turbines", dated January 1993), New Source Performance Standards (NSPS) (40 CFR 60 Subpart GG (Standards of Performance for Stationary Gas Turbines) & Subpart KKKK(Standards of Performance for Stationary Combustion Turbines)), and Maximum Achievable Control Technology (MACT) requirements (40 CFR 63 Subpart YYYY (NESHAP for Stationary Combustion Turbines)); additionally, there are no EPA Control Techniques Guidelines (CTG) listed for this category.

How does District Rule 4703 compare to rules in other air districts?

When comparing Rule 4703 to SCAQMD (Rule 1134—Emissions of Oxides of Nitrogen from Stationary Gas Turbines), BAAQMD (Regulation 9 Rule 9—Nitrogen Oxides from Stationary Gas Turbines), SMAQMD (Rule 413—Stationary Gas Turbines), and VCAPCD (Rule 74.23—Stationary Gas Turbines), the rule was found to be at least as stringent as these other rules.

In addition to being one of the most stringent rules in the nation for this source category, any new unit brought to the Valley, as well as any major modifications to existing units, would trigger Best Available Control Technology (BACT) requirements. Subsequently, these new or modified units would be required to use technology and control emissions beyond those established as RACT and implement the best available emission controls, as required by District Rule 2201 (New and Modified Stationary Source Review Rule).

Emission Reduction Opportunities

The District has adopted numerous rule amendments to the turbine rule that have successfully and significantly reduced emissions from this source category. The emissions inventory for NOx from turbines has been reduced from 31.9 tons per day (tpd) in 1994 to 3.24 tpd in 2012. Significant emission reductions have been achieved through the implementation of the most stringent regulations in the nation for this source category and significant investments by stakeholders to implement effective and innovative emission control technologies. The District has achieved substantial NOx emissions reductions in the past year as compliance dates went into effect at the beginning of 2012. Given the significant efforts and investments already made to reduce emissions from this source category, there are little remaining feasible opportunities for obtaining additional emissions reductions. For the sake of thoroughness, the possibility of further reducing emissions from turbines is evaluated in the following discussion.

BACT Comparisons

Comparisons of this rule with the District, BAAQMD, and SCAQMD BACT requirements showed that some BACT emissions limits are more stringent than Rule 4703 limits. For units greater than 3 MW, some of the District's NOx limits ranged from 3-5 ppmv, whereas the BACT limits ranged from 2-3 ppmv. For units less than 3 MW, the District's NOx limit was 9 ppmv, whereas the BACT limit was 5 ppmv. The BACT guidelines list Selective Catalytic Reduction (SCR) and SCONOx as the emissions control technologies used to achieve emission limits in the range of 2-5 ppmv. Although lower emission limits are potentially achievable for this source category, BACT requirements are imposed on new or modified turbine installations where ultra-low NOx controls can be installed and the equipment and the facility can be designed to function with this new technology. Rule 4703 is a prohibitory rule that has undergone several generations of NOx limits for existing units in the Valley; facilities comply with these limits by retrofitting their existing equipment. Requiring the installation of entirely new turbine systems is extremely expensive and not cost effective, and therefore not required of facilities.

Selective Catalytic Reduction

Many of the larger units (> 3MW) have already employed SCR to achieve the 5 ppmv limits in place. Therefore, the District evaluated the potential opportunity to employ SCR for units less than 3 MW.

A SCR system reduces NOx emissions by converting the emissions to water and elemental nitrogen. Ammonia is generally injected into the exhaust stream and reacts with the nitrogen. Due to the high cost of SCR systems, they are typically used for controlling emissions from larger units, greater than 3 MW, that generally create more emissions. The cost effectiveness of an SCR system for a 1 MW unit was calculated based on the cost effectiveness methodologies in the 2007 Staff Report for Rule 4703 and some of the newer methodologies used to calculate the cost effectiveness of SCR in the August 2011 Staff Report for Rule 4702. The tables below present the total annual costs for a new SCR system and a retrofit system.

Table D-4 SCR Annual Costs for a New Installation on a 1 MW Turbine

ITEM		SOURCE	COST
Turbine Rating	1 MW		
SCR Cost/KW	$125/KW	Middle point between high and low estimate from R4703 analysis	
Operating Hours	7884 hrs/year		
Direct Capital Costs			
Total Purchased Equip Cost	$125/KW x 1000 KW		$125,000
Freight	5% Purchased Equip. Cost (PEC)	Rule 4702	$6,250
Sales Tax	8.25% PEC	Rule 4702	$10,313
Direct Installation Costs	25% PEC	Rule 4702	$31,250
Total Direct Capital Costs			**$172,813**
Indirect Capital Costs			
Facilities	5% PEC	Rule 4702	$6,250
Engineering	10% PEC	Rule 4702	$12,500
Process Contingency	5% PEC	Rule 4702	$6,250
Total Indirect Capital Costs			**$25,000**
Project Contingency	20% PEC	R4702	$25,000
Total Capital Costs (TCC)	Direct Capital + Indirect Capital + Project Contingency	R4702	$222,813
Annualized Capital Costs (10 years @ 10%)	0.1627*TCC	R4702	**$36,252**
Direct Annual Costs			
Operating Costs			
Operator	0.5 hr/shift, $25/hr	OAQPS	$13,688
Supervisor	15% of operator	OAQPS	$2,053
Maintenance Costs			
Labor	0.5 hr/shift, $25/hr	OAQPS	$13,688
Material	100% of labor cost	OAQPS	$13,688
Utility Costs			
Electricity Costs		Variable	$5,747
Cat. Replacement		MHIA	$5,621
Cat. Disposal		OAQPS	$211
Ammonia		Variable	$1,008
NH3 Inject Skid		MHIA	$2,916
Total Direct Annual Costs			**$58,620**
Indirect Annual Costs			
Overhead	60% of Operating and Maintenance	OAQPS	$25,870
Administrative	0.02 x PEC	OAQPS	$2,500
Insurance	0.01 x PEC	OAQPS	$1,250
Property Tax	0.01 x PEC	OAQPS	$1,250
Capital Recovery	0.13 x PEC (10% int. rate, 15 yr period)	OAQPS	$16,250
Total Indirect Annual Costs			$47,120
Total Annual Costs	Annualized capital + Direct Annual + Indirect Annual		**$141,992**

Table D-5 SCR Annual Costs for a Retrofit on a 1 MW Turbine

ITEM		SOURCE	COST
Turbine Rating	1 MW		
SCR Cost/KW	$325/KW	Middle point between high and low estimate from R4703 analysis	
Operating Hours	7884 hrs/year		
Direct Capital Costs			
Total Purchased Equip Cost	$325/KW x 1000 KW		$325,000
Freight	5% Purchased Equip. Cost (PEC)	Rule 4702	$16,250
Sales Tax	8.25% PEC	Rule 4702	$26,813
Direct Installation Costs	25% PEC	Rule 4702	$81,250
Total Direct Capital Costs			**$449,313**
Indirect Capital Costs			
Facilities	5% PEC	Rule 4702	$16,250
Engineering	10% PEC	Rule 4702	$32,500
Process Contingency	5% PEC	Rule 4702	$16,250
Total Indirect Capital Costs			**$65,000**
Project Contingency	20% PEC	R4702	$65,000
Total Capital Costs (TCC)	Direct Capital + Indirect Capital + Project Contingency	R4702	$579,313
Annualized Capital Costs (10 years @ 10%)	0.1627*TCC	R4702	**$94,254**
Direct Annual Costs			
Operating Costs			
Operator	0.5 hr/shift, $25/hr	OAQPS	$13,688
Supervisor	15% of operator	OAQPS	$2,053
Maintenance Costs			
Labor	0.5 hr/shift, $25/hr	OAQPS	$13,688
Material	100% of labor cost	OAQPS	$13,688
Utility Costs			
Electricity Costs		Variable	$5,747
Cat. Replacement		MHIA	$5,621
Cat. Disposal		OAQPS	$211
Ammonia		Variable	$1,008
NH3 Inject Skid		MHIA	$2,916
Total Direct Annual Costs			**$58,620**
Indirect Annual Costs			
Overhead	60% of Operating and Maintenance	OAQPS	$25,870
Administrative	0.02 x PEC	OAQPS	$6,500
Insurance	0.01 x PEC	OAQPS	$3,250
Property Tax	0.01 x PEC	OAQPS	$3,250
Capital Recovery	0.13 x PEC (10% int. rate, 15 yr period)	OAQPS	$42,250
Total Indirect Annual Costs			$81,120
Total Annual Costs	Annualized capital + Direct Annual + Indirect Annual		**$233,994**

Potential Emissions Reduction Methodology

The estimated current annual NOx emissions and the estimated potential annual NOx emissions were calculated using the following equation:

NOx = LF x MMBtu/hr x HR x EF/ 2,000 lb/ton

Where:

NOx	=	Current annual NOx emissions or potential annual NOx emissions in tons/year
LF	=	turbine load factor
MMBtu/HR	=	heat input rating
HR	=	annual hours of operation
EF	=	NOx emission factor in pounds per MMBtu

Where:

EF	=	NOx emission factor in ppmv x 0.00366
ppmv	=	NOx emissions in parts per million corrected to 15% oxygen
0.00366	=	Conversion factor used: 0.00366 lb/MMBtu per ppmv NOx

The estimated annual NOx emissions reduction was calculated using the following equation:

NOx Emissions Reduction = Current annual NOx emissions - Potential annual NOx emissions.

Potential Emissions Reduction Calculation

The emissions reduction calculations below utilized the following information:

Loading factor = 0.75
Heat input rating for a 1 MW unit = 15 MMBtu/hr
Annual Hours of Operation = 7884 hours
Current Emission Factor in Rule 4703 = 9 ppmv
Potential Emissions Factor through the use of SCR = 5 ppmv

Current NOx	=	LF x MMBtu/hr x HR x EF / 2,000 lb/ton
	=	0.75 x 15 x 7884 x (9 x 0.00366) / 2000
	=	1.46 tons/year
Potential NOx	=	LF x MMBtu/hr x HR x EF / 2,000 lb/ton
	=	0.75 x 15 x 7884 x (5 x 0.00366) / 2000
	=	0.81 tons/year
Emissions Reduction	=	Current NOx emissions - Potential NOx emissions
	=	0.65 tons/year

Table D-6 SCR Cost Effectiveness

Type of Installation	MW	MMBtu/hr	Current NOx Emission Factor (EF), ppmv	Potential NOx EF, ppmv	NOx Reduction (Tons/Year)	Total Annual Cost ($)	Cost Effectiveness ($/ton)
New	1	15	9	5	0.65	$141,992	$218,449
Retrofit	1	15	9	5	0.65	$233,994	$359,991

Therefore, even though some of the BACT emissions limits for units less than 3 MW are more stringent than the current limit of 9 ppmv, this is not a cost effective option.

EMx

Certain BACT limits for simple cycle plants were achieved through the use of SCONOx. This multifaceted technology reduces NOx, SOx, carbon monoxide (CO), and volatile organic compound (VOC) emissions and is stated as achieving NOx levels less than 1.5 ppmv by its manufacturer. One issue with the use of SCONOx is that it requires steam to operate and simple cycle plants do not generate steam. Therefore, a simple cycle facility would have to add a boiler to their facility to generate steam for the SCONOx system, making the addition of this technology more costly. The District is not aware of any SCONOx applications on simple cycle plants.[22] While SCONOx is better suited for combined cycle turbines, this technology has not been achieved in practice (AIP) yet in the District.

BAAQMD evaluated SCONOx, now known as the EMx system, for turbines in a recent Final Determination of Compliance (FDOC) for the Oakley Generating Station. The FDOC states that EMx could potentially be an improvement over SCR as an add-on control device for achieving NOx reductions – assuming it can achieve the same level of NOx control – because it does not use ammonia. Ammonia has the potential, under certain atmospheric conditions, to react with nitric acid in the atmosphere to form ammonium nitrate, which can be a form of PM2.5. However, based on the implementation of EMx at a facility in Shasta County, BAAQMD voiced some concerns for its use.

EMx has never been used on a large utility-scale turbine and so there is no data on which to make a direct evaluation of how well the technology would work on larger turbines. EMx has been used on a smaller aeroderivitive turbine at the Redding Power Plant Unit No. 5, a 45-MW combined-cycle facility in Shasta County, CA. The Shasta County Air Quality Management District evaluated EMx at the Redding facility under a demonstration NOx limit of 2.0 ppm, which SCR can consistently achieve. After three years of operation, the Shasta County AQMD evaluated whether the facility was meeting this demonstration limit with EMx, and concluded that “*Redding Power is not*

[22] Brian K. Lusher. (June 2010). *Final Determination of Compliance: Marsh Landing Generating Station.* San Francisco, CA: Bay Area Air Quality Management District.

able to reliably and continuously operate while maintaining the NOx demonstration limit of 2.0 ppmvd @ 15% O2."[23]

The FDOC states that although the EMx manufacturer maintains that such problems have been overcome, concerns remain about how consistently the technology would be able to perform. Recent communications between BAAQMD and Shasta County Air District confirmed that the earlier conclusions about the achievability of a lower limit remain valid.[24] In addition, monthly reports of Continuous Emissions Monitoring System (CEMS) data submitted by Redding Power Plant to Shasta County Air District during 2007 and 2008 indicated that emissions have often been substantially higher.[25] Furthermore, the data from Redding is from a smaller aeroderivitive turbine, and there is no guarantee that if it were scaled up for uses on utility-size turbines that it would even be able to achieve the performance required from larger turbines. For these reasons, BAAQMD concluded that EMx is not as developed as SCR at this time and cannot achieve the same level of emissions performance that SCR is capable of.

SCAQMD is currently funding a research project that will study and demonstrate the feasibility of control technologies to reduce PM2.5 and ultrafine particulate emissions from natural gas-fired turbine power plants. EMx is one of the two technologies that were selected for demonstration and the project is expected to be completed by the end of 2012. The findings of this report could potentially be beneficial for evaluating the feasibility of EMx applications for turbines in the future.

SOx

The implementation of sulfur dioxide (SO2) limits at least as stringent as the requirements in 40 CFR 60 Subpart KKKK (Standards of Performance for Stationary Combustion Turbines) was considered for Rule 4703. Fuel treatment sulfur removal systems were recognized as being able to reduce SOx emissions from turbines, other than those fired on Public Utilities Commission (PUC) quality natural gas. One Valley facility is in the process of installing SCR onto their digester gas-fired turbine to meet the Rule 4703 limit. To do this, they must install a fuel pretreatment system that removes H2S and siloxanes, as they can damage the SCR catalyst if not removed. Other landfill and digester-gas turbines outside the District are also using these systems.

There are only 5 facilities in the Valley that utilized a fuel other than natural gas for their turbines in 2011. Each of those facilities operates on natural gas the majority of the time and operates on an alternate fuel part-time. Three of those facilities fired on diesel gas, while the other two operated on digester gas. Due to California Diesel Fuel requirements, the diesel facilities in the Valley are limited to a sulfur content of 0.0016 lb-SO2/MMBtu. PUC-quality natural gas typically has a sulfur content of 0.00285 lb-

[23] Letter from R. Bell, Air Quality District Manager, Shasta County Air Quality Management District, to R. Bennett, Safety & Environmental Coordinator, Redding Electric Utility, June 23, 2005.
[24] Kathleen Truesdell. (January 2011). *Final Determination of Compliance: Oakley Generating Station.* San Francisco, CA: Bay Area Air Quality Management District.
[25] Kathleen Truesdell. (January 2011). *Final Determination of Compliance: Oakley Generating Station.* San Francisco, CA: Bay Area Air Quality Management District.

SO2/MMBtu and digester turbines are limited to 0.016 lb-SO2/MMBtu per District permits' requirements. By comparison, the Subpart KKKK limit is much higher at 0.060 lb-SO2/MMBtu and all of the units in the Valley are achieving much lower SO2 limits. Adding a SO2 limit similar to Subpart KKKK to the rule will not foster additional emissions reductions for Valley facilities.

PM2.5

PM2.5 reduction technologies for turbines were also researched in an effort to conduct a PM2.5 technology cost effectiveness analysis. Post-combustion controls, including baghouses, electrostatic precipitators, and scrubbers were examined since these technologies can be used to remove PM2.5 emissions from exhaust gas streams

As previously mentioned, every unit in the Valley subject to Rule 4703 operated on strictly natural gas, with the exception of 5 facilities that operated on an alternate fuel part-time in 2011. Based on District Permits records and information in the BAAQMD FDOC for the Oakley Generating Station, electrostatic precipitators, baghouses, and scrubbers have not been achieved-in-practice for natural gas-fired turbines. These devices are normally used on solid fuel fired sources or others with high PM emissions, and are not used in natural gas-fired applications, which have inherently low PM emissions. The District is not aware of any gas turbine that has ever been required to use add-on controls such as these. BAAQMD reviewed the EPA BACT/LAER Clearinghouse and confirmed that EPA has no record of any post-combustion particulate controls that have been required for natural gas-fired gas turbines.[26]

Furthermore, these devices would not be technologically feasible to implement for certain facilities. As noted in the BAAQMD FDOC, if add-on control equipment were installed, it would create significant backpressure that would significantly reduce the efficiency of a power plant and would cause more emissions per unit power produced. Moreover, these devices are designed to be applied to emissions streams with far higher particulate emissions, and they would have very little effect on the low-PM emissions streams from natural gas-fired facilities in further reducing PM emissions.[27] It takes an emissions stream with a much higher grain loading for these types of abatement devices to operate efficiently. This low level of abatement efficiency (if any) also means that these types of control devices would not be cost effective, even if they could feasibly be applied to this type of source. For these reasons, post-combustion particulate control equipment is not technologically feasible for units subject to Rule 4703.

[26] Kathleen Truesdell. (January 2011). *Final Determination of Compliance: Oakley Generating Station.* San Francisco, CA: Bay Area Air Quality Management District.

[27] Kathleen Truesdell. (January 2011). *Final Determination of Compliance: Oakley Generating Station.* San Francisco, CA: Bay Area Air Quality Management District.

As previously mentioned, SCAQMD is currently funding a research project that will study and demonstrate the feasibility of control technologies to reduce PM2.5 and ultrafine particulate emissions from natural gas-fired turbine power plants. Sulfur removal and the EMx multi-pollutant control system are the two technologies which were selected for demonstration. The findings of this report could potentially be beneficial for evaluating the cost effectiveness and feasibility of applying these emerging technologies to turbines in future rule-amending projects.
At this time, the District's analysis indicates that there are no feasible opportunities for additional emission reduction regulatory strategies for this source category.

Risk-based Strategy Analysis

The emissions from units subject to Rule 4703 contribute 6.6% of average winter NOx, 5.1% of average winter SOx, and 2.8% of average winter PM2.5 emitted from stationary and area sources in the 2012 emission inventory. These units are primarily fired on PUC-quality natural gas, which is generally considered a clean burning fuel with low SOx and PM emissions. Overall, Rule 4703 has significantly reduced NOx and SOx emissions from these units and has assisted in reducing PM2.5 concentrations through reductions of these key precursors.

Control Measure Commitments

The following is a summary of recommended commitments for Rule 4703.

Regulatory Action

The District's analysis did not identify any additional technologically feasible and cost effective potential controls. Therefore, there are no recommendations for additional regulatory actions for Rule 4703.

Incentive Action

Stationary gas turbines subject to Rule 4703 are regulated units that have been subject to several generations of regulations; as such, the opportunities for incentive programs are minimal. There are no recommendations for incentive actions at this time.

Technology Advancement Action

There are no recommendations for a new technology advancement project specific to units subject to Rule 4703. Through its Technology Advancement Program, the District will continue to seek potential feasible and low-cost technologies that may provide for additional emission reduction opportunities in this category.

Policy Initiatives

The District's current legislative platform includes support for the increased development and use of cleaner-burning fuels. The recommendation is to continue supporting the current legislative platform but there are no recommendations for new policy initiatives at this time because the rule already requires the use of the most effective emission control technologies.

Education and Outreach

The District currently provides a robust education and outreach program for regulated sources through the Small Business Assistance program, Permit Stakeholder Meetings, Compliance Assistance Bulletins, and public notices for public workshops and public hearings. The District does not have recommendations for new education and outreach efforts for these sources. The District will continue to work closely with affected sources to ensure successful compliance.

D.2 INDUSTRIAL PROCESSES

The San Joaquin Valley air basin (Valley) is home to a wide range of industries and industrial processes. The industrial sector is a vital contributor to the health of the Valley's economy, and has made important contributions to air quality improvement. Whether coming under regulation for the first time or having undergone several generations of retrofit rules, the reductions achieved represent significant investments of finances and energy.

While the broad category of Industrial Processes includes many source categories, for the purposes of this appendix, this discussion is limited to the reduction of animal matter, flares, lime kilns, activities involving sulfur, and glass melting furnaces. Other industry groups and technologies addressed in this plan but not addressed in this section are discussed in other parts of this appendix.

The control measure source categories discussed in this section affect several industries in the Valley including, but not limited to the glass and related products, manufacturing, food and agricultural material processing, acid plants, oil and gas production, sewage treatment, landfills, incinerators, and petroleum refining industries.

Existing Control Strategies

Due to the degree of difficulty and enormity of the challenge that the Valley faces in meeting the National Ambient Air Quality Standards (NAAQS), the District recognizes that prohibitory rules alone are not enough to reduce emissions to meet attainment requirements and protect public health. The District's longstanding, progressive strategy for reducing emissions is a multifaceted effort that includes incentive programs and policy initiatives in addition to prohibitory rules. The following discussion summarizes both the existing District efforts to reduce emissions from this source category, and evaluations for potential opportunities for further emissions reductions.

Incentive Programs

Incentive programs are an integral part of the emission reduction efforts of the District, especially where the District lacks direct jurisdiction in establishing emission control requirements. The emission units within the Industrial Processes category are located at stationary sources and are subject to rules that have undergone several amendments and continue to be some of the most stringent rules in the nation; opportunities for incentive programs for units subject to these rules are minimal. The District is not currently implementing incentive programs specific to units used in industrial processes subject to rules in this category.

Policy Initiatives

Similar to the Incentive Programs, the District's policies and Legislative Platform are important components to the District's strategy to attain federal ambient air quality standards. The District utilizes policies and the legislative platform to bring attention to major issues that have a direct impact on the Valley's air quality. The District does not currently have a portion of the legislative platform dedicated specifically to this control measure source category.

Rules and Regulations

The following is a list of rules specific to the Industrial Processes category. Each of the following rules will be evaluated to examine potential opportunities for additional emissions reductions.

Table D-7 Current Industrial Process Rules

Rule		Last Amended/ Adopted
Rule 4104	**Reduction of Animal Matter**	12/17/1992
Rule 4311	**Flares**	06/18/2009
Rule 4313	**Lime Kilns**	03/27/2003
Rule 4354	**Glass Melting Furnaces**	05/15/2011
Rule 4802	**Sulfuric Acid Mist**	12/17/1992

D.2.1 Rule 4104 Reduction of Animal Matter

Source Category

Rule 4104 is applicable to any source operation used for the reduction of animal matter, including rendering, cooking, drying, dehydration, digesting, evaporating, and protein concentration. Adopted on May 21, 1992 and amended for District rule number reorganization on December 17, 1992, Rule 4104 requires 100% VOC capture and a high level of destruction (1,200 degree for 0.3 seconds). Rule 4104 was adopted primarily to control pathogens.

Emission Inventory

Pollutant	2007	2012	2014	2015	2016	2017	2018	2019
	Annual Average - Tons per day							
PM2.5	0.05	0.05	0.06	0.06	0.06	0.06	0.06	0.06
NOx	0	0	0	0	0	0	0	0
SOx	0.05	0.06	0.06	0.06	0.06	0.06	0.07	0.07
	Winter Average - Tons per day							
PM2.5	0.05	0.05	0.06	0.06	0.06	0.06	0.06	0.06
NOx	0	0	0	0	0	0	0	0
SOx	0.05	0.06	0.06	0.06	0.06	0.06	0.07	0.07

Regulatory Evaluation

How does District Rule 4104 compare with federal rules and regulations?

No applicable federal standards and guidelines, such as Control Techniques Guidelines (CTG), Alternative Control Techniques (ACT), New Source Performance Standards (NSPS), National Emission Standards for Hazardous Air Pollutants (NESHAP), and Maximum Achievable Control Technology (MACT) requirements have been identified for this source category.

How does District Rule 4104 compare to rules in other air districts?

Rule 4104 is as stringent or more stringent than the following similar regulations in other air districts in California: SCAQMD Rule 472 (Reduction of Animal Matter); BAAQMD Regulation 12 Rule 2 (Rendering Plants); SMAQMD Rule 410 (Reduction of Animal Matter); and VCAPCD Rule 58 (Reduction of Animal Matter).

EPA finalized approval for Rule 4104 on March 9, 2010 and deemed this rule RACT. There are no animal rendering Best Available Control Technology (BACT) guidelines that include any additional control technologies.

Emission Reduction Opportunities

Facilities generally use steam from a boiler (indirect-fired) or a rotary dryer (direct-fired) for their operations; NOx emissions are generated from these combustion units. Combustion units are regulated by other District rules; as such, those emissions are accounted for as a part of, and controlled by other District rules.

Rule 4104 effectively controls emissions from units subject to this rule, this effectiveness limits opportunities for additional emission reduction opportunities. The emission control equipment generally includes a condenser for VOC control, and a venturi scrubber or cyclone, followed by either a packed bed scrubber or a thermal oxidizer. Blood drying facilities have additional processes controlled by cyclones and a baghouse. For the sake of thoroughness, the District analyzed the potential of packed bed scrubbers and regenerative thermal oxidizers to further reduce emissions from units subject to Rule 4104.

Packed Bed Scrubbers

The potential opportunity to reduce emissions if facilities were to replace their thermal oxidizers with packed bed scrubbers is analyzed in the following discussion. In certain installations, packed bed scrubbers may be more efficient at removing PM from the exhaust and additionally do not create NOx or SOx. However, determining the scrubber medium may take some experimenting to ensure it does not cause an increase in emissions or violate other District rules. It would also need to be replaced periodically, adding to the cost of upkeep. Thermal oxidizers do not present similar issues. Also, facilities subject to Rule 4104 produce only a very small amount of directly emitted PM2.5 and are otherwise already required to have a high level of control for emissions. Therefore, the current requirements are as stringent as possible for these types of facilities.

Regenerative Thermal Oxidizers

The potential opportunity to reduce emissions from facilities by replacing thermal oxidizers with regenerative thermal oxidizers (RTO) with heat recovery, which is a current practice in place at some facilities in the Valley, is also considered for this analysis. RTO devices use less supplementary fuel. While using less fuel may reduce NOx emissions, this is not necessarily the case. The PM control efficiency is nearly the same for both thermal oxidizers and RTOs and the total NOx emissions from this category is relatively small given that there are only a few units subject to this rule that are not already subject to other combustion rules limiting NOx emissions. Any new units would be evaluated through the District's Best Available Control Technology New Source Review requirements.

There are no feasible opportunities for additional emission reduction regulatory strategies for this source category. The District will continue to evaluate the potential for additional emissions reductions from this source category through future plan development projects.

Risk-based Strategy Analysis
The emissions from this source category contribute 0.7% of average winter SOx, and 0.1% of average winter PM2.5 emitted from stationary and area sources in the 2012 emission inventory. The emissions from this source category are relatively small contributors to the Valley inventory throughout the year; the emissions are consistent and have no elevated emission levels in the winter months.

Control Measure Commitments
The following is a summary of recommended commitments for Rule 4104.

Regulatory Action
The District's analysis did not identify any additional technologically feasible and cost effective potential controls. Therefore, there are no recommendations for additional regulatory actions for Rule 4104.

Incentive Action
There are no recommendations for incentive actions for this source category at this time.

Technology Advancement Action
There is no recommendation for a new technology advancement project for units subject to Rule 4104. Through its Technology Advancement Program, the District will continue to seek potential feasible and low-cost technologies that may provide for additional emission reduction opportunities in this category.

Policy Initiatives
The District does not currently have any policy initiatives specific to units subject to this rule. There are no recommendations for new policy initiatives specific to these units.

Education and Outreach
The District currently provides a robust education and outreach program for regulated sources through the Small Business Assistance program, Permit Stakeholder Meetings, Compliance Assistance Bulletins, and public notices for public workshops and public hearings. There are no recommendations for additional education and outreach efforts for these sources. The District will continue to work closely with affected sources to ensure successful compliance.

D.2.2 Rule 4311 Flares

Source Category

The purpose of Rule 4311 is to limit volatile organic compounds (VOC), NOx, and SOx emissions from any operation involving the use of flares, with the exception of a few types of sources identified in the rule. Flaring is a high temperature oxidation process used to burn combustible components, mostly hydrocarbons, of waste gases from industrial operations. The majority of waste gases flared are natural gas, propane, ethylene, propylene, butadiene and butane. During combustion, gaseous hydrocarbons react with atmospheric oxygen to form carbon dioxide (CO_2) and water. In some waste gases, carbon monoxide (CO) is the major combustible component. Flares generate air pollutants such as NOx, sulfur dioxide, carbon monoxide, and particulate matter. Additionally, there is a possibility of release of hydrocarbons if they have not been completely combusted, seen by the naked eye as smoke. Complete combustion requires proper mixing of air and waste gas. There are two general types of flares, open and enclosed flares. Flares are further categorized by the height of the flare tip, and by the method of enhancing combustion by mixing at the flare tip (i.e., steam-assisted, air-assisted, pressure assisted, or non-assisted). Elevated flares are more common and have larger capacity than ground flares. Flares are normally used to dispose of low volume continuous emissions, but are designed to handle large quantities of waste gases associated with plant emergencies. Flare gas volumes can vary from a few cubic meters per hour during regular operations up to several thousand cubic meters per hour during major upsets.

This rule was originally adopted June 2002 to establish flaring requirements and reduce emissions from flares, and has been amended twice since then. The most recent amendment was made in September 2009 to incorporate requirements for flare minimization plans and to make existing requirements for sulfur emissions more stringent. EPA finalized approval for the most recent amendments to Rule 4311 on November 3, 2011 and deemed this rule as meeting established RACT standard requirements.

Emission Inventory

Pollutant	2007	2012	2014	2015	2016	2017	2018	2019
	Annual Average - Tons per day							
PM2.5	0.12	0.13	0.13	0.13	0.14	0.14	0.14	0.14
NOx	0.38	0.38	0.39	0.39	0.39	0.39	0.39	0.39
SOx	0.24	0.25	0.26	0.26	0.26	0.26	0.26	0.27
	Winter Average - Tons per day							
PM2.5	0.12	0.13	0.13	0.13	0.14	0.14	0.14	0.14
NOx	0.38	0.38	0.39	0.39	0.39	0.39	0.39	0.39
SOx	0.24	0.25	0.26	0.26	0.26	0.26	0.26	0.27

Regulatory Evaluation

How does District Rule 4311 compare with federal rules and regulations?

Rule 4311 is as stringent as or more stringent than the two New Source Performance Standards (NSPS) that are applicable to this source category, (40 CFR 60.18 – General Control Device Requirements and 40 CFR 65.147 – Flares). There are no applicable Control Techniques Guidelines (CTG), Alternative Control Techniques (ACT), National Emission Standards for Hazardous Air Pollutants (NESHAP) or Maximum Achievable Control Technology (MACT) requirements for this source category.

How does District Rule 4311 compare to rules in other air districts?

The standards of Rule 4311 were compared to rules for similar source categories in other air districts in California, and determined to be as stringent, or more stringent, than other air districts' rules for flaring activities. Specifically, this rule was compared to the following rules: SCAQMD Rule 1118 (Emissions from Refinery Flares); BAAQMD Regulation 12 Rule 11 (Flare Monitoring at Petroleum Refineries); BAAQMD Regulation 12 Rule 12 (Flares at Petroleum Refineries); and Santa Barbara County Air Pollution Control District Rule 4359 (Flares and Thermal Oxidizers). SMAQMD and VCAPCD do not have flare specific prohibitory rules.

Rule 4311 was found to be more stringent than the flare rules in other districts in that Rule 4311 is applicable to any operation that uses flares, while other districts limit applicability to oil and gas production, petroleum refineries, natural gas services, and similar industries. Additionally, Rule 4311 does not have as many exemptions as other air districts, for example Santa Barbara's rule has exemptions for the burning of sulfur in the manufacturing of sulfur compounds while District Rule 4311 does not contain these exemptions. Similarities between Rule 4311 and the flare rules in other districts include the requirement to submit and maintain flare minimization plans, monitoring, recordkeeping, and reporting requirements, and NOx and VOC emissions standards for ground-level enclosed flares.

Emission Reduction Opportunities

Rule 4311 is one of the most stringent rules in the nation for flaring activities, and was approved by EPA into the California State Implementation Plan (SIP) as meeting RACT requirements in November 2011. Overall, additional opportunities to further reduce emissions from flares and flaring activities in the Valley were not identified. The November 2011 EPA technical support document (TSD) for the approval of the 2009 amendments to Rule 4311 includes recommendations by EPA for exploring additional recordkeeping and monitoring requirements. A thorough analysis was performed of the recordkeeping and monitoring requirements during the rule-amending project, as discussed in the final draft staff report for the adopted rule. Existing recordkeeping and monitoring requirements are appropriate for facilities in the Valley to demonstrate compliance with rule requirements. No emission reductions, or other benefits to air quality, would result from amending the recordkeeping and monitoring requirements. Additionally, the EPA recommendations are not RACT requirements as demonstrated by EPA's approval of the rule into the SIP as RACT. The 2011 EPA TSD also recommended the District consider creating a separate rule for refinery and non-refinery flare rules. Both types of flares are included in the current version of District Rule 4311. No emission reductions would be gained by the bifurcation of the existing rule; therefore, bifurcation is not recommended as a part of this plan.

Sections 6.2.2 and 6.2.3 of Rule 4311 require facilities subject to flare minimization plans (FMP) to submit annual reports to the District with "Reportable Flaring Event" and "Annual Monitoring Report" data by a July 31, 2012 deadline. Analysis of the submitted data and comparisons of that data against the submitted FMPs will provide an opportunity to evaluate potential emission reduction opportunities from this category.

Risk-based Strategy Analysis

The emissions from units subject to Rule 4311 contribute 0.8% of average winter NOx, and 3.0% of average winter SOx emitted from stationary and area sources in the 2012 emission inventory. The emissions from this source category are a relatively small contributor to overall Valley emissions throughout the year, with no elevated emission levels in the winter months. Emissions from this category are well-controlled through existing Rule 4311 requirements.

Control Measure Commitments

The following is a summary of recommended commitments for Rule 4311.

Regulatory Action

The District's analysis did not identify any additional technologically feasible and cost effective potential controls. Therefore, there are no recommendations for additional regulatory actions for Rule 4311. EPA comments presented in the November 2011 TSD regarding additional recordkeeping and monitoring requirements will be re-evaluated as appropriate the next time that Rule 4311 is amended.

Further study of the FMPs and annual reportable flaring event data and the annual monitoring report data to determine if there are any opportunities to reduce additional emissions from facilities subject to Rule 4311 is recommended.

Incentive Action

Facilities that use flares are regulated sources that have been subject to several generations of rules, and Rule 4311 is one of the most stringent rules in the nation for flaring activities, which minimizes opportunities for incentive actions. There are no recommendations for incentive actions at this time.

Technology Advancement Action

There is no recommendation for a new technology advancement project for units subject to Rule 4311. Through its Technology Advancement Program, the District will continue to seek potential feasible and low-cost technologies that may provide for additional emission reduction opportunities in this category.

Policy Initiatives

The District is not currently supporting any policy initiatives specific to flares, and there are no recommendations for new policy initiatives for these sources.

Education and Outreach

The District currently provides a robust education and outreach program for regulated sources through the Small Business Assistance program, Permit Stakeholder Meetings, Compliance Assistance Bulletins, and public notices for public workshops and public hearings. No new education and outreach efforts are recommended for these sources at this time. The District will continue to work closely with affected sources to ensure successful compliance.

D.2.3 Rule 4313 Lime Kilns

Source Category

Rule 4313 limits NOx emissions from the operation of lime kilns. Lime kilns are used in a variety of manufacturing and processing operations, including food and agriculture. There are currently no lime kilns currently operating in the Valley. There were a total of three lime kilns in the Valley, used at two sugar processing plants; however, these plants have been non-operational since 2008.

Emission Inventory

Pollutant	2007	2012	2014	2015	2016	2017	2018	2019
	Annual Average - Tons per day							
PM2.5	0	0	0	0	0	0	0	0
NOx	0	0	0	0	0	0	0	0
SOx	0	0	0	0	0	0	0	0
	Winter Average - Tons per day							
PM2.5	0	0	0	0	0	0	0	0
NOx	0	0	0	0	0	0	0	0
SOx	0	0	0	0	0	0	0	0

Regulatory Evaluation

There are no opportunities for reduced emissions in the Valley from this source category; there are no lime kilns operating in the Valley.

Emission Reduction Opportunities

There are no opportunities for reducing emissions in the Valley from this source category. If an operator were to bring a lime kiln to the Valley with the intention of operating it, that lime kiln would be subject to District Rules 2201 (New and Modified Stationary Source Review Rule), and 4001 (New Source Performance Standards), among others, and would be required to meet District Best Available Control Technology (BACT) requirements.

Risk-based Strategy Analysis

No health risks are associated with lime kilns in the Valley.

Control Measure Commitments

There are no recommendations for future control measure commitments for Rule 4313.

D.2.4 Rule 4354 Glass Melting Furnaces

Source Category

The provisions of Rule 4354 are applicable to glass melting furnaces in the Valley. There are seven glass-making facilities with a total of 13 glass-melting furnaces subject to Rule 4354 in the Valley. Industrial glass making is a continuous process with raw materials supplied to the furnace at the front end, and product taken off the line at the back end of the process. The raw materials for making glass are silica sand and soda ash. Melting these basic materials and forming them into the desired product geometry creates the final glass product. The different end products vary widely in raw material additives, processing equipment and conditions, and product quality requirements.

Rule 4354 was adopted September 14, 1994 and has been subsequently amended six times. This rule is one of the most stringent rules of its kind in the nation, and is successful in limiting NOx, SOx, volatile organic compounds (VOC), carbon monoxide (CO), and PM emissions from glass melting furnaces. Rule 4354 was amended September 16, 2010 to strengthen NOx limits in the rule; EPA finalized approval for these amendments on August 29, 2011 and deemed this rule as RACT. Rule 4354 was subsequently amended again in May 19, 2011 to implement updated start-up requirements; EPA proposed approval of these amendments on November 5, 2012. As a result of this stringent prohibitory rule and continuing efforts on behalf of this industry to reduce emissions, the Valley is home to glass-making facilities with glass melting furnaces that utilize the most advanced low-NOx firing technology.

Emission Inventory

Pollutant	2007	2012	2014	2015	2016	2017	2018	2019
	Annual Average - Tons per day							
PM2.5	0.60	0.45	0.47	0.48	0.49	0.50	0.51	0.51
NOx	7.75	6.13	4.02	4.12	4.22	4.31	4.35	4.39
SOx	3.04	1.86	1.80	1.82	1.85	1.87	1.88	1.89
	Winter Average - Tons per day							
PM2.5	0.60	0.45	0.47	0.48	0.49	0.50	0.51	0.51
NOx	7.75	6.12	4.02	4.12	4.21	4.31	4.35	4.39
SOx	3.04	1.85	1.80	1.82	1.85	1.87	1.88	1.89

Regulatory Evaluation

How does District Rule 4354 compare with federal rules and regulations?

This rule is more stringent than federal rules and regulations. This rule was compared to the following federal rules and regulations: federal Alternative Control Techniques (ACT) (EPA-435/R-94-037 – Alternative Control Techniques Document – NOx Emissions from Glass Manufacturing); the one National Emission Standard for Hazardous Air Pollutants (NESHAP) that is applicable to glass melting furnaces (40

CFR 61 Subpart N (National Emission Standard for Inorganic Arsenic Emissions from Glass Manufacturing Plants); the following two Maximum Achievable Control Technology (MACT) standards, 40 CFR 63 Subpart NNN (National Emission Standards for Hazardous Air Pollutants for Wool Fiberglass Manufacturing Plants), and 40 CFR 63 Subpart SSSSSS (National Emission Standards for Hazardous Air Pollutants for Glass Manufacturing Area Sources). There is no Control Techniques Guidelines (CTG) for this source category.

How does District Rule 4354 compare to rules in other air districts?

The emission limits of Rule 4354 depend on the type of glass produced, furnace firing technology and the emission-averaging period. Evaluation of glass melting prohibitory rules in other air districts in California revealed that this rule is more stringent than equivalent rules in other air districts. Rules evaluated include SCAQMD Rule 1117 (Emissions of Oxides of Nitrogen from Glass Melting Furnaces) and BAAQMD Regulation 9 Rule 12 (Nitrogen Oxide Emissions from Glass Melting Furnaces). VCAPCD and SMAQMD do not have a specific prohibitory rule for this source category.

Emission Reduction Opportunities

Rule 4354 is among the most stringent rules in the nation for glass melting furnaces. The NOx emission limits contained within Rule 4354 require the installation of the best available NOx technology (i.e. oxy-fuel firing or SCR systems), with a compliance deadline of January 1, 2014; there are no feasible opportunities to further reduce NOx emissions from glass melting furnaces at this time.

District staff considered lowering the existing SOx limits for container plants from current limits of 0.9 and 1.1 lbs of SOx per ton of glass depending on cullet content to the District Best Available Control Technology (BACT) limit of 0.8 lbs/ton. The analysis below indicates that it is not reasonably feasible to reduce SOx limits from RACT levels to BACT levels.

The glass container industry is mandated by the State of California to use a minimum quantity of recycled glass (cullet) as part of the production process. The quantity of clear glass cullet available to glass manufacturers is very limited; therefore, cullet with a large portion of colored glass is included in each batch. The continued use of mixed color cullet is critically important to meeting California’s recycling goals. Due to the variable quality of mixed color cullet, SOx emissions produced by the melting of recycled cullet are also variable. Container glass manufacturers control multiple furnaces as a single unit, meaning that the exhaust from multiple furnaces are ducted together and the total emissions are averaged over the total amount of glass pulled from all furnaces. Because emissions are averaged across furnaces, EPA requires that there be a 10% air quality benefit, meaning that the overall limit for multiple furnaces be 10% less than the limit for a single furnace. This imposes the lowest SOx emission limit on container glass furnaces, but allows operators to install one control device per facility rather than one add-on control device per furnace. SOx emissions limits for container glass were adopted at 1.1 pounds per ton of glass produced if the operator uses at least

25% by weight of mixed color cullet and a limit of 0.9 pounds per ton of glass produced for all other container glass manufacturing. If the District were to lower the limits in the rule to the BACT limit of 0.8 lbs/ton, then the 10% required air quality benefit for multiple furnaces extend beyond BACT, which is not feasible. The 0.8 lbs/ton BACT limit is equivalent to the 0.9 lbs/ton limit with the additional EPA required 10% air quality benefit.

At this time, the District's analysis indicates that there are no feasible opportunities for additional emission reduction regulatory strategies for this source category.

Risk-based Strategy Analysis

The emissions from units subject to Rule 4354 contribute12.6% of average winter NOx, and 22.5% of average winter SOx emitted from stationary and area sources in the 2012 emission inventory. Emissions from this source are consistently emitted throughout the year with no peak emission in winter months. NOx emissions from these sources have been significantly reduced through this rule, which is one of the most stringent rules in the nation.

Control Measure Commitments

The following is a summary of recommended commitments for Rule 4354.

Regulatory Action

The District's analysis did not identify any additional technologically feasible and cost effective potential controls. Therefore, there are no recommendations for additional regulatory actions for Rule 4354.

Incentive Action

There are no technologies that could reduce emissions beyond that already required in the rule and achieved by facilities; therefore, there are no recommendations for incentive actions for glass melting furnaces.

Technology Advancement Action

There is no recommendation for a new technology advancement project for units subject to Rule 4354. Through its Technology Advancement Program, the District will continue to seek potential feasible and low-cost technologies that may provide for additional emission reduction opportunities in this category.

Policy Initiatives

The District does not currently support any legislative activities specific to glass melting operations; there are no recommendations for new policy initiatives at this time.

Education and Outreach

The District currently provides a robust education and outreach program for regulated sources through the Small Business Assistance program, Permit Stakeholder Meetings, Compliance Assistance Bulletins, and public notices for public workshops and public hearings. The District does not have recommendations for new education and outreach efforts for these sources. The District will continue to work closely with affected sources to ensure successful compliance.

D.2.5 Rule 4802 Sulfuric Acid Mist

Source Category

The purpose of Rule 4802 is to limit sulfuric acid emissions from any sulfuric acid production unit that was constructed or modified before August 17, 1971. The rule was adopted on May 21, 1992 and applies to only one facility in the Valley. The EPA approved Rule 4802 into the SIP on June 8, 1999.[28] District Rule 4802 limits sulfuric acid mist to 0.30 pounds per short ton of acid produced.

Emission Inventory

Pollutant	2007	2012	2014	2015	2016	2017	2018	2019
	Annual Average - Tons per day							
PM2.5	0.0004	0.0003	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004
NOx	0.027	0.022	0.022	0.022	0.023	0.023	0.023	0.024
SOx	0.95	0.76	0.78	0.79	0.79	0.81	0.81	0.83
	Winter Average - Tons per day							
PM2.5	0.0004	0.0003	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004
NOx	0.027	0.022	0.022	0.022	0.023	0.023	0.023	0.024
SOx	0.95	0.76	0.77	0.78	0.79	0.80	0.81	0.83

Regulatory Evaluation

How does District Rule 4802 compare with federal rules and regulations?

The rule reflects conformance with 40 CFR Part 60.30d Subpart Cd—Emissions Guidelines and Compliance Times for Sulfuric Acid Production Units (Part 60 of the CFS is Standards of Performance for New Stationary Sources (NSPS)), which sets emission limits for sulfuric acid mist at 0.5 pounds per ton of acid produced for sulfuric acid production plants operating before August 17, 1971.

There is one sulfuric acid plant in the Valley; this plant has been in operation since before August 17, 1971, and it is subject to the requirements of District Rule 4802. 40 CFR Part 60.30d Subpart Cd—Emissions Guidelines and Compliance Times for Sulfuric Acid Production Units establishes emission limits for such sulfuric acid plants. 40 CFR Part 60.80 Subpart H—Standards of Performance for Sulfuric Acid Plants, sets emission limits for sulfuric acid plants constructed or modified after August 17, 1971. There are no other federal guidelines, including Control Techniques Guidelines (CTG), Alternative Control Technology (ACT), Maximum Achievable Control Technology (MACT), and National Emission Standards for Hazardous Air Pollutants (NESHAP), that apply to the control of sulfuric acid mist. The Best Available Control Technology (BACT)

[28] (1999, June 8). *Approval and Promulgation of Implementation Plans; California State Implementation Plan Revision, South Coast Air Quality Management District, San Joaquin Valley Unified Air Pollution Control District, Siskiyou County Air Pollution Control District, and Bay Area Air Quality Management District*, 64 Fed. Reg. 109, pp. 30396–30398. (to be codified at 40 CFR Part 52)

determination for controlling sulfuric acid mist involves the use of candle filters (fiber bed mist eliminators), which reduce emissions to 0.10 pounds per ton of 100% sulfuric acid when measured as a three-hour average.

How does District Rule 4802 compare to rules in other air districts?

BAAQMD Regulation 9, Rule 1 (Sulfur Dioxide), regulates all sulfur dioxide emissions including sulfuric acid mist plants constructed or modified after August 17, 1971; the rule limits emissions from any source in the sulfuric acid plant effluent process gas containing sulfur dioxide in excess of 300 ppm by volume calculated at 12% oxygen. BAAQMD's Regulation 12, Rule 6 (Acid Mist from Sulfuric Acid Plants) requires that an operator not emit from a sulfuric acid production unit gases which contain acid mist expressed as H2SO4 in excess of 0.15 g per kg (0.3 lb/T) of acid produced. No other district-specific rules were indicated. SCAQMD Rule 469 (Sulfuric Acid Units) has the same limit as District Rule 4802. Both SMAQMD and VCAPCD regulate sulfuric acid mist through their new source review process, but do not have specific sulfuric acid mist rules.

Emission Reduction Opportunities

Only one facility in the Valley—a sulfuric acid plant—is subject to Rule 4802 (Sulfuric Acid Mist). This facility was in operation before 1971 and is limited by this rule to 0.30 pounds of acid mist per ton of acid produced. The facility uses a mist eliminator to remove fine particles from the acid gas stream, which has been determined to meet BACT requirements. By definition of Rule 4802, no new facility within the Valley will be subject to this rule. Instead, all new facilities would be subject to Rule 2201 (New and Modified Stationary Source Review Rule) and would be required to implement BACT level controls.

An identified potential opportunity to reduce emissions from this source category would be to reduce the allowed limit for sulfur emissions from 0.30 pounds per ton produced to 0.1 pound per ton produced, consistent with EPA's BACT determination. Source tests conducted in 2010 and 2011 at the single facility permitted under Rule 4802, showed an actual sulfuric acid mist emission rate of 0.09 pound per ton using existing technology. Hence, the facility is meeting the current national BACT standard with the most advanced technology currently available and enforced through existing permit requirements, despite the fact that their current permit and Rule 4802 do not set that requirement. Therefore, the District has determined that there are no potential opportunities to further reduce emissions from this source category.

Risk-based Strategy Analysis

The emissions from this source category contribute 9.2% of average winter SOx emitted from stationary and area sources in the 2012 emission inventory. As demonstrated in the emission inventory table above, these emissions are consistent throughout the year with no elevated emission levels in winter months.

Control Measure Commitments

The following is a summary of recommended commitments for Rule 4802.

Regulatory Action

The District's analysis did not identify any additional technologically feasible and cost effective potential controls. Therefore, there are no recommendations for additional regulatory actions for Rule 4802.

Incentive Action

The one unit subject to Rule 4802 is currently a regulated source that has been subject to this rule since 1992 and no new technologies were identified to further reduce emissions. There are no recommendations for incentive actions at this time.

Technology Advancement Action

There is no recommendation for a new technology advancement project for units subject to Rule 4802. Through its Technology Advancement Program, the District will continue to seek potential feasible and low-cost technologies that may provide for additional emission reduction opportunities in this category.

Policy Initiatives

The District is not currently supporting any policy initiatives specific to sulfuric acid mist operation and there are no recommendations for new policy initiatives for these sources.

Education and Outreach

The District currently provides a robust education and outreach program for regulated sources through the Small Business Assistance program, Permit Stakeholder Meetings, Compliance Assistance Bulletins, and public notices for public workshops and public hearings. No new education and outreach efforts are recommended for these sources at this time. The District will continue to work closely with affected sources to ensure successful compliance.

D.3 MANAGED BURNING

Managed burning is the controlled burning of materials. There are three types of managed burning that occur in the Valley including open burning of agricultural materials, hazard reduction burning, and prescribed burning. This managed burning control measure source category affects burning and disposal activities conducted by the agricultural industry, residents in the wildland/urban interface, and land management agencies operating on the San Joaquin Valley floor and within the National Parks and Forests.

For many years, the District managed the smoke impacts from the open burning of agricultural materials through a system of county-wide burn/no burn days. In 2004, the District established the Smoke Management System (SMS), a more refined method of authorizing or prohibiting individual burns, based on modeled smoke impacts. The SMS user considers projected meteorological conditions and air quality forecasts to determine the allowable amount and location of agricultural burning. Properly managed burning allocations under the existing District SMS ensures that air quality and health impacts of open burning of agricultural materials are minimized to the fullest extent, reducing public exposure to smoke and contributing to improvements to general air quality in the Valley. Under the SMS, agricultural burning is prohibited on days when an exceedance of a federal standard is forecast to occur. The implementation of the District's SMS, District Rule 4103 (Open Burning), and the use of sustainable agricultural practices have reduced the amount of materials being burned, thus resulting in reduced PM2.5 emissions.

Until recently, Land Management Agencies (LMAs) operated under a policy where naturally ignited wildfires (i.e. lightning strikes) were viewed as unhealthy and destructive for the ecosystem, and therefore were actively suppressed upon discovery. As this policy continued through the decades, the amount of fuel (dead plant materials, etc.) in the Sierra Nevada Mountains grew, which increased the likelihood of uncontrollable wildfires. It was later determined that fire is a natural part of the ecosystem, and that fire is necessary to reduce fuels on the forest floors to give space and a chance for new trees to grow, thus ensuring the health and continuity of the ecosystem. To achieve this, LMAs within the Valley currently conduct prescribed burning to reduce fuels in areas that are determined to be overgrown. Through these efforts, LMAs are able to burn on days when it is favorable from both meteorological and air quality considerations. Through District Rule 4106, a LMA must request authorization from the District before beginning a prescribed burn operation. This gives the District the discretion to not allow prescribed burning on days when dispersion and/or air quality is poor. This reduces emissions and protects public health by only allowing prescribed burning on days when smoke dispersion is favorable, thus reducing the chance for high concentrations of smoke to occur in nearby communities.

Similarly, hazard reduction burning occurs in communities that are within the wildland/urban interface, where homes and businesses in the foothills are often surrounded by dry brush. This fuel must be disposed of each year to ensure a barrier of fire protection of 100 feet in all directions, per Section 4291 of the California Public Resources Code. This disposal is usually in the form of burning, and as with prescribed burning, this is only allowed if the District forecasts favorable meteorological and air quality conditions.

Existing Control Strategies

Due to the degree of difficulty and enormity of the challenge that the Valley faces in meeting the National Ambient Air Quality Standards (NAAQS), the District recognizes that prohibitory rules alone are not enough to reduce emissions to meet attainment requirements and protect public health. The District's longstanding, progressive strategy for reducing emissions is a multifaceted effort that includes incentive programs and policy initiatives in addition to prohibitory rules. The following discussion summarizes both the existing District efforts to reduce emissions from this source category, and evaluations for potential opportunities for further emissions reductions.

Incentive Programs

Incentive programs are an integral part of the emission reduction efforts of the District, especially where the District lacks direct jurisdiction in establishing emission control requirements. The District is not currently implementing any incentive programs specific to this category. However, the District is actively seeking technology advancement projects to further develop low-emissions options for the handling of the wide variety of organic materials in the Valley.

Policy Initiatives

Similar to the Incentive Programs, the District's policies and Legislative Platform are important components to the District's strategy to attain federal ambient air quality standards. The District utilizes policies and the legislative platform to bring attention to major issues that have a direct impact on the Valley's air quality. The District's legislative platform currently includes the following items that are applicable to managed burning categories.

The biomass industry utilizes agricultural materials that would otherwise be burned using open burning methods. To maintain the viability of biomass power-generating plants, the District supports legislation that would provide for the continued operation of strategically located biomass facilities to provide disposal options for agricultural, urban, and forest wood materials. Subsidies and/or preferential utility rates for power produced from biomass can serve as measures to enhance the economic feasibility of this alternative.

Reducing wildfires and the resulting air pollutants requires a sustained and multi-faceted approach that employs effective measures to reduce fuel supplies and adequate resources to manage fires when they occur. Towards that end, the District supports policies and initiatives that would encourage rapid disposal of the fuel supply, including the following:

- Additional financial and staffing resources for public and private land managers to conduct prescribed burning as an effective means for reducing fuel supplies that lead to large and uncontrollable wildfires.
- Additional resources to manage wildfires when they occur.
- Lessening or removal of contradictory environmental protection policies that prohibit the use of mechanized methods, or prescribed burning to reduce fuels when those are the only feasible methods available.
- Changes in the federal policies that better incorporate air quality concerns by shifting focus to prescribed burning and employing fire management techniques that reduce air quality impacts when wildfires occur.

Rules and Regulations

The following is a list of rules specific to the Managed Burning category. Each of the following rules will be evaluated to examine potential opportunities for additional emissions reductions.

Table D-8 Current Managed Burning Rules

Rule		Last Amended/ Adopted
Rule 4103	**Open Burning**	04/15/2010
Rule 4106	**Prescribed Burning and Hazard Reduction Burning**	06/21/2001

D.3.1 Rule 4103 Open Burning

Source Category

This source category includes the open burning of materials such as agricultural materials, diseased materials, and contraband materials, as well as fires set for fire department training purposes. Rule 4103 was originally adopted on June 18, 1992 and it has since been amended several times to incorporate state law requirements. The provisions of Rule 4103 apply to open burning conducted in the Valley, with the exception of prescribed burning and hazard reduction burning, as defined in Rule 4106 (Prescribed Burning and Hazard Reduction Burning).

Rule 4103 and the District's Smoke Management System (SMS) have reduced the total acreage of agricultural materials burned in the Valley by 80% since 2002. California Senate Bill (SB) 705 (2003, Florez; California Health and Safety Code Section (CH&SC) 41855.5 and 41855.6) established a schedule for specific types of agricultural materials to no longer be burned, but allowed some postponement of the phase-out where justified by technical and economic impediments. In an effort to implement SB 705 and enhance the procedures for open burn requests, in 2004 the District established the SMS, a more refined method of authorizing or prohibiting individual burns, based on modeled smoke impacts. Under the SMS, agricultural burning is prohibited on days when an exceedance of a federal standard is forecast to occur.

In 2010, the District evaluated each crop category identified in CH&SC Section 41855.5 to determine any technologically and economically feasible alternatives to open burning. After working extensively with stakeholders to understand viable alternatives to burning and associated costs, the District provided recommendations for allowing or prohibiting the open burning of agricultural material categories in the District's *2010 Final Staff Report and Recommendations on Agricultural Burning*. The District amended Rule 4103 in April 2010 to incorporate CH&SC requirements and require the District to review its determinations for any postponed crops and materials at least once every five years. EPA finalized approval for Rule 4103 on January 4, 2012 and deemed this rule as at least meeting RACT requirements. The District most recently re-evaluated the availability of alternatives to open burning in May 2012. The District found the recommendations for postponement of certain crop categories are still valid and submitted a report of those findings to ARB, of which they concurred.

Emission Inventory

Pollutant	2007	2012	2014	2015	2016	2017	2018	2019
	Annual Average - Tons per day							
PM2.5	5.87	4.54	4.51	4.50	4.49	4.47	4.46	4.45
NOx	4.30	3.46	3.44	3.43	3.42	3.41	3.40	3.38
SOx	0.11	0.09	0.09	0.09	0.09	0.09	0.09	0.09
	Winter Average - Tons per day							
PM2.5	9.32	6.67	6.63	6.61	6.59	6.57	6.55	6.53
NOx	6.84	5.07	5.04	5.02	5.01	4.99	4.97	4.96
SOx	0.17	0.13	0.13	0.13	0.13	0.13	0.13	0.13

Regulatory Evaluation

How does District Rule 4103 compare with federal rules and regulations?

There are no specific federal guidelines for Open Burning in terms of New Source Performance Standards (NSPS), Control Techniques Guidelines (CTG), Maximum Achievable Control Technology (MACT) and National Emission Standards for Hazardous Air Pollutants (NESHAP).

How does District Rule 4103 compare to rules in other air districts?

No rules or Best Available Control Technology (BACT) guidelines in other California air districts are more stringent than the current Rule 4103. Rule 4103 sets the standard for agricultural burning programs, with extensive resources dedicated to implementing the District's smoke management program. Under Rule 4103 and the SMS, potential burning is evaluated and authorized only when the burning will not cause a significant impact on air quality.

The analogous rules of other California air districts evaluated for this plan include SCAQMD Rule 444 (Open Burning); BAAQMD Regulation 5 (Open Burning); SMAQMD Rule 407 (Open Burning); and VCAPCD Rule 56 (Open Burning).

Emission Reduction Opportunities

The District evaluated the feasibility and cost effectiveness of alternatives to burning in the *2010 Final Staff Report and Recommendations for Agricultural Burning* (*2010 Report*). The District determined, and ARB concurred, that there were no economically feasible alternatives to open burning of certain crop categories as outlined in the 2010 Report; this conclusion was reaffirmed in the *2012 Update: Recommendations on Agricultural Burning* (*2012 Report*).

Citrus Orchard Removal Threshold
The District has determined that citrus orchard removals less than 3,500 acres, under certain circumstances should still be allowed to burn when no other cost effective and feasible alternatives are available based on factors identified and discussed in length in the *2010 and 2012 Reports*. For the largest citrus growers (>3,500 acres), the District determined that it is economically feasible to send citrus orchard removal matter to biomass plants, as described in June 27, 2011 and October 12, 2012 letters to EPA that provided further clarification on this issue. Therefore, open burning of citrus orchard removals for large citrus growers (>3,500 acres) is not allowed. These determinations are based on the ability of large growers to provide a steady demand for chippers, the availability of chipping equipment, and the currently reduced supply of urban wood materials as fuel for biomass plants due to the economic downturn.

Open Burning
Burning of citrus orchard removal materials (less than 3,500 acres) is not automatically allowed, rather, each request to burn citrus orchard removals is evaluated on a case-by-case basis under the District's agricultural burn permit program, which does not allow burning if it will cause or contribute to the exceedance of air quality standards. To more specifically describe the criteria for case-by-case evaluations (and as described in the June 27, 2011 and October 12, 2012 letters to EPA), the District annually evaluates and determines the feasibility of further prohibiting open burning of these materials based on the availability of sufficient biomass capacity and economically feasible chipping services. As of July 2011, the prohibition threshold is established as citrus farms with a combined acreage of 3,500 acres or greater. Consistent with this criteria, any request (beyond the 15 acre allowance provided for all citrus orchard removals) from citrus farms to open burn orchard removals are evaluated on a case-by-case basis.

The following is a summary of the analysis the District used to make the citrus determinations; these contributing factors will be re-evaluated in 2015 as committed to in the 2010 Rule 4103 amendment.

Alternatives to Open Burning
The alternative to open-burning citrus orchard removal material is to chip the material and send it to biomass plant. Biomass plant capacity and the availability of economically feasible chipping services were evaluated in order to determine the feasibility of this alternative to open burning citrus orchard removals. Concerns raised in the *2010 Report* remain valid of whether or not biomass plants will accept citrus along with the additional processing and costs that are required to make the citrus chips acceptable as fuel, especially once the economy improves and construction material is more abundant.

- **Chipping.** The adobe soil in which citrus crops are usually grown is extremely difficult to remove from the extensive root system of citrus trees. Separating the roots from the trunk prior to chipping, as well as screening the chipped root material to remove excessive soil clumps all increase the costs associated with chipping citrus material.

- **Biomass.** Biomass facilities have a limited capacity for citrus orchard removals due to the composition of the citrus materials as discussed in detail in the *2010 Report*. In addition, ground citrus wood produces stringy material and takes longer to dry out enough to burn properly. As a result, biomass facilities which do accept citrus material will blend up to 30% of citrus material with other crops to promote better flow of the material through the equipment. There is uncertainty in the amount of citrus orchard removal biomass facilities will accept in the future as biomass facilities have not committed to burning a specific amount of agricultural material. As described in the *2012 Report*, there has not been a significant increase in biomass fuel consumption or storage capacity from the addition of new/converted facilities.

Previously, monetary incentives have also been provided to increase use of biomass and offset the cost of chipping services. However, these monetary incentive programs are short-term in nature, either because the program sunsets within a few years, funding for the program has to be re-appropriated, or funding per project is for a limited period. Funding previously available for chipping agricultural materials provided by the Natural Resources Conservation Service (NRCS) was discontinued in 2012, making it more cost prohibitive to completely prohibit open burning. Therefore, there are currently no long-term federal or state funding commitments for the operation of biomass facilities or development of alternatives to burning. The *2010 Report* specified that Rule 4103 is as stringent as economically and technologically feasible. Therefore, there are no additional identified opportunities for emissions reductions from this source category at this time. This category will be re-evaluated in 2015 as committed to in the 2010 Rule 4103 amendment.

Risk-based Strategy Analysis

The emissions from this source category contribute10.0% of average winter NOx, and 12.2% of average winter PM2.5 emitted from stationary and area sources in the 2012 emission inventory. District regulatory efforts have fostered significant reductions in emission from this source category. Although winter emissions are slightly elevated compared to summer emission levels, the District's Smoke Management System (SMS) prohibits agricultural burning on days when an exceedance of federal standards is forecast to occur, thus reducing potential public health impacts from this source category.

Control Measure Commitments

The following is a summary of recommended commitments for Rule 4103.

Regulatory Action

The District's analysis did not identify any additional technologically feasible and cost effective potential controls. Therefore, there are no recommendations for additional regulatory actions for Rule 4103. The District carefully manages agricultural burning with its SMS and continues to consider the economic feasibility of burning alternatives on a case-by-case basis and in accordance with the five year evaluation period outlined in Rule 4103.

Incentive Action
Over the past ten years, the Natural Resources Conservation Service (NRCS) has encouraged growers to chip or shred prunings from almond and walnut orchards by providing a cost-share basis through the Environmental Quality Incentives Program. According to conversations with NRCS staff, the program was not continued into 2012.

Technology Advancement Action
The District is currently funding a project through its Technology Advancement Program which will test a prototype device to reduce emissions from the burning of raisin trays. While this project, as well as many others, are in the process of developing alternatives to reduce emissions, it is still under evaluation and not yet commercially available.

There is no recommendation for a new technology advancement project for this source category. Through its Technology Advancement Program, the District will continue to seek potential feasible and low-cost technologies that may provide for additional emission reduction opportunities in this category.

Policy Initiatives
The District currently supports legislation that would provide for the continued operation of strategically located biomass facilities to provide disposal options for agricultural, urban, and forest wood waste. Subsidies and/or preferential utility rates for power produced from biomass can serve as measures to enhance the economic feasibility of this alternative. The recommendation is to continue supporting the current legislative platform but there are no recommendations for new policy initiatives at this time.

Education and Outreach
The District currently provides a robust education and outreach program for regulated sources through the Small Business Assistance program, Permit Stakeholder Meetings, Compliance Assistance Bulletins, and public notices for public workshops and public hearings. There are no recommendations for additional education and outreach efforts for Rule 4103 at this time. The District will continue to work closely with affected sources to ensure successful compliance.

D.3.2 Rule 4106 Prescribed Burning and Hazard Reduction Burning

Source Category

This source category includes all prescribed burning within the District. It also includes hazard reduction burning in the wildland/urban interface. Rule 4106 was adopted in June 2001. The adoption of Rule 4106 was not aimed at reducing the total emissions from this category as the District recognizes the importance of both prescribed burning and hazard reduction burning, but rather the adoption of established tools that the District could use to manage smoke emissions in the Valley. Through these tools, the District has expended considerable resources to ensure that the ignition of burn projects is only allowed when air quality and dispersion conditions are favorable, thus lessening the health impacts on Valley citizens and on air quality in the Valley.

EPA finalized approval for Rule 4106 on February 27, 2002. Rule 4106 was evaluated in the RACT State Implementation Plan (SIP) demonstration, however the Technical Support Document (TSD) states the rule is not subject to RACT because it is not a Control Techniques Guidelines (CTG) category and it does not regulate major sources.

Emission Inventory

Pollutant	2007	2012	2014	2015	2016	2017	2018	2019
	Annual Average - Tons per day							
PM2.5	9.31	9.32	9.32	9.32	9.33	9.33	9.33	9.33
NOx	3.26	3.26	3.26	3.26	3.26	3.26	3.26	3.26
SOx	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
	Winter Average - Tons per day							
PM2.5	0.72	0.73	0.73	0.74	0.74	0.74	0.75	0.75
NOx	0.21	0.21	0.21	0.21	0.21	0.22	0.22	0.22
SOx	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05

Regulatory Evaluation

How does District Rule 4106 compare with federal rules and regulations?

There is currently no federal guidance given for this source category under the federal Alternative Control Techniques (ACT), New Source Performance Standards (NSPS), National Emission Standards for Hazardous Air Pollutants (NESHAP), Maximum Achievable Control Technology (MACT), and Control Techniques Guidelines (CTG).

How does District Rule 4106 compare to rules in other air districts?

Upon comparing Rule 4106 to other California air districts' rules for similar sources, it has been determined that Rule 4106 is as stringent as the following analogous rules: SCAQMD Rule 444 (Open Burning); BAAQMD Regulation 5 (Open Burning); SMAQMD Rule 501 (Agricultural Burning); VCAPCD Rule 56 (Open Burning), and Placer County

APCD Rule 301 (Nonagricultural Burning Smoke Management) and Rule 303 (Prescribed Burning Smoke Management).

Prescribed Burning Emission Reduction Opportunities
Land Management Agencies (LMAs) are the agencies that regularly conduct prescribed burning operations. Since the adoption of Rule 4106, the District has developed cooperative relationships with the LMAs. Through this cooperation, the District advises the LMA on which days would be the most conducive for igniting a burn project, based on air quality and meteorological conditions. The District will continue to work with LMAs to identify favorable burning conditions with the goal of completing a maximum number of prescribed burning projects while minimizing air quality impacts. This collaborative effort ensures that the ignition of burn projects occurs when air quality and dispersion conditions are favorable, thus lessening the impacts on air quality in the Valley. Diligent District analysis identified the following two potential opportunities to reduce emissions from this process: the use of firebox air curtain burners and increased communication between the District and LMAs in managing wild fires.

Firebox Air Curtain Burners
As opposed to burning, a LMA may be able to mechanically remove material from the project site. This could achieve a significant reduction in emissions, yet it is often not practical or possible to bring mechanical equipment to remote and dense forest lands. Mechanical removal is much more expensive for the LMA to reduce the fuels in an area as compared to burning, and is not physically possible for many sites, making it not a feasible alternative. However, assuming that a LMA could mechanically remove all of the material from a project burn site, and the material was placed in piles and prepared for burning, an alternative to open burning would be to use a firebox air curtain burner. A firebox air curtain burner is a device that circulates large volumes of air over a burning fire in an open topped fire proof metal box. When compared to open burning, firebox air curtain burners have been shown to greatly reduce PM and carbon dioxide emissions, but have greater emissions of NOx than open burning. Based on District analysis in 2009, firebox air curtain burners on average cost $75,000, and the cost effectiveness was calculated at $40,308 per ton of PM2.5, and $238,182 per ton of NOx. This alternative is not cost effective and therefore not feasible.

Wild Fires
Often, primarily during the warm summer months, wildfires are naturally ignited through lightning strikes from passing storms. These wildfires have the potential to produce significant emissions and heavily impact residents within the Valley. When these wildfires occur, the District works with the responsible LMA in managing the fire as the dispersion and air quality conditions fluctuate. This cooperation allows the LMA to be more aggressive with the fire when meteorological conditions are favorable and more defensive when the conditions are poor. The District will continue to use the tools available to guide the activities of LMAs when wildfires occur; and is continuously seeking opportunities to work with LMAs to improve the management of these fires in order to reduce emissions and impacts to Valley residents.

Hazard Reduction Burning Emission Reduction Opportunities

Section 4291 of the California Public Resources Code states that structures must maintain a defensible perimeter of 100 feet in all directions; this defensible perimeter is commonly created through the clearing of vegetation. Although Section 4291 doesn't require it, most of this vegetation is burned, because it's less expensive, faster, and more convenient than other options. Potential opportunities evaluated in this plan development process included the reorganization of hazard reduction zones, and the feasibility of alternatives to burning the vegetation.

Reorganization of Hazard Reduction Zones

The possibility of reducing emissions by reorganizing the currently established hazard reduction zones is examined in the following discussion. Under Rule 4106, hazard reduction burning is only allowed when the District forecasts favorable air quality and dispersion conditions. Currently this forecast is based on a county-by-county basis, with appropriate elevation breaks. As an improvement to this zone system, and similar to agricultural burning, the Valley could be separated into smaller hazard reduction zones to provide more effective smoke management. Managing the allowance of hazard reduction burning under this type of scheme also has the potential to limit smoke impacts on residents. Establishing this type of management system would not cause an increase in costs for landowners, making this a cost effective opportunity. However, emissions reduced would be minimal, since the burning would still occur, just on different days when conditions are favorable.

Alternatives to Burning

As an alternative to the open burning of the vegetation, the District could encourage alternative methods like chipping or burn boxes through grant programs targeted at communities that regularly conduct hazard reduction burning. These options are discussed below.

Note that the year 2012 emissions inventory for the hazard reduction burning portion of this control measure category is 0.21 tons per day of PM2.5, 0.05 tons per day of NOx, and 0.0043 tons per day of SOx. So although the alternatives below may be successful, the reductions in the inventory will be minimal.

Chipping

As previously mentioned, one alternative to the open burning of material is to use a chipper to break down the material into small pieces suitable for landscaping, dust control cover, or biomass burning. Further evaluation of this alternative option revealed that chippers are not a viable alternative because the requirement of the defensible perimeter of 100 feet is enforced annually; therefore, the types of materials to be cleared and disposed of are leaves, pine needles, weeds, and some small brush, all of which are not considered acceptable materials for wood chippers. The amount of useable material produced from this type of chipping would be negligible at best.

Firebox Air Curtain Burners

Another potential opportunity examined is the feasibility of usage of a firebox air curtain burner, which was described earlier. Based on the District's analysis in 2009, the average cost of a firebox air curtain burner is $75,000. Through the use of a firebox air curtain burner for hazard reduction burning, the cost effectiveness of emissions reductions was determined to be $34,026 per ton of PM2.5, and $204,154 per ton of NOx. This is not cost effective, and therefore not recommended.

Biomass Removal Program

A potential opportunity to reduce emissions from hazard reduction burning by removing the biomass from the area and sending it for combustion at a biomass plant, similar to a program implemented by the Placer County Air Pollution Control District (Placer) was evaluated. Placer implemented a "Biomass Box" program beginning in the spring of 2007 to collect and utilize biomass that would traditionally be collected and burned as a part of hazard reduction efforts, for use as fuel for producing energy. The program collected the biomass by distributing 20' to 40' industrial containers throughout participating communities in the county. When full, the containers were transported to another location where the materials were grinded into useable fuel that biomass energy companies accept. The chipped biomass was then loaded onto larger trucks and hauled to one of two biomass facilities. This was a very successful program for Placer, with net air pollution reductions at 88.6%, including 24.7 tons of particulates and 4.0 tons of NOx reduced at a cost of $80,000.

Evaluation of this program supports Placer's assertion that this is a highly successful program and a similar program could benefit the Valley. However, the Valley faces several challenges in implementing such a program due to our unique geography. The Valley is considerably larger than Placer County with the Sierra Nevada mountain range stretching the length of the Valley. This poses two unique challenges to the feasibility of this program; the first being the challenge of distributing the boxes and the quantity of boxes needed to be effective, and the second challenge being the distance from the box collection locations to the biomass power plants. The Placer program estimated total transport miles for the entire program to be 14,800 miles. The mileage required in the Valley to distribute, collect, and transport the materials to a biomass power plant would be significantly more than Placer, which brings into issue the increased truck emissions. Additionally, as stated before, the annual emissions from hazard reduction burning in the Valley are 0.05 tpd of NOx and 0.21 tpd of PM2.5, meaning emissions reduced could be lower than those achieved in Placer.

Risk-based Strategy Analysis
The emissions from this source category contribute 1.3% of average winter PM2.5 emitted from stationary and area sources in the 2012 emission inventory. Because of the nature of the source of these emissions, the emissions are primarily a summer issue, as illustrated in the emission inventory table above. This source category does not significantly contribute to winter time PM2.5 concentrations; further control of this source would not make a significant impact towards the region's attainment of the federal PM2.5 air quality standard. However, since wildfires can often heavily impact the health of Valley residents, prescribed and hazard reduction burning mitigate the impact that a wildfire can have on the landscape, thus reducing the public's potential exposure to smoke. Continued support and management of this source category will ensure an improvement in both the health of the public and the ecosystems of the parks and forests within the San Joaquin Valley.

Control Measure Commitments
The following is a summary of recommended commitments for Rule 4106.

Regulatory Action
The District's analysis did not identify any additional technologically feasible and cost effective potential controls. Therefore, there are no recommendations for additional regulatory actions for Rule 4106. Further study is recommended to determine the feasibility of utilizing a biomass removal program similar to that in Placer County.

Incentive Action
There are no incentive programs currently funded by the District specific to prescribed or hazard reduction burning. There are no recommendations for new incentive actions for this source category at this time.

Technology Advancement Action
There is no recommendation for a new technology advancement project for this source category. Through its Technology Advancement Program, the District will continue to seek potential feasible and low-cost technologies that may provide for additional emission reduction opportunities in this category.

Policy Initiatives
Reducing wildfires and the resulting air pollutants requires a sustained and multi-faceted approach that employs effective measures to reduce fuel supplies and adequate resources to manage fires when they occur. Towards that end, the District currently supports policies and initiatives that would encourage rapid disposal of the fuel supply, including the following:

- Additional financial and staffing resources for public and private land managers to conduct prescribed burning as an effective means for reducing fuel supplies that lead to large and uncontrollable wildfires.
- Additional resources to manage wildfires when they occur.
- Lessening or removal of contradictory environmental protection policies that prohibit the use of mechanized methods, or prescribed burning to reduce fuels when those are the only feasible methods available.
- Changes in the federal policies that better incorporate air quality concerns by shifting focus to prescribed burning and employing fire management techniques that reduce air quality impact when wildfires occur.

While there are no recommendations for new policy initiatives, the recommendation is to continue supporting the policies and initiatives identified above.

Education and Outreach
The District currently provides a robust education and outreach program for regulated sources through the Small Business Assistance program, Permit Stakeholder Meetings, Compliance Assistance Bulletins, and public notices for public workshops and public hearings. No new education and outreach efforts are recommended for these sources at this time. The District will continue to work closely with affected sources to ensure successful compliance.

D.4 AGRICULTURAL PROCESSES

For many years, the Valley's agricultural community has employed sound conservation management practices to safeguard the natural resources of the land. However, prior to 2004, agricultural operations were exempt from air permitting requirements in California. Agricultural processors were regulated as permitted sources; and regulation of agricultural emissions was limited to Title 13 restrictions on open burning. Particulate emissions for unpaved roads and storage piles were regulated through Regulation VIII, but only where the extent of these emissions exceeded threshold exemption values.

In September 2003, Governor Gray Davis signed Senate Bill 700 (2003) which amended air pollution control requirements in the California Health and Safety Code to include requirements for agricultural sources of air pollution. Since then, the District has implemented a series of stringent regulatory changes that added more oversight to agricultural operations and set new emission control goals. The agricultural sector has responded with significant investments in new emission control programs, and considerable changes to their longstanding practices. Collectively, the mitigation measures implemented have met or exceeded desired PM10 and VOC emissions reductions. The agricultural community has also replaced thousands of old, high-emitting diesel irrigation engines with cleaner, more efficient engines and electric motors with the assistance of District grant programs.

This control measure source category includes in-field food and agriculture production, and food and agriculture product processing. For the discussions about engines or other combustion devices used at these sources, refer to the Combustion Devices control measure source category discussion of this appendix.

Existing Control Strategies

Due to the degree of difficulty and enormity of the challenge that the Valley faces in meeting the National Ambient Air Quality Standards (NAAQS), the District recognizes that prohibitory rules alone are not enough to reduce emissions to meet attainment requirements and protect public health. The District's longstanding, progressive strategy for reducing emissions is a multifaceted effort that includes incentive programs and policy initiatives in addition to prohibitory rules. The following discussion summarizes both the existing District efforts to reduce emissions from this source category, and evaluations for potential opportunities for further emissions reductions.

Incentive Programs

Incentive programs are an integral part of the emission reduction efforts of the District, especially where the District lacks direct jurisdiction in establishing emission control requirements. The District is currently funding one incentive program that is specific to engines used in the agricultural sector. The stationary agricultural irrigation pump engine program component of the District's *Heavy-Duty Engine Program* was created to assist agricultural stakeholders in replacing old polluting internal combustion engines with new more efficient and less polluting units or with electric units with zero emissions.

For more information about this incentive program please refer to the Combustion Devices control measure source category discussion of this appendix.

In addition to District incentive programs, there are federal funding opportunities offered by various organizations including the Natural Resources Conservation Service (NRCS) and EPA. The Environmental Quality Incentives Program through NRCS for example, provides financial assistance to help plan and implement conservation practices specifically to help operators meet environmental regulations. The variety of programs that provide funding to agricultural operations have resulted in significant emissions reductions for the agricultural sector.

Policy Initiatives

Similar to the Incentive programs, the District's policies and Legislative Platform are important components to the District's strategy to attain federal ambient air quality standards. The District utilizes policies and the legislative platform to bring attention to major issues that have a direct impact on the Valley's air quality.

The District encourages federal support for the continuation of air quality funding in the Farm Bill that is designed to accelerate the replacement of agricultural equipment. As part of the efforts to attain federal air quality standards in the Valley, the California Air Resources Board (ARB) committed to reducing emissions from in-use agricultural equipment to achieve five to ten tons per day of NOx reductions in the Valley by 2017. This measure would accelerate fleet turnover of equipment with engines to new cleaner units that meet new engine NOx standards. This is being implemented through the District's Tractor Replacement Program and the Natural Resource Conservation Service (NRCS) Conservation Innovation Grants program. These programs combined are on track to achieve the five to ten tons per day of NOx reductions by 2017.

The District supports efforts to secure federal funds and other mechanisms to achieve near-term reductions from agricultural equipment that can be credited to the SIP. Towards that end, the District supports the inclusion of continued air quality funding through the United States Department of Agriculture (USDA) in the Farm Bill, including funding to reduce emissions from agricultural equipment.

Adoption of Senate Bill 705, which phases out the ability to burn certain agricultural material in the field, has underlined the importance of biomass facilities in providing a mechanism to dispose of this agricultural material. As such, the District supports efforts that provide cost effective alternatives to agricultural burning, including subsidies and/or preferential utility rates for power produced from biomass and additional research to identify other technologically and economically feasible alternatives. The legislative platform also supports energy efficiency/alternative energy policies and initiatives that will result in emissions reductions and cost effective alternatives to burning agricultural waste.

Rules and Regulations

The following is a list of rules specific to the Agricultural Processes category. Each of the following rules will be evaluated to examine potential opportunities for additional emissions reductions. Refer to other sections of this appendix for discussions on other rules that may be applicable to the agricultural community, but that are not agriculture-specific.

Table D-9 Current Agricultural Process Rules

Rule		Last Amended/ Adopted
Rule 4204	**Cotton Gins**	02/17/2005
Rule 4550	**Conservation Management Practices**	08/19/2004

D.4.1 Rule 4204 Cotton Gins

Source Category

Adopted on February 17, 2005, Rule 4204 is intended to reduce particulate emissions from cotton ginning facilities operating within the Valley. The implementation of this rule has achieved 0.79 tpd of PM10 reductions from this source category. EPA finalized approval of Rule 4204 on November 9, 2006 and deemed this rule as at least meeting established RACT standards.

There are two types of cotton gins, saw and roller. A saw gin is commonly used for short fiber cotton where the cotton is pulled across knifed edges to remove seeds and trash. A roller gin is instead used for long fiber cotton and the cylinders or rollers carry the cotton across screens or perforated metal where the trash is removed. Throughput for saw gins can be higher than that of a roller gin but a roller gin gives a higher quality end-product.

Emission Inventory

Pollutant	2007	2012	2014	2015	2016	2017	2018	2019
	Annual Average - Tons per day							
PM2.5	0.24	0.23	0.24	0.23	0.23	0.24	0.24	0.24
NOx	0	0	0	0	0	0	0	0
SOx	0	0	0	0	0	0	0	0
	Winter Average - Tons per day							
PM2.5	0.37	0.34	0.35	0.34	0.35	0.36	0.36	0.37
NOx	0	0	0	0	0	0	0	0
SOx	0	0	0	0	0	0	0	0

Regulatory Evaluation

How does District Rule 4204 compare with federal rules and regulations?

There are no specific federal guidelines applying to cotton gins in terms of New Source Performance Standards (NSPS), Control Techniques Guidelines (CTG), Alternative Control Technology (ACT), Maximum Achievable Control Technology (MACT) and National Emission Standards for Hazardous Air Pollutants (NESHAP). There are currently no Best Available Control Technology (BACT) determinations more stringent than what is currently required in Rule 4204.

How does District Rule 4204 compare to rules in other air districts?

There are no comparable rules in other air districts in California. Regulations on cotton ginning operations do exist in states other than California; upon evaluation of regulations in other states, new or more stringent device or stack requirements were not identified. The following regulations are included as a part of the District's analysis:

- New Mexico Administrative Code 20.2.66.1 Cotton Gins
- Louisiana Environmental Regulatory Code
- North Carolina Environmental Management Commissions, Dept. of Environment and Natural Resources, Division of Air Quality Article 21B of Chapter 143
- South Carolina Air Pollution Control Regulations and Standards, Regulation 61-62.5, Standards No. 4 Emissions from Process Industries, Section V Cotton Gins
- Oklahoma Dept. of Environmental Quality, Air Pollution Control, 252:100-23 Cotton Gins
- Texas Commission on Environmental Quality, Control of Air Pollution by Permits on Cotton Gin Facilities and Cotton Burr Tub Grinders

Emission Reduction Opportunities

Rule 4204 is among the most stringent rules in the nation for cotton gins and cotton ginning operations, leaving little remaining opportunities for additional emissions reductions. Research[29] is in progress to determine accurate PM2.5 control efficiencies attributable to various types of control equipment utilized to reduce PM emissions from the ginning process. The impact of this regulation on PM2.5 emissions has not been determined as of yet. As indicated in the emission inventory above, the PM2.5 emissions are a relatively small contributor to particulate matter emissions in the Valley. As a part of due diligence in evaluating potential opportunities to further reduce emissions in the Valley, the analysis below includes a discussion of research of the undetermined PM2.5 fraction of emissions from cotton ginning operations, and of potential, but not feasible, opportunities to reduce emissions further.

Research and PM2.5 Fraction

Research is currently being conducted by the United States Department of Agriculture – Agricultural Research Service (USDA-ARS), in partnership with cotton associations, EPA, the California Air Resources Board (ARB) and the District to measure actual PM10 and PM2.5 emissions from stack sources and fugitive emissions in and around the ginning facility. This research will provide emission factors for comparison to previous estimations that are included in emission inventories and will provide data for both types of cotton gins currently in use in California. This project was designed to measure emissions from facilities with current emissions control technologies in place and to improve emission estimation by measurement with the highest quality methods and instruments. The project was not designed to evaluate new technologies or measures to further reduce emissions. Preliminary results for the seven gins that were

[29] Agricultural Research Service. (2012). *2011 Final Report for Characterization of Cotton Gin Particulate Matter Emissions.* United States Department of Agriculture.

sampled for the project indicate the estimated ratio of PM2.5 to PM10 is approximately 15%.[30] This fraction of PM2.5 to PM10 is lower than indicated in the emissions inventory currently being used. According to the 2011 Final Report update[31], this study will finish the laboratory analysis for the final gin in early 2012 and continue processing stack sampling data.

1D-3D Cyclones with Expansion Chamber
Currently, all cotton gins in the Valley are required to operate using a 1D-3D cyclone. About two thirds of the 1D-3D cyclones used in the Valley have an expanded chamber outlet. Research has shown that an expansion chamber allows for more flow since it is not as narrow. In initial tests, a larger D/3 size expanded chamber exit produced PM10 emissions that were about 8% lower than those resulting from use of the standard, small-diameter (D/4) exit[32]. However, there is no completed research indicating the fraction of PM2.5 emitted or the effectiveness of reducing PM2.5 by installing an expanded chamber. As 1D-3D cyclones are already required by the current rule, and there is no definitive data to verify effectiveness in reducing PM2.5 emissions with an expansion chamber, this is not a feasible opportunity to reduce emissions.

Loadout
Rule 4204 currently requires wind screens for loadout. Two potential opportunities to reduce emissions through control options to capture PM10 emissions from the truck loading operation were identified as follows: 1) venting the loadout area to pre-cleaning cyclones and a baghouse; and 2) venting the receiving pit to a 1D-3D cyclone. While it is technologically feasible to enclose the loadout area and receiving pits and vent to the respective control devices, the District's BACT Guideline 5.1.8 has found those options to not be cost effective. This previous analysis was calculated according to PM10 emission factors and again, the PM2.5 fraction is unknown at this time.

Mechanical Conveyance
Mechanical conveyance for the main trash handling system could be a potential opportunity to reduce emissions but it has only been demonstrated as feasible for newly constructed or re-built cotton gins. Mechanical conveyance almost entirely eliminates emissions from gin trash handling exhaust streams, which were previously moved pneumatically. The gin trash handling systems only comprise a fraction of the emissions that are released from the full cotton ginning process. Newer or re-built gins are able to accommodate a mechanical conveyance system since they are able to design the gin around the equipment and space needed. Operators that have installed a mechanical conveyance system for their gin have had to build a lower floor, below the main level containing the major gin equipment, to house the mechanical conveyors. Therefore, as confirmed by industry representatives and equipment manufacturers, it is not technologically feasible to retrofit existing gins with a mechanical conveyance

[30] Agricultural Research Service. (2012). 2012 *2nd Quarter Report for Characterization of Cotton Gin Particulate Matter Emissions.* United States Department of Agriculture.
[31] Agricultural Research Service. (2012). *2011 Final Report for Characterization of Cotton Gin Particulate Matter Emissions.* United States Department of Agriculture.
[32] Baker R.V. and Hughs S.E., 1998. Influence of Air Inlet and Outlet Design and Trash Exit Size on 1D3D Cyclone Performance. Transactions of the ASAE, vol. 42(1): 17-21.

system to replace existing trash handling equipment. Additionally, any new facilities would trigger New Source Review requirements and would be required to implement BACT level controls.

Plenum Chambers
Plenum chambers are in use at a number of gins in the Valley. Plenum chambers are placed upstream of selected cyclones to remove large trash. Studies have been inconclusive in demonstrating an increase in PM control efficiency with the utilization of a plenum chamber. Most cotton ginning facilities that have chosen to install plenum chambers are using those devices to reduce the wear and tear on the cyclones, thus prolonging the life of the cyclones, and not for increased particulate matter controls.

The District's analysis indicates that there are no feasible opportunities for additional emission reductions for this source category.

Risk-based Strategy Analysis
The emissions from this source category contribute 0.6% of average winter PM2.5 emitted from stationary and area sources in the 2012 emission inventory. The emissions from this source category are relatively small throughout the year, with no significant increase in emission levels in the winter months.

Control Measure Commitments
The following is a summary of recommended commitments for Rule 4204.

Regulatory Action
The District's analysis did not identify any additional technologically feasible and cost effective potential controls. Therefore, there are no recommendations for additional regulatory actions for Rule 4204.

Incentive Action
Units subject to Rule 4204 are currently regulated stationary sources making opportunities for incentive actions minimal; there are no recommendations for incentive actions at this time.

Technology Advancement Action
There is no recommendation for a new technology advancement project for this source category. Through its Technology Advancement Program, the District will continue to seek potential feasible and low-cost technologies that may provide for additional emission reduction opportunities in this category.

Policy Initiatives
The District does not currently have any policy initiatives specific to cotton ginning activities. There are no recommendations for new policy initiatives specific to these units.

Education and Outreach

The District currently provides a robust education and outreach program for regulated sources through the Small Business Assistance program, Permit Stakeholder Meetings, Compliance Assistance Bulletins, and public notices for public workshops and public hearings. There are no recommendations for additional education and outreach efforts for these sources. The District will continue to work closely with affected sources to ensure successful compliance.

D.4.2 Rule 4550 Conservation Management Practices

Source Category

Rule 4550 was adopted on August 19, 2004 to help bring the Valley into attainment of federal PM10 standards, and applies to on-field farming and agricultural operation sites located within the Valley. Rule 4550 has served as a model for other regions seeking to reduce fugitive particulate emissions from agricultural sources. EPA finalized approval of Rule 4550 on February 14, 2006 and determined that the rule met Best Available Control Measure (BACM) requirements of Clean Air Act (CAA) 189(b).

The District worked extensively with numerous stakeholders, growers, and the Agricultural Technical Committee for the San Joaquin Valleywide Air Pollution Study Agency (AgTech) for two years prior to developing the Conservation Management Practices (CMP) Rule. Rule 4550 is unique because it is intended primarily to reduce fugitive particulate matter emissions and is based upon a menu approach of control techniques to accommodate the variability of agricultural industries. The selected CMPs are listed on application forms that are submitted to the District for approval as a CMP Plan. The District worked with agricultural stakeholders and other agencies, such as the Natural Resources Conservation Service (NRCS), to ensure affected sources were assisted as much as possible in understanding and complying with the requirements of Rule 4550. Efforts included creating an informational pamphlet, assisting stakeholders through the application process, and extensive outreach through 40 workshops throughout the Valley.

Emission Inventory

Pollutant	2007	2012	2014	2015	2016	2017	2018	2019
	Annual Average - Tons per day							
PM2.5	19.31	18.90	18.74	18.66	18.57	18.49	18.41	18.33
NOx	0	0	0	0	0	0	0	0
SOx	0	0	0	0	0	0	0	0
	Winter Average - Tons per day							
PM2.5	15.10	14.72	14.57	14.50	14.42	14.35	14.28	14.20
NOx	0	0	0	0	0	0	0	0
SOx	0	0	0	0	0	0	0	0

Regulatory Evaluation

How does District Rule 4550 compare with federal rules and regulations?

Federal requirements such as New Source Performance Standards (NSPS), National Emission Standards for Hazardous Air Pollutants (NESHAP), and Maximum Achievable Control Technology (MACT) requirements are not applicable to this source category; additionally, there are no EPA Control Techniques Guidelines (CTGs) or Alternative Control Techniques (ACTs) listed for this category.

How does District Rule 4550 compare to rules in other air districts?

Rule 4550, when compared to other California air districts' rules for similar sources and is found to be at least as stringent as the analogous rules for Imperial County Air Pollution Control District (ICAPCD) Rule 806 (Conservation Management Practices) and SMAQMD Rule 215 (Agricultural Permit Requirements and New Agricultural Permit Review). SCAQMD and the Arizona Department of Environmental Quality have adopted agricultural best management practices programs, which were approved by EPA as Best Available Control Measures (BACMs); however, the District's CMP rule exceeds these standards. Similar rules were not found for BAAQMD or VCAPCD.

Emission Reduction Opportunities

Rule 4550 was the first rule of its kind in the nation to target fugitive particulate emissions from agricultural operations. Through this rule, PM10 emissions have been reduced by 35.3 tons per day, which is approximately a 24% reduction for this source category. Similarly, implementation of Rule 4550 by agricultural operations has resulted in the reduction of PM2.5 emissions through the reduction of passes of agricultural equipment and implementation of other conservation practices. A full evaluation of the success seen through implementation of the Rule 4550 CMP Program can be found on the District's website at:
http://www.valleyair.org/farmpermits/updates/cmp_program_report_for_2005.pdf.

While Rule 4550 has been successful in reducing both PM10 and PM2.5 emissions, recent studies have indicated that the PM2.5 fraction of emissions makes up a small portion of the total particulate emissions from agricultural operations. Additionally, particulate emissions from agricultural operations are geologic in nature. As described in Chapter 2 of this plan, these geologic particulate emissions make up a relatively small portion of the overall PM2.5 concentrations during the winter season, and have relatively low toxicity. Accordingly, particulate emissions from agricultural sources do not play a significant role with regard to attainment of the 24-hour PM2.5 standard addressed by this plan, and Rule 4550 is primarily a PM10 reduction strategy. EPA's approval of Rule 4550 as BACM and the District's review of similar rules in other regions also demonstrate that the District has adopted the most stringent rule of its kind. Given the relatively low contribution that emissions from this category make to the Valley's 24-hour PM2.5 concentrations and current stringent requirements under Rule

4550, the District has not identified any additional opportunities for further emission reductions from this category.

Risk-based Strategy Analysis

Particulate matter emissions from agricultural operations are primarily geologic in nature, and do not constitute a significant fraction of the total PM2.5 concentrations during the winter season, the period during which exceedances for the 24-hour PM2.5 standard are observed. As discussed in Chapter 2, research indicates that the geologic fraction of PM2.5 has a relatively low toxicity. Given the relative insignificance of PM2.5 emissions from this category and the relative low toxicity, further reductions from this category will not significantly expedite attainment or provide accelerated health benefits.

Control Measure Commitments

The following is a summary of recommended commitments for Rule 4550.

Regulatory Action

There are no recommendations for additional regulatory actions for Rule 4550. The District will continue to work collaboratively with NRCS, researchers, and agricultural stakeholders to evaluate current and potential CMPs to determine if there are more effective options for reducing emissions. Further study through additional research on the PM2.5 fraction and effectiveness of CMPs in reducing PM2.5 emissions is recommended.

Incentive Action

There are no recommendations for new incentive actions at this time.

Technology Advancement Action

Through its Technology Advancement Program and other research efforts, the District will continue to seek projects that support the development of new technologies and practices that provide further potential options for reducing emissions from agricultural operations. One example of a research effort in this area includes a recent study aimed at understanding of the effectiveness of reducing particulate emissions through implementation of CMPs. This Regional Applied Research Effort (RARE) is a collaborative study by the District and EPA, and is focused on comparatively evaluating particulate emissions from conventional agricultural tillage methods and a CMP tillage method utilizing the Optimizer during after-harvest land preparation. The Optimizer is a tillage implement that incorporates functions from multiple conventional tillage implements into one piece of equipment. Preliminary results indicate that the Combined Operations tillage method reduced PM2.5 emissions by 29%, PM10 by 60%, and total suspended particulates (TSP) by 25%.[33] The District will continue to seek additional opportunities for supporting the advancement of new technologies and practices in this area.

[33] Williams, D. et al. *Los Banos, CA Fall 2007 Tillage Campaign: Data Analysis.*

Policy Initiatives

The District currently supports efforts to secure federal funds and other mechanisms to achieve near-term reductions from agricultural equipment that can be credited to the State Implementation Plan (SIP), and supports the inclusion of continued air quality funding through the NRCS in the Farm Bill, including funding to reduce emissions from agricultural equipment and conservation practices. Although there are no recommendations for new policy initiatives, the recommendation is to continue supporting the current District legislative platform items as identified above.

Education and Outreach

The District currently provides a robust education and outreach program for regulated sources through the Small Business Assistance program, Permit Stakeholder Meetings, Compliance Assistance Bulletins, and public notices for public workshops and public hearings. The outreach program developed collaboratively with the USDA-NRCS and agricultural stakeholders to assist affected agricultural sources to understand and comply with Rule 4550 requirements has served as a model for other agencies seeking to adopt similar strategies. The District will continue to work closely with affected sources to ensure successful compliance.

D.5 RESIDENTIAL AND COMMERCIAL

Significant emissions have been reduced in the Valley through several generations of regulations focused on industrial stationary sources. With emissions from stationary sources having been greatly reduced, the Valley is receiving diminishing returns from new controls on these stationary sources. The work of identifying more regulatory control measure source categories for stationary sources continues, but it is critical that Valley residents reduce emissions in their daily routines as well.

Population-wise, the Valley is California's fastest growing region, with its population expected to grow to over four and a half million by 2019, the expected attainment year for the 2006 PM2.5 standard. Increased population results in increased vehicle activity and consumer product use, which leads to increased pollutant emissions – potentially undermining progress made by regulations.

The District's regulatory jurisdiction is somewhat limited when it comes to pollutant sources linked to the general population. For example, ARB regulates consumer products. Also, since direct regulatory authority on motor vehicle tailpipe emissions rests with ARB and EPA, the District can only decrease pollutant emissions from vehicles through incentives, public outreach, and innovative regulations focused on fleets or indirect means (see Appendix C on mobile source control measures for more information).

Through the District's Rule 4901 (Wood Burning Fireplaces and Wood Burning Heaters), Valley residents are taking actions that are achieving significant reductions of health-impacting pollutants when and where these reductions are most needed. Through the District's Healthy Air Living program, Valley residents (as well as businesses) are provided the tools to make air quality a priority in their day-to-day decisions.

Additionally, emissions from under-fired charbroilers in the Valley continue to be a concern. Local restaurants using uncontrolled under-fired charbroilers can often heavily impact residents in the surrounding neighborhoods, especially on days when dispersion is poor. Emissions from this source are known to be hazardous to human health, and therefore reductions in this category would be valuable in light of the District's Risk-based Strategy.

There is potential for both regulatory and innovative approaches for reducing emissions from residential sources, as is shown in the following control measure source category discussion.

Existing Control Strategies

Due to the degree of difficulty and enormity of the challenge that the Valley faces in meeting the National Ambient Air Quality Standards (NAAQS), the District recognizes that prohibitory rules alone are not enough to reduce emissions to meet attainment requirements and protect public health. The District's longstanding, progressive strategy for reducing emissions is a multifaceted effort that includes incentive programs and policy initiatives in addition to prohibitory rules. The following discussion summarizes both the existing District efforts to reduce emissions from this source category, and evaluations for potential opportunities for further emissions reductions.

Incentive Programs

Incentive programs are an integral part of the emission reduction efforts of the District, especially where the District lacks direct jurisdiction in establishing emission control requirements. The District is currently funding two incentive programs that affect the residential sector. The *Clean Green Yard Machine* program has provided $1,472,977 in grant money toward the replacement of 8,600 gas-powered lawn mowers in the Valley. For more details on the *Clean Green Yard Machine* program and other programs related to lawn care refer to the Additional Sources section of this appendix. The *Wood Stove Change Out* program has provided $1,190,000 in grant money toward the replacement of 1,988 units, resulting in a reduction of 342 tons of particulate matter emissions in the Valley.

In an effort to demonstrate and establish a proven technology for reducing emissions from under-fired charbroilers in the Valley, the District established the Charbroiler Incentive Program (ChIP) in October 2009, concurrent with the last amendment of Rule 4692. Due to lack of participation from the industry, the program was extended until March 2011 and outreach efforts were increased. However, no applications for funding were submitted during the extended solicitation period. With new technology options potentially becoming available, the District will continue to seek local demonstration projects to develop control technology options.

Policy Initiatives

Similar to the Incentive Programs, the District's policies and Legislative Platform are important components to the District's strategy to attain federal ambient air quality standards. The District utilizes policies and the legislative platform to bring attention to major issues that have a direct impact on the Valley's air quality. The District supports policies and has legislative platforms for energy efficiency and clean alternatives, and opposes legislation that limits the District's ability to regulate the installation and utilization of wood-burning devices at residences.

The District promotes energy efficiency and clean alternatives as they provide an opportunity for meaningful reductions in emissions in areas with well-established strong regulatory measures on stationary sources such as in the Valley. For more details about these efforts refer to the Additional Sources section of this appendix.

Rules and Regulations

The following is a list of rules specific to the Residential and Commercial category. Each of the following rules will be evaluated to examine potential opportunities for additional emissions reductions.

Table D-10 Current Residential and Commercial Rules

Rule		Last Amended/ Adopted
Rule 4692	**Commercial Charbroiling**	9/17/2009
Rule 4901	**Wood Burning Fireplaces and Wood Burning Heaters**	10/16/2008
Rule 4902	**Residential Water Heaters**	03/19/2009
Rule 4905	**Natural Gas-Fired, Fan-Type, Residential Central Furnaces**	10/20/2005

D.5.1 Rule 4692 Commercial Charbroiling

Source Category

There are two types of commercial charbroilers: chain-driven and under-fired. A chain-driven charbroiler is a semi-enclosed broiler that moves food mechanically through the device on a grated grill to cook the food for a specific amount of time. An under-fired charbroiler has a metal "grid," a heavy-duty grill like that of a home barbecue, with gas burners, electric heating elements, or wood under the grid to cook the food. The smoke and vapors generated by cooking on either type of charbroiler contain water, volatile organic compounds (VOCs), and PM. Larger particles and grease are typically captured by the grease filter of the ventilation hood over the charbroiler. The remaining VOCs and PM2.5 are exhausted outside the restaurant, unless a secondary control is installed.

Currently, District Rule 4692 reduces emissions by requiring catalytic oxidizers for chain-driven charbroilers that meet rule applicability thresholds. Charbroiler exhaust is directed through the catalytic oxidizer with little loss of temperature. As high-temperature exhaust goes through the heated catalyst, PM and VOC are oxidized to carbon dioxide and water vapor. This chemical reaction releases energy that heats the catalyst and is transferred to a heat recovery system, so no additional fuel is needed for the unit.

The original rule, adopted in March 2002, reduced PM2.5 emissions from chain-driven charbroilers by 84%. The September 2009 rule amendment expanded rule applicability to more chain-driven charbroilers, reducing 25% of the remaining PM2.5 chain-driven charbroiler emissions. EPA finalized approval for Rule 4692 on November 3, 2011. The District evaluated Rule 4692 in its RACT State Implementation Plan (SIP) demonstration; however, EPA noted in its Technical Support Document (TSD) for the approval of Rule 4692 that the rule is not subject to RACT because it is not subject to Control Techniques Guidelines (CTG) requirements and it does not regulate major sources.

The District created and implemented a pilot program, the Charbroiler Incentive Program (ChIP), to provide grant funding to cover a significant portion of the cost of installing particulate control devices on under-fired charbroilers. However, there has been no stakeholder interest in this program so far. Zero proposals were submitted, so no projects have been funded under ChIP.

The District has also been tracking and involved with technology demonstration projects for under-fired charbroilers at other agencies:

- **SCAQMD:** South Coast has partnered with the University of California at Riverside to test control technologies for under-fired charbroilers at the College of Engineering's Center for Environmental Research and Technology (CE-CERT). District staff participated in proposal review for this program in early 2012 and have been actively tracking the progress of this project, which should be complete by the end of 2012.

- **EPA:** EPA contracted with Innova Tech, who has manufactured a low-cost and low-maintenance under-fired charbroiler filtration device. Initial testing of Innova Tech's NovaMist™ aerosol particulate filtration technology has shown that their system has the capability of removing over 98% of aerosol particulates at particulate concentrations less than or equal to 40 µg/m^3, as well as a general VOC reduction of 42%. This control device is also self-cleaning, continually degreasing itself during use. The next step for Innova Tech is to partner with other corporations to aid in the commercialization and marketing of their product.

Emission Inventory – All Charbroilers

Pollutant	2007	2012	2014	2015	2016	2017	2018	2019
	Annual Average - Tons per day							
PM2.5	2.85	2.89	2.98	3.03	3.08	3.13	3.17	3.22
NOx	0	0	0	0	0	0	0	0
SOx	0	0	0	0	0	0	0	0
	Winter Average - Tons per day							
PM2.5	2.85	2.88	2.98	3.03	3.08	3.12	3.17	3.22
NOx	0	0	0	0	0	0	0	0
SOx	0	0	0	0	0	0	0	0

This emission inventory includes emissions from both chain-driven and under-fired charbroilers. Based on the data included in the District's 2009 emission inventory methodology for commercial charbroiling, chain-driven charbroilers account for about 42% of the charbroiling inventory, and under-fired charbroilers account for about 58% of the inventory.

The emissions inventory above accounts for emissions reductions achieved by Rule 4692's controls on chain-driven charbroilers. The inventory above is grown in future years due to human population growth in the Valley.

Emission Inventory – Under-Fired Charbroilers

Pollutant	2007	2012	2014	2015	2016	2017	2018	2019
	Annual Average - Tons per day							
PM2.5	1.66	1.68	1.73	1.76	1.79	1.82	1.84	1.87
NOx	0	0	0	0	0	0	0	0
SOx	0	0	0	0	0	0	0	0
	Winter Average - Tons per day							
PM2.5	1.66	1.68	1.73	1.76	1.79	1.82	1.84	1.87
NOx	0	0	0	0	0	0	0	0
SOx	0	0	0	0	0	0	0	0

These emissions inventories include emissions from food cooking only, not from fuel use. The combustion of the fuel source for the cooking equipment is a very small component of the NOx and SOx emissions in the Stationary Source Fuel Combustion category, "Service and Commercial," which is not reflected in the inventory for this control measure.

Regulatory Evaluation

How does Rule 4692 compare with federal rules and regulations?

There is currently no guidance given for this source category under the federal Alternative Control Techniques (ACT) documents, the New Source Performance Standards (NSPS), the National Emission Standards for Hazardous Air Pollutants (NESHAP), and the Maximum Achievable Control Technology (MACT) requirements. Additionally, there is no EPA CTG listed for this category.

How does Rule 4692 compare to rules in other air districts?

Rule 4692 was compared to other California air districts' rules for similar sources and was found to be more stringent than SCAQMD Rule 1138 (Control of Emissions from Restaurant Operations) and VCAPCD (Rule 74.25 Restaurant Cooking Operations). Rule 4692 and these two rules apply to chain-driven charbroilers only, and not under-fired. However, the SCAQMD and VCAPCD rules apply to charbroilers cooking 875 pounds of meat or more per week, whereas the District rule applies to charbroilers cooking 400 pounds of meat or more per week. BAAQMD Regulation 6 Rule 2(Commercial Cooking Equipment) is applicable to chain-driven charbroilers in a restaurant that purchases 500 pounds of beef or more per week or an under-fired charbroiler in a restaurant that purchases 1,000 pounds of beef or more per week. SMAQMD does not currently have a rule for commercial charbroiling.

As previously mentioned, BAAQMD Regulation 6 Rule 2 regulates both chain-driven and under-fired units. Newly installed under-fired units with more than 10 square feet of cooking area are required to limit emissions to 1 lb of PM10 per 1,000 lbs of cooked beef. Effective January 2013, the same emissions requirements will also apply to pre-existing units. However, as the BAAQMD rule is implemented, a significant portion of under-fired charbroilers are below the applicability thresholds for grill size or amount of food cooked, and are thus exempt from rule requirements.

Emission Reduction Opportunities

Potential emission reduction opportunities from this source category include emissions from two types of charbroilers: chain-driven charbroilers and under-fired charbroilers. District Rule 4692 is one of the most stringent rules in the nation for chain-driven charbroilers and therefore the primary focus for potential emissions reductions as discussed below focus on the under-fired charbroilers. Discussions on both technologies are discussed below.

Chain-Driven Charbroilers

Rule 4692 requires emission controls for chain-driven charbroilers that cook 400 pounds of meat or more per week. In 2009, the amended rule was estimated to apply to about 280 of the 427 chain-driven identified charbroilers of the Valley. This rule thus applies to about 65% of the units and a much greater percentage of the total emissions from chain-driven charbroilers since they are higher use. The applicability threshold for chain-driven charbroilers under Rule 4692 could be lowered to make smaller facilities subject to the rule. However, these currently-exempt chain-driven units are a very small portion of the total inventory for this category. Emissions reductions would be minimal and costly through this approach. Furthermore, the District's applicability threshold is already lower than that of other air districts.

Under-Fired Charbroilers

Rule 4692 does not currently require emissions controls for under-fired charbroilers. Catalytic oxidizers are not effective for reducing emissions from under-fired charbroilers because the exhaust from these devices loses too much heat as it is directed to the control device, and the reactions at the catalyst cannot take place under this lower temperature. The following control strategies are more effective for under-fired charbroilers:

- **High efficiency particulate-arresting (HEPA) filtration systems:** This system adds a HEPA filter to the appliance's existing grease filters to effectively eliminate particulates down to about 0.3 microns in diameter. System maintenance is relatively easy to perform, but filters need to be regularly changed (perhaps weekly, depending on the amount of food cooked).

- **Electrostatic precipitators (ESPs):** Exhaust particles become electrically charged as they pass through an electrically charged screen. These ionized particles are then collected by one of two oppositely-charged plates. ESP systems need filtration prior to the ESP itself to remove grease and larger particles from kitchen exhaust. These devices are cleaned daily with a clean-in-place system, and more thorough cleaning is required once or twice a year.

Routine maintenance often requires hiring an outside company, since the ESP plates can weigh as much as 75 pounds.

- **Wet scrubbers:** A fine stream of water and detergent "washes" the particulates from the kitchen exhaust. The particulate/water/detergent mix is then filtered: the filtered water/detergent mix is recycled through to clean more exhaust, and the particulate-laden wash water is discharged to the sewer system. In addition to the cost of the system itself, associated water/sewer usage costs and detergent costs can be high, although recent improvements in design are improving system efficiencies.

These controls for under-fired charbroilers were unproven and extremely costly as of the District's 2009 amendment of Rule 4692. The costs of these under-fired charbroiler controls, as analyzed in 2009, ranged from $37,500 to $104,000, with a cost effectiveness of up to $58,200 per ton of PM2.5 reduced. However, the control technology for under-fired units has continued to develop over the past few years, in part through the SCAQMD and EPA technology demonstration efforts. Since under-fired charbroilers are a larger part of the total commercial charbroiling inventory, and since these units are currently unregulated in the Valley, there is potential to achieve emissions reductions from under-fired charbroilers.

In parallel with this plan, SCAQMD has also included a draft commitment in Chapter 4 of their *Draft 2012 AQMP* to achieve a 1 tpd PM2.5 reduction from under-fired charbroilers, though the details of their approach are yet to be determined[34]. South Coast AQMD would submit their approach into the SIP once technically feasible and cost effective options are confirmed.

Risk-based Strategy Analysis

The emissions from units subject to Rule 4692 contribute 5.2% of average winter PM2.5 emitted from stationary and area sources in the 2012 emission inventory. Although the emissions from commercial charbroiling are small in comparison to the total emissions inventory, this category is one of the largest single contributors of directly emitted PM2.5 in the Valley. Photochemical modeling conducted for this plan shows that reducing commercial charbroiling emissions would contribute to improved PM2.5 air quality and PM2.5 attainment in the Valley.

Furthermore, charbroiling emissions occur in populated areas. The PM2.5 species associated with charbroiling is organic carbon (OC) [35]; as noted in Chapter 2, health research shows there is evidence of high toxicity and significant health effects associated with OC. Since the cooking of meat can release carcinogenic PM2.5 species like polycyclic aromatic hydrocarbons (PAH), controlling emissions from under-fired charbroilers would have a substantial positive impact on public health. The air quality impacts on neighborhoods near restaurants with under-fired charbroilers can be significant on days when meteorological conditions are stable, when dispersion is

[34] http://aqmd.gov/aqmp/2012aqmp/draft/Chapters/Ch4.pdf
[35] See Schauer and Cass (2000) Environmental Science and Technology, Vol. 34 (9), pp. 1821-1832.

limited and emissions are trapped near the surface within the surrounding neighborhoods. This potential for neighborhood-level concentration of emissions during evening or multi-day stagnation events raises environmental justice concerns.

Control Measure Commitments

The following is a summary of recommended commitments for Rule 4692.

Regulatory Action

The recommendation is to amend Rule 4692 to reduce PM2.5 emissions from under-fired charbroilers. As part of this process, the District would conduct a thorough review of all available information about under-fired charbroilers and under-fired charbroiler controls. The District would take advantage of the most recent technology demonstration information available and, if needed, initiate an independent technology demonstration. To allow sufficient time for this and other related rule development work, the recommendation is to amend Rule 4692 in 2016. The District estimates that this amendment would achieve, at minimum, a 20% reduction in the baseline emissions inventory for under-fired charbroilers. The modeling conducted for this plan shows that reducing emissions from under-fired charbroiling by 20% in Kern County is necessary for attainment; thus, by reducing emissions 20% Valley-wide, the District achieves significant health benefits Valley-wide per the District's Risk-based Strategy. Refer to Chapter 9 for more details.

Table D-11 Estimated Emissions Reductions

	2007	2012	2014	2015	2016	2017	2018	2019
PM2.5 Tons per day – winter season								
Kern County (Attainment Need)	0	0	0	0	0	0.1	0.1	0.1
Other Valley Counties	0	0	0	0	0	0.3	0.3	0.3
Valley-wide Total	0	0	0	0	0	0.4	0.4	0.4

Incentive Action

The District's current ChIP is a pilot demonstration plan, rather than a more widely-available incentive program. After completion of a few pilot demonstration projects under ChIP, though, the District could consider expanding its charbroiling incentive efforts into a broader incentive program. Therefore, although there are no recommendations for new incentive actions at this time, the recommendation is to continue the District ChIP.

Technology Advancement Action

The District will also seek to identify restaurants to participate in the District's existing ChIP pilot program to demonstrate promising under-fired charbroiler emissions controls in a working-restaurant setting in the Valley. Such a demonstration project could eventually be developed into a larger incentive program. Additionally, the District will continue to collaborate with EPA and South Coast technology demonstration efforts for under-fired charbroiling. The South Coast project should be completed by the end of 2012, and may yield useful information to assist in implementing emission reduction strategies for this category.

Policy Initiatives
The District is not currently supporting any policy initiatives specific to commercial charbroiling and there are no recommendations for new policy initiatives for this source.

Education and Outreach
The District currently provides a robust education and outreach program for regulated sources through the Small Business Assistance program, Permit Stakeholder Meetings, Compliance Assistance Bulletins, and public notices for public workshops and public hearings. It is recommended that the District provide strong stakeholder outreach in conjunction with the regulatory, incentives, and technology demonstration commitments as appropriate. The District will continue to work closely with affected sources to ensure successful compliance.

D.5.2 Rule 4901 Wood Burning Fireplaces and Wood Burning Heaters

Source Category

Residential wood burning is one of the Valley's largest sources of directly-emitted PM2.5 in the winter. Rule 4901 (Wood Burning Fireplaces and Wood Burning Heaters) limits emissions from wood burning fireplaces, wood burning heaters, and outdoor wood burning devices. Rule 4901 also restricts the sale and transfers of non-compliant wood burning devices, and limits the installation of wood burning devices in new residential developments.

Through the Check Before You Burn program, which is based on Rule 4901, the District has declared and enforced episodic wood burning curtailments, also called "No Burn" days, since 2003. Check Before You Burn and District Rule 4901 reduce harmful species of PM2.5 when and where those reductions are most needed: in impacted urbanized areas when the local weather is forecast to hamper PM dispersion.

Rule 4901 was adopted in 1993 and has been amended twice. The adoption of Rule 4901 established a public education program on techniques to reduce wood burning emissions. It also enforced EPA Phase II requirements for new wood burning heaters, prohibited the sale of used wood burning heaters, established a list of prohibited fuel types, and required the District to request voluntary curtailment of wood burning on days when the ambient air quality was unhealthy.

In 2003, the rule was amended to include episodic wood burning curtailments when air quality was forecast to be at 150 or higher on the air quality index (AQI), which is equivalent to a PM2.5 concentration of 65 $\mu g/m^3$. The 2003 amendments also added restrictions on the installation of wood burning devices in new residential developments, based on housing density. In 2008, the District amended Rule 4901 again, this time to lower the mandatory curtailment level to a PM2.5 concentration of 30 $\mu g/m^3$ (based on EPA's 2006 PM2.5 National Ambient Air Quality Standard (NAAQS) of 35 $\mu g/m^3$ with an added margin of safety). The 2008 amendments also included a contingency measure to lower the wood burning curtailment level to 20 $\mu g/m^3$ in the event that EPA finds that the Valley does not attain the 1997 PM2.5 air quality standard in 2014. EPA finalized approval for District Rule 4901 on November 10, 2009.

Rule 4901 wood burning curtailments only apply in areas with natural gas service, and wood burning curtailments do not apply to homes for which wood burning is the only source of heat. Compared to other District rules, District Rule 4901 provides for the most cost effective means to reduce wintertime PM2.5 concentrations. Direct PM2.5 emissions are controlled by approximately 14% for this source category during the wood burning season. The full effectiveness of the rule can be understated when considered in terms of annual average emissions or even "average winter emissions". On a Valley-wide "No Burn" day, Rule 4901 has the potential to reduce 16 tons of directly emitted PM2.5.

Emission Inventory

Pollutant	2007	2012	2014	2015	2016	2017	2018	2019
	Annual Average - Tons per day							
PM2.5	10.63	4.48	4.28	4.28	4.28	4.28	4.28	4.28
NOx	1.20	0.50	0.48	0.48	0.48	0.48	0.48	0.48
SOx	0.20	0.08	0.08	0.08	0.08	0.08	0.08	0.08
	Winter Average - Tons per day							
PM2.5	20.72	8.73	8.35	8.35	8.35	8.35	8.35	8.35
NOx	2.35	0.98	0.94	0.94	0.94	0.94	0.94	0.94
SOx	0.39	0.16	0.15	0.15	0.15	0.15	0.15	0.15

Regulatory Evaluation

How does District Rule 4901 compare with federal rules and regulations?

Rule 4901 is as stringent as the current federal New Source Performance Standards (NSPS) (40 CFR 60 Subpart AAA (Standards of Performance for New Residential Wood Heaters). The District continues to track EPA's current efforts to revise this NSPS. Additionally there are no EPA Control Techniques Guidelines (CTG), Alternative Control Techniques (ACT), National Emission Standards for Hazardous Air Pollutants (NESHAP), or Maximum Achievable Control Technology (MACT) guidelines for this source category.

How does District Rule 4901 compare to rules in other air districts?

Rule 4901 is compared to other air districts' rules for similar sources, including Washington State's Department of Ecology regulation Chapter 173-433 WAC (Solid Fuel Burning Devices); Colorado Air Quality Control Commissions Regulation No. 4, Spokane Regional Clean Air Agency Regulation I Article VIII; Oregon Department of Environmental Quality Division 262 (Heat Smart Program for Residential Woodstoves and Other Solid Fuel Heating Devices); SCAQMD Rule 445 (Wood Burning Devices); BAAQMD Regulation 6 Rule 3 (Wood-Burning Devices); Yolo-Solano Air Quality Management District Rule 2.40 (Wood Burning Appliances), and SMAQMD Rules 417 (Wood Burning Appliances); and 421 (Mandatory Episodic Curtailment of Wood and other Solid Fuel Burning). SCAQMD Rule 445 prohibits installation of wood burning devices in new developments that have access to natural gas service. However, District Rule 4901 has the most stringent wood burning curtailment level, compared to those of other air districts.

Emission Reduction Opportunities

The District evaluated Rule 4901 for potential opportunities to reduce emissions. Potential opportunities evaluated include an analysis of benefits from reducing the curtailment level, allowing cleaner wood burning devices under certain circumstances to encourage consumers to switch to these clean devices from uncontrolled fireplaces, the possibility of extending the wood burning season, and the possibility of amending the portion of the rule pertaining to the quantity of units allowed in new developments. These evaluations resulted in the District committing to amend Rule 4901 through a public rule-amending process (see Chapters 5 and 10 for these commitments). The analyses are as follows:

Curtailment Level

A potential opportunity for further emissions reductions is to lower the curtailment level, which would reduce emissions by increasing the number of "No Burn" days. Lowering the curtailment level below the current level would reduce the build-up of emissions during the long stagnation periods experienced in the Valley during the winter season, and would help avoid exceedances of the PM2.5 standard. The table below shows the average number of days wood burning could be prohibited if the curtailment level was reduced below the current level of 30 µg/m³, based on 2009-2012 air quality forecasts. The actual number of "No Burn" days that would occur under the lower curtailment level would likely be lower when actually implemented, since additional emissions reductions will phase in and improve PM2.5 air quality before the lower "No Burn" level would take effect. As discussed in Chapter 4, this reduction in emissions during the peak PM2.5 winter would significantly reduce PM2.5 concentrations in Kern County, and greatly assist in attaining the 24-hour PM2.5 standard.

Table D-12 Average Number of Days Forecast Above Curtailment Thresholds*

	Current Threshold		*Contingency Threshold*
County	**>=30 µg/m³**	**>=25 µg/m³**	**>=20 µg/m³**
San Joaquin	18	30	47
Stanislaus	36	62	74
Merced	26	43	63
Madera	37	56	73
Fresno	53	75	85
Kings	41	60	73
Tulare	40	59	71
Kern	47	66	78
Kern (Greater Frazier Park Area)	0	2	3

*Based on the 2009-10, 2010-11, and 2011-12 wood-burning seasons.

Wood burning curtailments under Rule 4901 have been shown to significantly reduce PM2.5 concentrations on "No Burn" days, as demonstrated in the District's annual "End of the Season Wood Burning Reports." Currently, Valley-wide curtailment of wood burning during winter is estimated to reduce 16 tons per day of PM2.5 emissions. Prohibitions are declared by county or forecast area and apply to areas with natural gas service, allowing the rule to target the most densely-populated urban areas that are most likely to experienced localized effects of wood burning in the neighborhood.

Although a “No Burn” day can increase a resident’s natural gas costs, natural gas can more efficiently heat the whole home; some homes could also offset increased natural gas costs by spending less on wood. Compared to other District rules, curtailing burning under Rule 4901 is the most cost effective rule for reducing PM2.5 concentrations.

Wood Burning Devices
Rule 4901 limits the installation of new wood burning devices, and limits the use of wood burning devices on “No Burn” days in areas that have natural gas service. When and where residents are allowed to burn and choose to do so, they are encouraged to burn as cleanly as possible. For example, dry, seasoned wood and manufactured logs burn cleaner than unseasoned wood.

Upgrading a home’s wood burning device also reduces air pollutant emissions on days when wood burning is allowed. By operating more efficiently, these devices can lower the overall home heating cost. District Rule 4901 neither prohibits nor requires wood burning device upgrades. However, the District encourages such upgrades through its public outreach and through its *Burn Cleaner Program*, which provides funding to Valley residents to upgrade their current wood-burning devices and open fireplaces to natural or propane gas devices, to certified wood stoves or inserts, or to pellet devices. The District’s webpage[36] has more information on program eligibility and qualified devices.

There are several types of wood burning devices and device inserts available. Wood stoves, especially newer models, are generally safe and efficient devices for home heating. There are two types of wood stoves: catalytic and non-catalytic. EPA’s Phase II certified wood stoves produce only 2 to 7 grams of smoke per hour, compared to 15 to 30 grams of smoke per hour from older, uncertified devices.

Pellet stoves are similar in appearance to wood stoves, but burn compressed pellets made of ground, dried wood and other biomass wastes. Pellet stoves are generally more expensive than wood stoves and require electricity for operation; however, they are typically more efficient than wood stoves due to the better fuel-to-air ratio in the combustion chamber. EPA also certifies pellet stoves.

Wood burning fireplaces include traditional masonry fireplaces built into brick or stone, constructed in the home, and “low mass” fireplaces that are pre-fabricated prior to installation. Most fireplaces are not used as a primary source of heat, but serve as a secondary heating source or for ambiance. Fireplaces generate much more emissions than wood stoves or pellet stoves, but fireplace inserts are available to reduce

[36] www.valleyair.org/Grant_Programs/GrantPrograms.htm#WoodStoveChangeOut

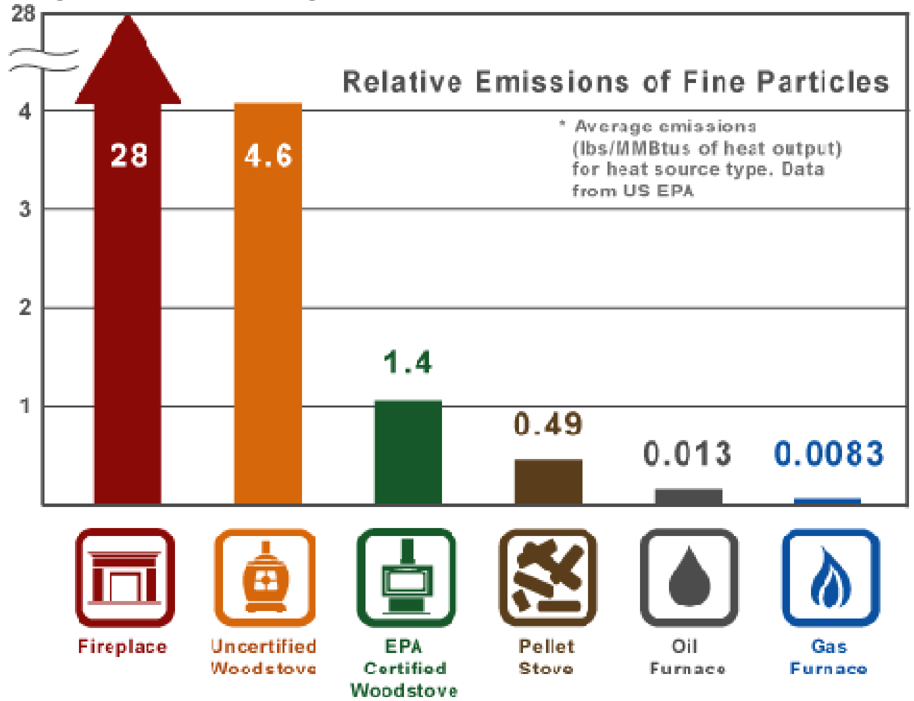
emissions. EPA does not certify fireplaces or fireplace inserts, but does have a voluntary program for devices that meet qualifications to be considered cleaner burning than typical fireplaces and fireplace inserts. Phase I qualified units are approximately 57% cleaner than older fireplace models, while Phase II qualified units are approximately 70% cleaner. While these devices reduce emissions relative to uncontrolled fireplaces, their emissions are still relatively higher than certified wood stoves and pellet stoves.

Gas stoves and gas fireplaces burn natural gas or propane, emit very little air pollution, and require little maintenance. Gas devices are not subject to the requirements of Rule 4901, so they can be used on “No Burn” days. For more information about the various types of wood burning devices available, see EPA’s Burn Wise program webpages[37].

The District will consider allowing the use of cleaner EPA-certified wood burning devices, particularly during new potential curtailment days aimed at reducing the buildup of PM2.5 emissions. EPA-certified devices have been designed and demonstrated to reduce PM2.5 emissions by 70% or greater in comparison to uncertified woodstoves, and by 95% in comparison to wood-burning fireplaces. Pellet stoves have demonstrated even greater reductions in PM2.5 emissions, with an 89% reduction in comparison to uncertified woodstoves and a 98% reduction from wood-burning fireplaces. Figure D-1 illustrates the average PM2.5 emissions based on various heat sources.

[37] www.epa.gov/burnwise

Figure D-1 Average PM2.5 Emissions based on Device[38]



Many Valley residents have upgraded their homes with these newer devices, including through programs such as the *District's Burn Cleaner Program* and federal tax incentives. Given their much lower relative emissions, allowed use of these devices during a lower curtailment level could still achieve the goal of significantly reducing the overall emissions that ultimately lead to violations of the standard. This potential allowance and the appropriate level of acceptable clean certified devices will be examined through the public rule amendment process. Enforcing this added flexibility would be difficult given the challenge in distinguishing wood smoke emissions from various wood burning devices, and the District would explore various options during the rule development process for ensuring that this issue is addressed. Along with this potential allowance, the District will continue to provide incentives to encourage the replacement of existing older devices with newer clean devices.

Wood Burning Season

An additional opportunity for further reducing emissions from this source includes lengthening the wood burning curtailment season, given the relatively high levels of PM2.5 emissions often observed during the months of October and March. The District's current Rule 4901 wood burning curtailment season runs from the beginning of November until the end of February. Expanding District Rule 4901's curtailment season to include October and/or March would potentially increase the number of curtailment days in each wood burning season, particularly in October, based on recent air quality data. However, measured Valley concentrations of levoglucosan, a primary indicator for

[38]EPA. Consumers – Energy Efficiency and Wood-Burning Stoves and Fireplaces. (2012, November 14). Retrieved from http://www.epa.gov/burnwise/energyefficiency.html.

wood burning, are not nearly as high in October or March as found to be during the current curtailment season of November through February. Therefore, while total PM2.5 concentrations are often relatively high during the months of October and March, there may be limited potential benefit in extending the season to these months if the amount of wood burning and related contribution to the total PM2.5 concentrations is limited in scale. Extending the wood burning season to include curtailments in October and/or March and the associated potential air quality benefits resulting from that extension will be considered during the public rule amending process for Rule 4901.

New Residential Developments
The District considered further limiting the installation of wood burning fireplaces and heaters in new residential developments by strengthening Section 5.3 of Rule 4901. South Coast Rule 445 prohibits the installation of wood burning devices in any development that has natural gas service. However, since most of the Valley's new developments are already subject to restrictions based on their housing densities, the emissions reduction potential is minimal.

Risk-based Strategy Analysis
Wood smoke contains PM2.5, carbon monoxide, formaldehyde, sulfur dioxide, irritant gases, and known and suspected carcinogens, such as polycyclic aromatic hydrocarbons (PAH). The toxic air pollutants in wood smoke can cause human health impacts such as coughs, headaches, and eye and throat irritation. Studies show that prolonged inhalation of wood smoke contributes to chronic interstitial lung disease, pulmonary arterial hypertension, and cor pulmonale, which can eventually lead to heart failure, in adults[39]. Wood smoke has also been linked to detrimental mutagenic and systemic effects such as oxidative stress and coagulation, which can ultimately result in cell damage and possibly lead to cancer[40, 41, 42]. Children with the highest exposure to wood smoke show a significant decrease in lung function[43]. Studies also found that wood smoke is twelve times more carcinogenic than an equal concentration of cigarette smoke[44]. Efforts to reduce wood smoke target some of the most harmful species of PM2.5.

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[39] Sandoval, J.; Slas, J.; Martinez-Guerra, M.L.; Gomez, A.; Martinez, C.; Portales, A.; Palomar, A.; Villegas, M.; and Barrios, R. Pulmonary Arterial Hypertension and Cor Pulmonale Associated with Chronic Domestic Woodsmoke Inhalation. (1993) Chest 103:12-20.
[40] Danielsen, P.H.; Bräuner, E.V.; Barregard, L.; Sällsten, G.; Wallin, M.; Olinski, R.; Rozalski, R.; Møller, P.; Loft, S. Oxidatively damaged DNA and its repair after experimental exposure to wood smoke in healthy humans. (2008) Mutat Res. 642(1-2):37-42.
[41] Barregard, L.; Allsten, G.S.; Gustafson, P.; Johansson, L.; Johannesson, S.; Basu, S.; Stigendal, L. Experimental Exposure to Wood-Smoke Particles in Healthy Humans: Effects on Markers of Inflammation, Coagulation, and Lipid Peroxidation (2006) Inhalation Toxicology 18:845–853.
[42] Sapkota, A.; Gajalakshmi, V.; Jetly, D.H.; Roychowdhury, S.; Dikshit, R.P.; Brennan, P.; Hashibe, M.; Boffetta, P. Indoor air pollution from solid fuels and risk of hypopharyngeal/laryngeal and lung cancers: a multicentric case-control study from India. (2008) Int J Epidemiol. 37(2):321-8.
[43] Heumann, M.; Foster, L.R.; Johnson, L; Kelly, L. Woodsmoke Air Pollution and Changes in Pulmonary Function Among Elementary School Children (1991) Air & Waste Management Association 84th Annual Meeting & Exhibition, Vancouver, British Columbia.
[44] Lewtas, J.; Zweidinger, R.B.; Cupitt, L.; Mutagenicity, Tumorigenicity and Estimation of Cancer Risk from Ambient Aerosol and Source Emissions from Woodsmoke and Motor Vehicles. (1991) Air and Waste Management Association 84th Annual Meeting & Exhibition, Vancouver, British Columbia.

People can be exposed to wood smoke when they use their wood burning devices. Additionally, people can be exposed to wood smoke when people in their neighborhoods use their wood burning devices; windows and doors cannot keep the particles in wood smoke out of homes. A recent ARB-funded study of residential wood smoke impacts on indoor air quality was conducted in Cambria, California and published in 2011. Using aethalometers designed to monitor carbon black as the definitive chemical signature of wood smoke, the study found nocturnal outdoor concentrations in Cambria neighborhoods that were 2 to 10 times higher than the cleanest part of the city. Most significantly, over the course of the winter season, indoor concentrations of carbon black in non-burning homes were found to be 74% as high as concentrations measured just outside the same homes. This combination of processes results in a very high intake fraction (the portion of the total emissions that actually end up being inhaled) for neighborhood wood combustion when compared to other sources of PM that are less proximate.

The studies referenced above demonstrate the importance of reducing wood burning emissions to improve public health. Rule 4901 prohibits wood burning by county or forecast area on days when that area is forecast to exceed 30 µg/m³ (the level of EPA's 2006 health-based PM2.5 standard of 35 µg/m³, plus a margin of safety). Thus, District Rule 4901 and its corresponding *Check Before You Burn Program* reduce PM2.5 when and where those reductions are most needed: in impacted urbanized areas when the local weather is forecast to hamper PM dispersion.

Given the time, location, and type of PM2.5 emissions reductions associated with District wood burning prohibitions, Rule 4901 is a key component of the District's Risk-based Strategy. In 2008, the Central Valley Health Policy Institute found that District wood burning curtailments on high pollution days reduced annual exposure by about 13% in Bakersfield and Fresno, resulting in 30 to 70 avoided cases of annual premature mortality. Strengthening Rule 4901 could allow for even greater health benefits.

The emissions from this source category contribute 15.6% of average winter PM2.5 emitted from stationary and area sources in the 2012 emission inventory making residential wood burning one of the Valley's largest source of directly-emitted PM2.5. Also, emissions associated with residential wood burning are confined to the time of year when the Valley experiences its PM2.5 exceedance days. Reducing emissions from this source category further is a key strategy for the Valley to attain the PM2.5 national ambient air quality standards. Photochemical modeling conducted for this plan shows that further reducing residential wood burning emissions would contribute to improved PM2.5 air quality in the Valley.

Control Measure Commitments

The following is a summary of recommended commitments for Rule 4901.

Regulatory Action

There is potential to reduce residential wood combustion PM2.5 emissions by lowering the threshold at which a "No Burn" day is called for each county. As discussed above, the recommendation is to lower the curtailment threshold to 20 µg/m³. While significantly below the federal standard of 35 µg/m³, establishing the curtailment threshold at this level will reduce the buildup of emissions during the long stagnation periods characteristic to the Valley. Table D-12 details the impact that lowering the threshold will have on the number of "No Burn" days in each county for the current November – February wood burning season under Rule 4901.

With this lower wood burning curtailment threshold, intended to reduce buildup during stagnation events, the District will consider allowing the use of cleaner EPA-certified wood burning devices during these buildup periods. Given their much lower relative emissions, allowed use of these devices during certain curtailment levels could still achieve the goal of significantly reducing the overall emissions that ultimately lead to violations of the standard.

Expanding the applicability of Rule 4901 curtailments to include October and/or March will also be considered when Rule 4901 is next amended. This could potentially increase the number of "No Burn" days, particularly in October. At this time, the District does not propose to change any of the existing rule exemptions. However, exemptions could be re-evaluated during the rule amendment process.

Contingency
With the District's 2008 adoption of a contingency measure that would lower the wood burning curtailment level to 20 µg/m³ in 2014, the District committed to evaluate the appropriateness of a substitute contingency measure starting in 2012. In conjunction with the District's current recommendation to formally lower the curtailment level to 20 µg/m³, the District proposes a new contingency level of 15 µg/m³, to be implemented if EPA finds that the Valley fails to attain the 2006 PM2.5 NAAQS by 2019. In addition, the attainment year contingency-trigger would achieve an additional 1.5 tons per day of PM2.5, as an average day during the wood burning season (November - February). This would serve as additional contingency reductions in 2020.

Table D-13 Potential Emissions Reductions

	2007	2012	2014	2015	2016	2017	2018	2019
PM2.5 Tons per day – winter season								
Kern and Kings Counties (Attainment Need)	0	0	0	0	0.1	0.2	0.2	0.2
Other Valley Counties	0	0	0	0	0.7	1.3	1.3	1.3
Valley-wide Total	0	0	0	0	0.8	1.5	1.5	1.5

Table D-14 Estimated Change in Number of No Burn Days

County	"No Burn" Days at Current Threshold >=30 µg/m³	"No Burn" Days at Lower Threshold >=20 µg/m³	"No Burn" Days at Contingency Threshold >=15 µg/m³
San Joaquin	18	47	71
Stanislaus	36	74	93
Merced	26	63	85
Madera	37	73	96
Fresno	53	85	104
Kings	41	73	96
Tulare	40	71	92
Kern	47	78	100

Incentive Action

No new incentive actions are recommended for wood burning fireplaces and wood burning heaters. The District expects to continue its *Burn Cleaner Program* to change out older wood burning devices.

Technology Advancement Action

Several manufacturers are developing Phase 2 qualified fireplace inserts and fireplaces that emit less PM2.5 than their uncontrolled fireplace counterparts. However, Phase II certified wood stoves, pellet stoves, and natural gas heating emit less PM2.5 than even the cleanest Phase 2 qualified fireplaces and fireplace inserts. The District does not anticipate participating in any technology advancement actions related to wood burning fireplaces at this time.

Policy Initiatives

The District will evaluate potential strategies for implementing the lower curtailment level during the public rule development process.

Education and Outreach

The District's comprehensive, multimedia "Check Before You Burn" outreach utilizes billboards, radio ads, brochures, social media, strong media partnerships and more to ensure the public is informed about wood burning curtailments. The District is committed to continuing this strong public outreach effort to educate the public, help ensure the success of the District's Rule 4901, and reduce these emissions in the Valley.

D.5.3 Rule 4902 Residential Water Heaters

Source Category

Rule 4902 applies to manufacturers, distributors, retailers, and installers of Public Utilities Commission (PUC) quality natural gas-fired residential water heaters with heat input rates less than or equal to 75,000 Btu/hr. It is a point-of-sale type of rule that limits NOx emissions from residential water heaters.

Rule 4902 was adopted on July 17, 1993 to control NOx emissions from natural gas-fired water heaters. The original rule enforced a NOx emissions limit of 40 nanograms of NOx per Joule of heat output (ng/J). Since its adoption, the rule has been amended once. The March 2009 amendments strengthened the rule by enforcing a limit of 10 ng/J for new or replacement water heaters and a limit of 14 ng/J for instantaneous water heaters. EPA finalized approval for Rule 4902 on May 5, 2010. Rule 4902 is not subject to RACT because it is not a Control Techniques Guidelines (CTG) category and it is applicable to sources that are too small to exceed the major source threshold.

Emission Inventory

Pollutant	2007	2012	2014	2015	2016	2017	2018	2019
	Annual Average - Tons per day							
PM2.5	0.20	0.20	0.20	0.20	0.21	0.21	0.21	0.21
NOx	2.44	2.16	2.13	2.11	2.10	2.08	2.06	2.05
SOx	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
	Winter Average - Tons per day							
PM2.5	0.28	0.27	0.27	0.27	0.28	0.28	0.29	0.29
NOx	3.30	2.91	2.87	2.85	2.82	2.80	2.78	2.76
SOx	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02

Regulatory Evaluation

How does District Rule 4902 compare with federal rules and regulations?

There is currently no federal guidance given for this source category under the federal CTG, Alternative Control Techniques (ACT), New Source Performance Standards (NSPS), National Emission Standards for Hazardous Air Pollutants (NESHAP), and Maximum Achievable Control Technology (MACT) requirements.

How does District Rule 4902 compare to rules in other air districts?

District analysis compares Rule 4902 to the following analogous rules in other air districts: SCAQMD Rule 1121 (Control of Nitrogen Oxides from Residential Type, Natural Gas-Fired Water Heaters), SMAQMD Rule 414 (Water Heaters, Boilers and Process Heaters Rated Less than 1,000,000 BTU Per Hour), BAAQMD Regulation 9 Rule 6 (Nitrogen Oxides Emissions from Natural Gas-Fired Boilers and Water Heaters), and VCAPCD Rule 74.11 (Natural Gas-Fired Water Heaters) and determined that Rule 4902 is at least as stringent as those rules.

Emission Reduction Opportunities

As stated above, the most recent amendment of Rule 4902 strengthened the emission limit and as a result, NOx emissions have been controlled by approximately 88% for this source category. Units subject to Rule 4902 are fired on PUC quality natural gas, and are inherently low-emitters of SOx and PM2.5 emissions. Given the significant efforts and investments already made to reduce emissions from this source category, there are little remaining opportunities for obtaining additional emissions reductions. For the sake of thoroughness, the possibility of further reducing emissions from natural-gas fired water heaters is evaluated in the following discussion.

The potential opportunity evaluated is the possibility of achieving additional emission reductions from this category by taking advantage of lower emitting water heating technology. Rule 4902 is a point of sale rule, and nearly all water heaters sold in the District are conventional storage water heaters that operate on natural gas. The potential opportunity would be to replace natural gas and propane water heaters with units that run on electricity. A comparison of three water heaters that utilize the different fuel types with an emissions reduction and cost effectiveness analysis for these units is summarized below.

Table D-15 Emissions Reductions and Cost Effectiveness of Water Heaters by Fuel Type

Fuel Type	Low NOx Natural Gas	Propane	Electricity
Capacity[1]	50 gallons	50 gallons	50 gallons
Shipping Weight[1]	180 lbs	151 lbs	109 lbs
Energy Factor[1]	0.62	0.59	0.91
Purchase Price[1]	$902.00	$899.00	$473.25
Estimated Life Expectancy[2]	13 years	13 years	13 years
Lifetime Energy Use[2]	3,133 therms	2,867 gallons of LP	62,439 kWh
Lifetime Energy Costs[3]	$3,568	$7,176	$9,834
Lifetime NOx Emissions[4]	30.60 lbs	48.09 lbs	0.00 lbs
Annual NOx Emissions	2.35 lbs	3.70 lbs	0.00 lbs
Comparing Natural Gas and Propane to Electricity			N/A
Annualized capital cost[5]	$76.99	$76.99	
Annual Operating Cost Savings Compared to Electric	$482.00	$204.46	
Cost per pound NOx	$237.87	$76.07	
Cost per ton NOx	**$475,736**	**$152,135**	

[1] Unit specifications and prices acquired from Grainger Industrial Supply as of August 7, 2012
[2] Data from US Department of Energy – Energy Cost Calculator for Electric and Gas Water Heaters http://www1.eere.energy.gov/femp/technologies/eep_waterheaters_calc.html
[3] Cost data based on the of the average cost of units of energy in 2010 according to the US Energy Information Administration. http://www.eia.gov/
[4] Emissions factors derived from Appendix EA-1 of US Department of Energy's Energy Assessment for Proposed Energy Conservation Standards for Residential Clothes Washers
[5] The annualized capital equipment cost is calculated by multiplying the installed equipment cost by the capital recovery factor of 0.1627.

The operating cost for electric water heaters is higher than for propane and natural gas units, due to the higher cost of electricity over propane and natural gas. However, the initial purchase price is considerably lower for electric units. Converting to an electric water heater also may require modifications to the residence and have associated costs, though electric water heaters are amongst the safest units available. Electric units also weigh considerably less, due to the lack of safety equipment needed on a gas fueled water heater. While the lifetime cost of an electric water heater is higher than that of propane and natural gas, the emissions benefits may make converting to electric water heating a viable control strategy.

Risk-based Strategy Analysis

The emissions from units subject to Rule 4902 contribute 6.0% of average winter NOx emitted from stationary and area sources in the 2012 emission inventory. As illustrated in the emission inventory table above, the emissions from this source category are more prominent during winter months. However, these units are primarily fired on PUC-quality natural gas, which is generally considered a clean burning fuel with low SOx and PM emissions. Overall, Rule 4902 has significantly reduced NOx and SOx emissions from these units and has assisted in reducing PM2.5 concentrations through reductions of this key precursor.

Control Measure Commitments

The following is a summary of recommended commitments for Rule 4902.

Regulatory Action

The District's analysis did not identify any additional technologically feasible and cost effective potential controls. Therefore, there are no recommendations for additional regulatory actions for Rule 4902.

Incentive Action

The District does not currently fund any incentive programs specific to residential water heating, and there are no recommendations for new incentive programs for these sources at this time.

Technology Advancement Action

There are no recommendations for technology advancement actions at this time. Through its Technology Advancement Program, the District will continue to seek potential feasible and low-cost technologies that may provide for additional emission reduction opportunities in this category.

Policy Initiatives

The District does not currently have any policy initiatives specific to this rule. There are no recommendations for new policy initiatives specific to these units.

Education and Outreach

The District currently provides a robust education and outreach program for regulated sources through the Small Business Assistance program, Permit Stakeholder Meetings, Compliance Assistance Bulletins, and public notices for public workshops and public hearings. As this is a point of sale rule, this outreach would be applicable to retailers and manufacturers of residential water heaters. The District will continue to work closely with affected sources to ensure successful compliance. No new education and outreach efforts are recommended for these sources at this time.

D.5.4 Rule 4905 Natural Gas-Fired, Fan-Type, Residential Central Furnaces

Source Category

Rule 4905 is a point of sale rule that applies to any person who sells, offers for sale, installs or solicits the installation of natural-gas-fired, fan-type residential central furnaces, for use within the Valley with a rated heat input capacity of less than 175,000 Btu/hour, and for combination heating and cooling units with a rated cooling capacity of less than 65,000 Btu/hour.

The rule was adopted on October 20, 2005 to establish NOx limits for residential central furnaces supplied, sold, or installed in the Valley. The rule set a NOx emission limit of 0.093 pounds per million Btu of heat output (lb/MMBtu). EPA finalized approval for Rule 4905 on May 30, 2007. Rule 4905 is not subject to RACT requirements because it is not a Control Techniques Guidelines (CTG) category and it is applicable to sources that are too small to exceed the major source threshold.

Emission Inventory

Pollutant	2007	2012	2014	2015	2016	2017	2018	2019
	Annual Average - Tons per day							
PM2.5	0.20	0.19	0.20	0.20	0.20	0.21	0.21	0.21
NOx	2.49	2.40	2.45	2.48	2.51	2.54	2.58	2.61
SOx	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
	Winter Average - Tons per day							
PM2.5	0.36	0.35	0.36	0.36	0.36	0.37	0.37	0.38
NOx	4.47	4.31	4.40	4.45	4.51	4.56	4.62	4.68
SOx	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03

Regulatory Evaluation

How does District Rule 4905 compare with federal rules and regulations?

There are no applicable CTG, Alternative Control Techniques (ACT), New Source Performance Standards (NSPS), National Emission Standards for Hazardous Air Pollutants (NESHAP), or Maximum Achievable Control Technology (MACT) guidelines for this source category.

How does District Rule 4905 compare to rules in other air districts?

Rule 4905 when compared to other California air districts' rules for similar sources is found to be at least as stringent as the other rules. Specifically, Rule 4905 was compared to the following rules: SMAQMD Rule 414 (Water Heaters, Boilers and Process Heaters Rated Less Than 1,000,000 BTU Per Hour), BAAQMD Regulation 9

Rule 4 (Nitrogen Oxides from Fan Type Residential Central Furnaces), and VCAPCD Rule 74.22 (Natural Gas-Fired, Fan-Type Central Furnaces).

SCAQMD Rule 1111 (Reduction of NOx Emissions from Natural Gas-Fired, Fan-Type Central Furnaces) limits NOx emissions of all furnaces to 0.0325 lb/MMBtu by October 1, 2018, whereas the Rule 4905 NOx limit is 0.093 lb/MMBtu. In addition, SCAQMD Rule 1111 applies to both commercial and residential units, whereas District Rule 4905 only applies to residential units. The District has already committed to amending Rule 4905 in 2014.

Emission Reduction Opportunities

The District committed to amending Rule 4905 in the 2008 *PM2.5 Plan*. This amendment is scheduled for 2014, and will lower NOx emission limits for new natural gas-fired, fan-type residential central furnaces as appropriate for the Valley based on NOx limits within SCAQMD Rule 1111. However, it has still not been determined if manufacturers will be able to meet the limits in SCAQMD Rule 1111. In 2010, SCAQMD released a Request for Proposal (RFP) for the development of prototype ultra-low NOx natural gas-fired fan-type central furnaces. Four different projects were selected with different burner and emission control technologies for funding and are ongoing. The District will work closely with South Coast staff throughout the technology development project. When Rule 4905 is amended, NOx emission limits will be based on the results of those studies and the technology that is expected to be available.

Commercial Furnaces

As previously stated, SCAQMD Rule 1111 currently regulates small residential and commercial furnaces less than 175,000 Btu/hr, whereas District Rule 4905 regulates residential furnaces of the same size, but not commercial furnaces. The technology of commercial furnaces does not differ from residential central furnaces.

As a part of their on-going research efforts, SCAQMD plans on conducting a new technical assessment of the technology available to offset emissions from commercial central furnaces greater than 175,000 Btu/hr by 2014. SCAQMD plans on following up the assessment with a rule amendment that incorporates a new NOx limit for commercial units greater than 175,000 Btu/hr, which are currently unregulated, by 2016.

The District has committed to amending Rule 4905 in 2014 to lower NOx limits; during that rule-amending project the possibility of extending the applicability of this rule to include commercial units based on technological feasibility and cost effectiveness will also be evaluated. The District will work closely with SCAQMD to discuss the findings from their technical assessments of low-NOx technologies for commercial furnaces.

Risk-based Strategy Analysis

The emissions from units subject to Rule 4905 contribute 8.9% of average winter NOx emitted from stationary and area sources in the 2012 emission inventory. As illustrated in the emission inventory table above, the emissions from this source category are primarily a winter issue.

Control Measure Commitments

The following is a summary of recommended commitments for Rule 4905.

Regulatory Action

The recommendation is to amend the rule in 2014 as committed to in the District *2008 PM2.5 Plan*, and as a part of that process examine the possibility of extending the applicability of rule requirements to include natural gas-fired, fan-type, commercial central furnaces.

Incentive Action

Rule 4905 is currently under commitment to be amended to make the rule more stringent, and no new technologies were identified to further reduce emissions beyond those technologies that will be evaluated during the 2014 rule amending project. No new incentive actions are recommended for these natural gas-fired, fan-type, residential central furnaces.

Technology Advancement Action

As discussed above, the SCAQMD is currently testing new technologies to reduce emissions from these sources and the District intends to use the findings from that testing to make determinations as to the appropriate amendments for the rule. This effort, aside, there is no recommendation for a new technology advancement project for this source category. Through its Technology Advancement Program, the District will continue to seek potential feasible and low-cost technologies that may provide for additional emission reduction opportunities in this category.

Policy Initiatives

The District is not currently supporting any policy initiatives specific to natural gas-fired, fan-type, residential central furnaces, and there are no recommendations for new policy initiatives for these sources.

Education and Outreach

The District currently provides a robust education and outreach program for regulated sources through the Small Business Assistance program, Permit Stakeholder Meetings, Compliance Assistance Bulletins, and public notices for public workshops and public hearings. This is a point of sale rule; District outreach is primarily applicable to retailers of these natural gas-fired, fan-type, residential central furnaces. No new education and outreach efforts are recommended for these retailers at this time. The District will continue to work closely with affected sources to ensure successful compliance.

D.6 FUGITIVE PARTICULATE MATTER

District Regulation VIII is comprised of eight rules that regulate fugitive dust emissions. Regulation VIII applies only to outdoor anthropogenic (human-caused) fugitive dust sources; primary PM10 sources that result in fugitive dust emissions such as construction, demolition, excavation, extraction or other earthmoving activities; handling, transport, and storage of bulk materials; landfill operations; carryout and trackout; open areas with disturbed soil; unpaved roads; unpaved vehicle/equipment traffic areas (such as parking, shipping, receiving, transfer, and service areas), and off-field agricultural sources. Regulation VIII does not apply to PM10 precursor sources or sources of smoke. Regulation VIII prohibitory standards are performance based whereby the operators are allowed to determine the control technique sufficient to limit visible dust emissions to 20 percent opacity and, in certain instances, to implement requirements for a stabilized surface.

Regulation VIII was critical in the District's attainment of the National Ambient Air Quality Standard for PM10. However, a variety of studies have been conducted which may indicate that the PM2.5 fraction of the PM emissions from this source category may not be as significant as the PM coarse fraction. A better quantification of the PM2.5 fraction is required to develop a more accurate emissions inventory for the various activities in this category and to indicate the level of significance of those PM2.5 emissions. At this time, PM2.5 emission control factors are not well defined and it is not known if controls for PM10 are effective for producing PM2.5 emissions reductions for this category.

In the Risk-based Strategy chapter of this plan, modeling results show that the geologic fraction of PM2.5 found in the San Joaquin Valley makes a relatively small contribution to overall PM2.5 mass (see Figure 2.1). In addition, studies have shown that geologic dust, by itself, has relatively low toxicity. For more information on the impacts of geologic PM2.5 refer to Chapter 2.

Regulation VIII Rules do not regulate the vehicles that create dust because the District does not have the jurisdiction to regulate mobile sources. Refer to Chapter 6 (Incentive Programs) and Appendix C (Mobile Source Control Strategies) for details on how the District addresses mobile sources.

Existing Control Strategies

Due to the degree of difficulty and enormity of the challenge that the Valley faces in meeting the National Ambient Air Quality Standards (NAAQS), the District recognizes that prohibitory rules alone are not enough to reduce emissions to meet attainment requirements and protect public health. The District's longstanding, progressive strategy for reducing emissions is a multifaceted effort that includes incentive programs and policy initiatives in addition to prohibitory rules. The following discussion summarizes both the existing District efforts to reduce emissions from this source category, and evaluations for potential opportunities for further emissions reductions.

Incentive Programs

Incentive programs are an integral part of the emission reduction efforts of the District, especially where the District lacks direct jurisdiction in establishing emission control requirements. Because the District has regulatory authority and currently regulates these control measure source categories, the opportunities for incentive programs are minimal. In fact, there are not currently any incentive programs specific to the reduction of fugitive PM from sources subject to the Regulation VIII rules. The District does however implement incentive programs for off-road vehicles; refer to Chapter 6 for details on those programs.

Policy Initiatives

Similar to the Incentive Programs, the District's policies and Legislative Platform are important components to the District's strategy to attain federal ambient air quality standards. The District utilizes policies and the legislative platform to bring attention to major issues that have a direct impact on the Valley's air quality. Water shortages have an adverse impact on air quality in the Valley in a number of ways. Taking agricultural land out of production has led to the exposure of bare land, which can cause soil erosion and result in wind-blown dust. Furthermore, one of the key dust control measures that the Valley relies upon to control fugitive dust is wet suppression, which also requires water. With this in mind, the District supports measures to provide reliable water supplies to the Valley.

Rules and Regulations

The following table identifies the District Regulatory VIII rules, each of which will be evaluated to examine potential opportunities for additional emissions reductions.

Table D-16 Current Regulation VIII Rules

Rule		Last Amended/ Adopted
Rule 8011	**General Requirements**	08/19/2004
Rule 8021	**Construction, Demolition, Excavation, Extraction, and Other Earthmoving Activities**	08/19/2004
Rule 8031	**Bulk Materials**	08/19/2004
Rule 8041	**Carryout and Trackout**	08/19/2004
Rule 8051	**Open Areas**	08/19/2004
Rule 8061	**Paved and Unpaved Roads**	08/19/2004
Rule 8071	**Unpaved Vehicle/ Equipment Traffic Areas**	08/19/2004
Rule 8081	**Agricultural Sources**	08/19/2004

D.6.1 Rule 8011 General Requirements

Source Category

The provisions of Rule 8011 are applicable to specified outdoor fugitive dust sources. The definitions, exemptions, requirements, administrative requirements, recordkeeping requirements, and test methods set forth in this rule are applicable to all rules under District Regulation VIII (Fugitive PM10 Prohibitions). The Regulation VIII series was adopted in November 2001, and subsequently amended in 2004. The rules were developed pursuant to EPA guidelines for serious PM10 nonattainment areas. In 2004, the District adopted amendments to Regulation VIII to upgrade existing Reasonably Available Control Measure (RACM) level rules to meet the more stringent Best Available Control Measure (BACM) level required in serious PM10 nonattainment areas.

Emission Inventory

The emission inventory for this rule is not quantified because it is a supplementary rule to the other seven Regulation VIII Rules. Although this rule applies to all sources that have the potential to emit particulate matter there are no control requirements established within this rule. Emissions and emission reductions are addressed in the other seven Regulation VIII Rules. Emissions from Regulation VIII Rules can be found in Appendix B, and summarized in the other seven Regulation VIII rule discussions in this appendix.

Regulatory Evaluation

How does District Rule 8011 compare with federal rules and regulations?

Rule 8011 when compared to EPA rules, regulations, and guidelines that apply to fugitive dust is found to meet or exceed these standards. Federal requirements are located in General Preamble for Title I of the Clean Air Act Amendments of 1990 Appendix (57 FR 13498, April 16, 1992) and Fugitive Dust Background Document and Technical Information Document for Best Available Control Measures (EPA-450/2-92-004).

How does District Rule 8011 compare to rules in other air districts?

Rule 8011 was compared to fugitive dust regulations at other air districts and where comparable, is at least as stringent, if not more stringent, than other districts' rules. Comparisons to other air district rules, included SCAQMD Rule 1156 (Further Reductions of Particulate Emissions from Cement Manufacturing Facilities), SCAQMD Rule 1157 (PM10 Emission Reductions from Aggregate and Related Operations), SMAQMD Rule 403 (Fugitive Dust), VCAPCD Rule 55 (Fugitive Dust), and Clark County Department of Air Quality (CCDAQ) Section 41 (Fugitive Dust). BAAQMD does not have a comparable rule.

Emission Reduction Opportunities
This rule is administrative in nature, and is intended to be a supplementary rule to the other District Regulation VIII rules. Opportunities for emission reductions would be found with each of the other Regulation VIII rules and would not be identified as a possibility for this rule. As such, there are no emission reduction opportunities for Rule 8011.

Risk-based Strategy Analysis
As discussed above, the emissions from this source category are accounted for with the other Regulation VIII rules. This is a general requirement rule meant to supplement and support the other Regulation VIII rules. The emissions associated with the Regulation VIII rules are geological; as discussed in Chapter 2, research indicates that the geologic fraction of PM2.5 in the Valley makes a relatively small contribution to overall PM2.5 mass in peak winter months, and by itself has a relatively low toxicity. The emissions associated with sources subject to each of the Regulation VIII rules are identified and discussed in each rule control measure source category discussion.

Control Measure Commitments
The following is a summary of recommended commitments for Rule 8011.

Regulatory Action
This rule is an administrative and supplemental rule to other Regulation VIII rules. The District's analysis did not identify any additional technologically feasible and cost effective potential controls. Therefore, there are no recommendations for additional regulatory actions for Rule 8011.

Incentive Action
There are no recommendations for incentive actions for this rule because the rule is administrative in nature and if any incentive actions were to be recommended, they would need to be directed at the other Regulation VIII rules.

Technology Advancement Action
There is no recommendation for a new technology advancement project for this source category. Through its Technology Advancement Program, the District will continue to seek potential feasible and low-cost technologies that may provide for additional emission reduction opportunities in this category.

Policy Initiatives
As discussed previously, one of the key dust control measures that residents and operators in the Valley rely upon to control fugitive dust is wet suppression. Being mindful of this, the District currently supports legislative measures to provide reliable water supplies to the Valley. While there are no recommendations for new policy initiatives, the recommendation is to continue supporting legislative activities that aim to provide reliable water supplies to the Valley.

Education and Outreach

The District currently provides a robust education and outreach program for regulated sources through the Small Business Assistance program, Permit Stakeholder Meetings, Compliance Assistance Bulletins, and public notices for public workshops and public hearings. The District does not have recommendations for new education and outreach efforts for these sources. The District will continue to work closely with affected sources to ensure successful compliance.

D.6.2 Rule 8021 Construction, Demolition, Excavation, Extraction, and Other Earthmoving Activities

Source Category

Rule 8021 applies to construction or demolition related disturbances of soil, including land clearing, grubbing, scraping, excavation, extraction, land leveling, grading, cut and fill operations, travel on the site, travel access roads to and from the site, and demolition activities. The rule also applies to construction of new landfill disposal sites or modifications to existing landfill disposal sites prior to commencement of landfilling activities.

In 2004, the District adopted amendments to Regulation VIII to upgrade existing RACM level rules to meet the more stringent BACM level required in serious PM10 nonattainment areas. Rule 8021 was amended to add dust suppression requirements, and to require submittal of Dust Control Plans on residential construction sites 10.0 acres or more in size and on non-residential construction sites 5.0 acres or more in size.

Emission Inventory

Pollutant	2007	2012	2014	2015	2016	2017	2018	2019
	Annual Average - Tons per day							
PM2.5	1.19	1.11	1.12	1.13	1.14	1.15	1.16	1.17
NOx	0	0	0	0	0	0	0	0
SOx	0	0	0	0	0	0	0	0
	Winter Average - Tons per day							
PM2.5	1.09	1.01	1.03	1.04	1.05	1.06	1.06	1.07
NOx	0	0	0	0	0	0	0	0
SOx	0	0	0	0	0	0	0	0

Regulatory Evaluation

How does District Rule 8021 compare with federal rules and regulations?

Rule 8021, when compared to EPA rules, regulations, and guidelines that apply to fugitive dust, is found to meet or exceed these standards. Federal requirements are located in General Preamble for Title I of the Clean Air Act Amendments of 1990 Appendix (57 FR 13498, April 16, 1992) and Fugitive Dust Background Document and Technical Information Document for Best Available Control Measures (EPA-450/2-92-004).

How does District Rule 8021 compare to rules in other air districts?

Rule 8021 was compared to fugitive dust regulations at other air districts and where comparable, is at least as stringent, if not more stringent, than other districts' rules. Comparisons to other air district rules included SCAQMD Rule 1156 (Further

Reductions of Particulate Emissions from Cement Manufacturing Facilities), SCAQMD Rule 1157 (PM10 Emission Reductions from Aggregate and Related Operations), SMAQMD Rule 403 (Fugitive Dust), VCAPCD Rule 55 (Fugitive Dust), and Clark County Department of Air Quality (CCDAQ) Section 94 (Permitting and Dust Control for Construction Activities). BAAQMD does not have a comparable rule.

Emission Reduction Opportunities

District analysis identified one potential opportunity to further reduce emissions from this source category; to require signs to be posted at certain size work sites, asking the public to contact the District if the work site is producing significant dust emissions. While, this potential opportunity would increase the awareness of the workers and the public, there is no conclusion that it would result in reduced emissions. If emissions are reduced, it is not likely to result in quantifiable emission reductions.

Risk-based Strategy Analysis

The emissions from this source category contribute to 1.8% of average winter PM2.5 emitted from stationary and area sources in the 2012 emission inventory. The particulate matter emissions are geological and the inventory is relatively small and consistent throughout the year, with no elevated emission levels in winter months. As discussed in Chapter 2, research indicates that the geologic fraction of PM2.5 in the Valley makes a relatively small contribution to overall PM2.5 mass in peak winter months, and by itself has a relatively low toxicity.

Control Measure Commitments

The following is a summary of recommended commitments for Rule 8021.

Regulatory Action

The District's analysis did not identify any additional technologically feasible and cost effective potential controls. Therefore, there are no recommendations for additional regulatory actions for Rule 8021.

Incentive Action

The District does not currently have an incentive program specific to construction or demolition related disturbances of soil. There are no recommendations for new incentive actions at this time.

Technology Advancement Action

There is no recommendation for a new technology advancement project for this source category. Through its Technology Advancement Program, the District will continue to seek potential feasible and low-cost technologies that may provide for additional emission reduction opportunities in this category.

Policy Initiatives

As discussed previously, one of the key dust control measures that residents and operators in the Valley rely upon to control fugitive dust is wet suppression. Being mindful of this, the District currently supports legislative measures to provide reliable water supplies to the Valley. While there are no recommendations for new policy initiatives, the recommendation is to continue supporting legislative activities that aim to provide reliable water supplies to the Valley.

Education and Outreach

The District currently provides a robust education and outreach program for regulated sources through the Small Business Assistance program, Permit Stakeholder Meetings, Compliance Assistance Bulletins, and public notices for public workshops and public hearings. There are no recommendations for new education and outreach efforts for these sources. The District will continue to work closely with affected sources to ensure successful compliance.

D.6.3 Rule 8031 Bulk Materials

Source Category

Rule 8031 applies to the outside storage and handling of any unpackaged material, which emits or has the potential to emit dust when stored or handled. Rule 8031 requires bulk handling and storage facilities to restrict dust from material transfer, and reduce emissions from transport material and storage piles that emit dust. Facilities subject to Rule 8031 are required use control measures to ensure that visible dust emissions are limited to 20% opacity or less. These control measures can include application of water or other dust stabilizers, covering of bulk materials, construction of wind barriers, covering of haul trucks, etc.

In 2004, the District adopted amendments to Regulation VIII to upgrade existing RACM level rules to meet the more stringent BACM level required in serious PM10 nonattainment areas. Rule 8031 was amended to require construction and maintenance of wind barriers when handling bulk materials.

Emission Inventory

Pollutant	2007	2012	2014	2015	2016	2017	2018	2019
	Annual Average - Tons per day							
PM2.5	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
NOx	0	0	0	0	0	0	0	0
SOx	0	0	0	0	0	0	0	0
	Winter Average - Tons per day							
PM2.5	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
NOx	0	0	0	0	0	0	0	0
SOx	0	0	0	0	0	0	0	0

Regulatory Evaluation

How does District Rule 8031 compare with federal rules and regulations?

Rule 8031, when compared to EPA rules, regulations, and guidelines that apply to fugitive dust, is found to meet or exceed these standards. Federal requirements are located in General Preamble for Title I of the Clean Air Act Amendments of 1990 Appendix (57 FR 13498, April 16, 1992) and Fugitive Dust Background Document and Technical Information Document for Best Available Control Measures (EPA-450/2-92-004).

How does District Rule 8031 compare to rules in other air districts?

Rule 8031 was compared to fugitive dust regulations at other air districts and where comparable, is at least as stringent, if not more stringent, than other districts' rules. Comparisons to other air district rules included SCAQMD Rule 1156 (Further Reductions of Particulate Emissions from Cement Manufacturing Facilities), SCAQMD Rule 1157 (PM10 Emission Reductions from Aggregate and Related Operations), SMAQMD Rule 403 (Fugitive Dust), VCAPCD Rule 55 (Fugitive Dust), and Clark County Department of Air Quality (CCDAQ) Section 41 (Fugitive Dust). BAAQMD does not have a comparable rule.

Emission Reduction Opportunities

Rule 8031 currently employs the best dust mitigation techniques; there are no additional potential opportunities for further reductions of emissions from this source category. Rule 8031's requirement of limiting opacity to 20% is as or more stringent than any other District's rule and compliance with the standard requires significant mitigation efforts from sites that store bulk materials.

Risk-based Strategy Analysis

The PM2.5 emissions from this source category contribute to 0.04% of average winter PM2.5 emitted from stationary and area sources in the 2012 emission inventory. The particulate matter emissions are geological and the inventory is relatively small and consistent throughout the year, with no elevated emission levels in winter months. As discussed in Chapter 2, research indicates that the geologic fraction of PM2.5 in the Valley makes a relatively small contribution to overall PM2.5 mass in peak winter months, and by itself has a relatively low toxicity.

Control Measure Commitments

The following is a summary of recommended commitments for Rule 8031.

Regulatory Action

The District's analysis did not identify any additional technologically feasible and cost effective potential controls. Therefore, there are no recommendations for additional regulatory actions for Rule 8031.

Incentive Action

The District does not currently fund incentive programs specific to the outside storage and handling of bulk materials. There are no recommendations for new incentive actions at this time.

Technology Advancement Action

There is no recommendation for a new technology advancement project for this source category. Through its Technology Advancement Program, the District will continue to seek potential feasible and low-cost technologies that may provide for additional emission reduction opportunities in this category.

Policy Initiatives

As discussed previously, one of the key dust control measures that residents and operators in the Valley rely upon to control fugitive dust is wet suppression. Being mindful of this, the District currently supports legislative measures to provide reliable water supplies to the Valley. While there are no recommendations for new policy initiatives the recommendation is to continue supporting legislative activities that aim to provide reliable water supplies to the Valley.

Education and Outreach

The District currently provides a robust education and outreach program for regulated sources through the Small Business Assistance program, Permit Stakeholder Meetings, Compliance Assistance Bulletins, and public notices for public workshops and public hearings. There are no recommendations for new education and outreach efforts for these sources. The District will continue to work closely with affected sources to ensure successful compliance.

D.6.4 Rule 8041 Carryout and Trackout

Source Category

Rule 8041 applies to the prevention and cleanup of mud and dirt whenever it is deposited (carryout and trackout) onto public paved roads from activities subject to the requirements of Rules 8021, 8031, 8061, and 8071. The rule contains requirements for: removing carryout and trackout at the end of each workday; thresholds for any site with 150 daily vehicle trips; addressing carryout and trackout in Dust Control Plans; removing carryout and trackout in urban areas; paved interior roads; and prevention of carryout and trackout.

In 2004, the District adopted amendments to Regulation VIII to upgrade existing RACM level rules to meet the more stringent BACM level required in serious PM10 nonattainment areas. Rule 8041 was amended to require a threshold for vehicles with three or more axles to takes actions for carryout/trackout. Amendments included a threshold for projects located in rural areas, a provision requiring actions within half an hour if specified measures are insufficient to prevent carryout/trackout, and specifications for dust collectors, gravel pads, and paved surfaces.

Emission Inventory

The emission inventory for this rule is not quantifiable independent from paved and unpaved roads. These emissions occur on paved and unpaved roads and therefore are documented as a part of the inventory for Rule 8061 (Paved and Unpaved Roads). Refer to the control measure write up for Rule 8061 for this combined inventory.

Regulatory Evaluation

How does District Rule 8041 compare with federal rules and regulations?

Rule 8041, when compared to EPA rules, regulations, and guidelines that apply to fugitive dust, is found to meet or exceed these standards. Federal requirements are located in General Preamble for Title I of the Clean Air Act Amendments of 1990 Appendix (57 FR 13498, April 16, 1992) and Fugitive Dust Background Document and Technical Information Document for Best Available Control Measures (EPA-450/2-92-004).

How does District Rule 8041 compare to rules in other air districts?

Rule 8041 was compared to fugitive dust regulations at other air districts and where comparable, is at least as stringent, if not more stringent, than other districts' rules. Comparisons to other air district rules included SCAQMD Rule 1156 (Further Reductions of Particulate Emissions from Cement Manufacturing Facilities), SCAQMD Rule 1157 (PM10 Emission Reductions from Aggregate and Related Operations), SMAQMD Rule 403 (Fugitive Dust), VCAPCD Rule 55 (Fugitive Dust), and Clark County Department of Air Quality (CCDAQ) Section 94 (Permitting and Dust Control for Construction Activities). BAAQMD does not have a comparable rule.

Emission Reduction Opportunities

Two potential opportunities to reduce emissions were identified, evaluated, and determined to not be feasible. The first potential emission reduction opportunity would be to reduce the threshold for daily trips per worksite that requires a carryout and trackout prevention system (currently 150 trips). Reducing this threshold would require smaller worksites to install costly trackout prevention equipment like wheel washers, metal grates, and gravel pads. At these smaller worksites the emission reductions that would be achieved would be minimal and not cost effective because of the small size of the sites. The second potential opportunity would be to shorten the distance from the nearest unpaved exit point of a site at which trackout must be immediately cleaned (currently 50 feet). Lowering this threshold would significantly increase the use of street sweepers and their associated emissions, which are more toxic to human health (see Chapter 2). Therefore this opportunity has been determined to not be feasible.

Risk-based Strategy Analysis

The emissions from this source category are documented as a part of the emissions inventory for Rule 8061 (Paved and Unpaved Roads). The PM2.5 emissions from these two source categories combined contribute to 11.2% of the average winter PM2.5 emitted from stationary and area sources in the 2012 emission inventory. The particulate matter emissions are geological and the inventory is relatively small and consistent throughout the year, with no elevated emission levels in winter months. As discussed in Chapter 2, research indicates that the geologic fraction of PM2.5 in the Valley makes a relatively small contribution to overall PM2.5 mass in peak winter months, and by itself has a relatively low toxicity.

Control Measure Commitments

The following is a summary of recommended commitments for Rule 8041.

Regulatory Action

The District's analysis did not identify any additional technologically feasible and cost effective potential controls. Therefore, there are no recommendations for additional regulatory actions for Rule 8041.

Incentive Action

The District does not currently fund incentive programs specific to this source category; there are no recommendations for new incentive actions at this time.

Technology Advancement Action

There is no recommendation for a new technology advancement project for this source category. Through its Technology Advancement Program, the District will continue to seek potential feasible and low-cost technologies that may provide for additional emission reduction opportunities in this category.

Policy Initiatives

As discussed previously, one of the key dust control measures that residents and operators in the Valley rely upon to control fugitive dust is wet suppression. Being mindful of this, the District currently supports legislative measures to provide reliable water supplies to the Valley. While there are no recommendations for new policy initiatives the recommendation is to continue supporting legislative activities that aim to provide reliable water supplies to the Valley.

Education and Outreach

The District currently provides a robust education and outreach program for regulated sources through the Small Business Assistance program, Permit Stakeholder Meetings, Compliance Assistance Bulletins, and public notices for public workshops and public hearings. There are no recommendations for new education and outreach efforts for these sources. The District will continue to work closely with affected sources to ensure successful compliance.

D.6.5 Rule 8051 Open Areas

Source Category

Rule 8051 applies to any open area 0.5 acres or more within urban areas, or 3.0 acres or more within rural areas that contains at least 1,000 square feet of disturbed surface area. The rule has requirements for limiting visible dust emissions (VDE) to 20% opacity, to comply with the conditions of a stabilized surface, and to install barriers to prevent unauthorized vehicles from accessing the stabilized areas.

In 2004, the District adopted amendments to Regulation VIII that upgraded existing RACM level rules to meet the more stringent BACM level required in serious PM10 nonattainment areas. Rule 8051 was amended to add applicability thresholds for rural and urban areas.

Emission Inventory

Pollutant	2007	2012	2014	2015	2016	2017	2018	2019
	Annual Average - Tons per day							
PM2.5	0.41	0.34	0.34	0.34	0.34	0.34	0.34	0.34
NOx	0	0	0	0	0	0	0	0
SOx	0	0	0	0	0	0	0	0
	Winter Average - Tons per day							
PM2.5	0.26	0.21	0.21	0.21	0.21	0.21	0.21	0.21
NOx	0	0	0	0	0	0	0	0
SOx	0	0	0	0	0	0	0	0

Regulatory Evaluation

How does District Rule 8051 compare with federal rules and regulations?

Rule 8051, when compared to EPA rules, regulations, and guidelines that apply to fugitive dust, is found to meet or exceed these standards. Federal requirements are located in General Preamble for Title I of the Clean Air Act Amendments of 1990 Appendix (57 FR 13498, April 16, 1992) and Fugitive Dust Background Document and Technical Information Document for Best Available Control Measures (EPA-450/2-92-004).

How does District Rule 8051 compare to rules in other air districts?

Rule 8051 was compared to fugitive dust regulations at other air districts and where comparable, is at least as stringent, if not more stringent, than other districts' rules. Comparisons to other air district rules included SCAQMD Rule 1156 (Further Reductions of Particulate Emissions from Cement Manufacturing Facilities), SCAQMD Rule 1157 (PM10 Emission Reductions from Aggregate and Related Operations), SMAQMD Rule 403 (Fugitive Dust), VCAPCD Rule 55 (Fugitive Dust), and Clark

County Department of Air Quality (CCDAQ) Section 90 (Permitting and Dust Control for Construction Activities). BAAQMD does not have a comparable rule.

Emission Reduction Opportunities

The District's analysis did not identify any potential opportunities to further reduce emissions from this source category beyond those emissions that are already being reduced by rule requirements. As a part of due diligence efforts in seeking addition emission reduction opportunities, the following two potential opportunities have been identified to improve rule clarity. Language could be added to the rule to clarify that it applies to off-road recreational vehicle use areas. Also, the rule provides an exemption for weed abatement activity utilizing mowing and/or cutting. Adding language to specify that weed abatement by tilling is not exempt would also add clarity to the rule.

Risk-based Strategy Analysis

The emissions from this source category contribute 0.4% of average winter PM2.5 emitted from stationary and area sources in the 2012 emission inventory. The particulate matter emissions are geological and the inventory is relatively small and consistent throughout the year, with no elevated emission levels in winter months. As discussed in Chapter 2, research indicates that the geologic fraction of PM2.5 in the Valley makes a relatively small contribution to overall PM2.5 mass in peak winter months, and by itself has a relatively low toxicity.

Control Measure Commitments

The following is a summary of recommended commitments for Rule 8051.

Regulatory Action

The District's analysis did not identify any additional technologically feasible and cost effective potential controls that would result in reduced emissions. Therefore, there are no recommendations for additional regulatory actions for Rule 8051.

Incentive Action

The District does not currently fund any incentive programs specific to this source category; there are no recommendations for new incentive actions at this time.

Technology Advancement Action

There is no recommendation for a new technology advancement project for this source category. Through its Technology Advancement Program, the District will continue to seek potential feasible and low-cost technologies that may provide for additional emission reduction opportunities in this category.

Policy Initiatives
As discussed previously, one of the key dust control measures that residents and operators in the Valley rely upon to control fugitive dust is wet suppression. Being mindful of this, the District currently supports legislative measures to provide reliable water supplies to the Valley. While there are no recommendations for new policy initiatives the recommendation is to continue supporting legislative activities that aim to provide reliable water supplies to the Valley.

Education and Outreach
The District currently provides a robust education and outreach program for regulated sources through the Small Business Assistance program, Permit Stakeholder Meetings, Compliance Assistance Bulletins, and public notices for public workshops and public hearings. No new education and outreach efforts are recommended for these sources at this time. The District will continue to work closely with affected sources to ensure successful compliance.

D.6.6 Rule 8061 Paved and Unpaved Roads

Source Category

Rule 8061 establishes standards for the construction of new and modified paved roads in accordance with published guidelines by the American Association of State Highway and Transportation Officials for road construction and applies to any paved, unpaved, or modified public or private road, street highway, freeway, alley way, access drive, access easement, or driveway. The rule also allows alternative means of achieving the same level of dust reduction. Rule 8061 also establishes thresholds that when exceeded require that roads are treated to reduce visible dust emissions.

In 2004, the District adopted amendments to Regulation VIII to upgrade existing RACM level rules to meet the more stringent BACM level required in serious PM10 nonattainment areas. Rule 8061 was amended to replace the existing 75 maximum daily vehicle trip threshold with a 26 annual average daily vehicle trips (AADT) threshold on unpaved roads, and require all new unpaved roads within urban areas be paved.

Emission Inventory

This inventory accounts for emissions occurring on paved and unpaved roads and includes the inventory from carryout and trackout (Rule 8041) activities onto these roads.

Paved Roads

Pollutant	2007	2012	2014	2015	2016	2017	2018	2019
	Annual Average - Tons per day							
PM2.5	5.57	5.18	5.18	5.18	5.18	5.18	5.18	5.18
NOx	0	0	0	0	0	0	0	0
SOx	0	0	0	0	0	0	0	0
	Winter Average - Tons per day							
PM2.5	4.80	4.46	4.46	4.46	4.46	4.46	4.46	4.46
NOx	0	0	0	0	0	0	0	0
SOx	0	0	0	0	0	0	0	0

Unpaved Roads

Pollutant	2007	2012	2014	2015	2016	2017	2018	2019
	Annual Average - Tons per day							
PM2.5	2.02	1.96	1.98	1.99	2.01	2.02	2.04	2.05
NOx	0	0	0	0	0	0	0	0
SOx	0	0	0	0	0	0	0	0
	Winter Average - Tons per day							
PM2.5	1.82	1.77	1.79	1.80	1.81	1.82	1.84	1.85
NOx	0	0	0	0	0	0	0	0
SOx	0	0	0	0	0	0	0	0

Regulatory Evaluation

How does District Rule 8061 compare with federal rules and regulations?

Rule 8061, when compared to EPA rules, regulations, and guidelines that apply to fugitive dust, is found to meet or exceed these standards. Federal requirements are located in General Preamble for Title I of the Clean Air Act Amendments of 1990 Appendix (57 FR 13498, April 16, 1992) and Fugitive Dust Background Document and Technical Information Document for Best Available Control Measures (EPA-450/2-92-004).

How does District Rule 8061 compare to rules in other air districts?

Rule 8061 was compared to fugitive dust regulations at other air districts and where comparable, is at least as stringent, if not more stringent, than other districts' rules. Comparisons to other air district rules included SCAQMD Rule 1156 (Further Reductions of Particulate Emissions from Cement Manufacturing Facilities), SCAQMD Rule 1157 (PM10 Emission Reductions from Aggregate and Related Operations), SMAQMD Rule 403 (Fugitive Dust), VCAPCD Rule 55 (Fugitive Dust), Clark County Department of Air Quality (CCDAQ) Section 91 (Fugitive Dust from Unpaved Roads, Unpaved Alleys, and Unpaved Easement Roads), and CCDAQ Section 93 (Fugitive Dust from Paved Roads and Street Sweeping Equipment). BAAQMD does not have a comparable rule.

Emission Reduction Opportunities

The following potential opportunity to reduce emissions from paved and unpaved roads was identified and determined to be not feasible. Section 5.2.1 of the rule requires dust control measures for any unpaved road segments with 26 or more annual average daily trips. A potential opportunity to reduce emissions would be to lower this threshold. This would require more owners/operators to implement at least one control measure to reduce fugitive emissions.

Analysis of the emission inventory indicates that the majority of the particulate emissions attributable to unpaved roads are generated from unpaved roads already subject to the mitigation requirements of Rule 8061. Therefore, the remaining portion of emissions associated with unpaved roads (less than 26 AADT) does not provide an opportunity for additional reductions.

Additionally, emissions from unpaved roads are lowest in the winter months, when the District's PM2.5 24-hour exceedances occur. District staff believes the winter average PM2.5 emission inventory is overestimated for the following reasons:

- ARB methodology assumes that rainfall of at least 0.01 inch on any day mitigates unpaved road dust for 24 hours
- 71% of the days with precipitation occur during the winter months.
- Many US Forest and Park Roads are inaccessible during winter months due to increased amounts of rain and snow, yet emissions from these roads make up a larger percentage of the total unpaved road emissions in winter (42.8%) than in the annual average (40.7%)

For these reasons, lowering the trip threshold is not a viable emission reduction opportunity.

Risk-based Strategy Analysis

The emissions inventory from this source category includes the inventory for emissions from sources subject to the Rule 8041 (Carryout and Trackout) control measure source category. The emissions from these two source categories combined contribute to 11.2% of average winter PM2.5 emitted from stationary and area sources in the 2012 emission inventory. The particulate matter emissions are geological and the inventory is relatively small and consistent throughout the year, with no elevated emission levels in winter months. As discussed in Chapter 2, research indicates that the geologic fraction of PM2.5 in the Valley makes a relatively small contribution to overall PM2.5 mass in peak winter months, and by itself has a relatively low toxicity.

Control Measure Commitments

The following is a summary of recommended commitments for Rule 8061.

Regulatory Action

The District's analysis did not identify any additional technologically feasible and cost effective potential controls. Therefore, there are no recommendations for additional regulatory actions for Rule 8061. The key potential opportunity identified to reduce emissions for this rule is to lower the trip threshold that requires dust control measures on public unpaved roads. Staff reviewed this source category and determined that lowering this threshold would not result in measureable emission reductions.

Incentive Action
The District does not currently fund an incentive program specific to paved and unpaved roads; there are no recommendations for new incentive actions specific to this rule at this time.

Technology Advancement Action
There is no recommendation for a new technology advancement project for this source category. Through its Technology Advancement Program, the District will continue to seek potential feasible and low-cost technologies that may provide for additional emission reduction opportunities in this category.

Policy Initiatives
As discussed previously, one of the key dust control measures that residents and operators in the Valley rely upon to control fugitive dust is wet suppression. Being mindful of this, the District currently supports legislative measures to provide reliable water supplies to the Valley. While there are no recommendations for new policy initiatives the recommendation is to continue supporting legislative activities that aim to provide reliable water supplies to the Valley.

Education and Outreach
The District currently provides a robust education and outreach program for regulated sources through the Small Business Assistance program, Permit Stakeholder Meetings, Compliance Assistance Bulletins, and public notices for public workshops and public hearings. There are no recommendations for new education and outreach efforts for these sources. The District will continue to work closely with affected sources to ensure successful compliance.

D.6.7 Rule 8071 Unpaved Vehicle/ Equipment Traffic Areas

Source Category

Rule 8071 is applicable to unpaved vehicle/equipment areas, parking, fueling and service areas, and shipping, receiving, and transfer areas. The rule contains requirements for when vehicle traffic reaches or exceeds specified thresholds, limitations on visible dust emissions (VDE), compliance requirements with the conditions of a stabilized surface, and lists control techniques, which could be implemented to limit VDE and to comply with the conditions of a stabilized surface.

In 2004, the District adopted amendments to Regulation VIII to upgrade existing RACM level rules to meet the more stringent BACM level required in serious PM10 nonattainment areas. Rule 8071 was amended to remove the 1.0 acre or larger threshold; change the vehicle threshold from 75 vehicle daily trips to 50 annual average daily trips; add a single day peak threshold of 150 VDT or require control for sources that exceed the 150 VDT threshold limit on at least 30 days per year; and add a requirement whenever 25 or more three-axle vehicle trips will occur on an unpaved vehicle/equipment traffic area.

Emission Inventory

Pollutant	2007	2012	2014	2015	2016	2017	2018	2019
	Annual Average - Tons per day							
PM2.5	1.01	0.99	0.99	0.99	0.99	0.99	0.99	0.99
NOx	0	0	0	0	0	0	0	0
SOx	0	0	0	0	0	0	0	0
	Winter Average - Tons per day							
PM2.5	1.03	1.01	1.01	1.01	1.01	1.01	1.01	1.01
NOx	0	0	0	0	0	0	0	0
SOx	0	0	0	0	0	0	0	0

Regulatory Evaluation

How does District Rule 8071 compare with federal rules and regulations?

Rule 8071, when compared to EPA rules, regulations, and guidelines that apply to fugitive dust, is found to meet or exceed these standards. Federal requirements are located in General Preamble for Title I of the Clean Air Act Amendments of 1990 Appendix (57 FR 13498, April 16, 1992) and Fugitive Dust Background Document and Technical Information Document for Best Available Control Measures (EPA-450/2-92-004).

How does District Rule 8071 compare to rules in other air districts?

Rule 8071 was compared to fugitive dust regulations at other air districts and where comparable, is at least as stringent, if not more stringent, than other districts' rules. Comparisons to other air district rules included SCAQMD Rule 1156 (Further Reductions of Particulate Emissions from Cement Manufacturing Facilities), SCAQMD Rule 1157 (PM10 Emission Reductions from Aggregate and Related Operations), SMAQMD Rule 403 (Fugitive Dust), VCAPCD Rule 55 (Fugitive Dust), and Clark County Department of Air Quality (CCDAQ) Section 92 (Fugitive Dust from Unpaved Parking Lots and Storage Areas). BAAQMD does not have a comparable rule.

Emission Reduction Opportunities

Section 5.2.1 of current rule language requires dust control measures for any unpaved traffic area with 50 or more annual average daily trips. Analysis of lowering this threshold to determine if it is a feasible option to reduce emissions determined that this is not a cost effective opportunity. Lowering the trip threshold of Rule 8071 would result in direct PM emission reductions, but would also result in the requirement that owners and/or operators implement a dust control measure. The most common control measures are watering and covering with gravel. Local cost estimates indicate that installing a 2 inch gravel base with another 2 inches of top gravel would cost approximately $1.90 per square foot, or around $83,000 per acre. Based on the small size of the emissions from this source category, and the estimated mitigation costs, requiring control measures for areas with such minimal activity is not a cost effective option.

Risk-based Strategy Analysis

The emissions from this source category contribute to 1.8% of average winter PM2.5 emitted from stationary and area sources in the 2012 emission inventory. The particulate matter emissions are geological and the inventory is relatively small and consistent throughout the year, with no elevated emission levels in winter months. As discussed in Chapter 2, research indicates that the geologic fraction of PM2.5 in the Valley makes a relatively small contribution to overall PM2.5 mass in peak winter months, and by itself has a relatively low toxicity.

Control Measure Commitments

The following is a summary of recommended commitments for Rule 8071.

Regulatory Action

The District's analysis did not identify any additional technologically feasible and cost effective potential controls. Therefore, there are no recommendations for additional regulatory actions for Rule 8071.

Incentive Action

There are no recommendations for new incentive programs specific to this source category at this time.

Technology Advancement Action
There is no recommendation for a new technology advancement project for this source category. Through its Technology Advancement Program, the District will continue to seek potential feasible and low-cost technologies that may provide for additional emission reduction opportunities in this category.

Policy Initiatives
As discussed previously, one of the key dust control measures that residents and operators in the Valley rely upon to control fugitive dust is wet suppression. Being mindful of this, the District currently supports legislative measures to provide reliable water supplies to the Valley. While there are no recommendations for new policy initiatives the recommendation is to continue supporting legislative activities that aim to provide reliable water supplies to the Valley.

Education and Outreach
The District currently provides a robust education and outreach program for regulated sources through the Small Business Assistance program, Permit Stakeholder Meetings, Compliance Assistance Bulletins, and public notices for public workshops and public hearings. There are no recommendations for new education and outreach efforts for these sources. The District will continue to work closely with affected sources to ensure successful compliance.

D.6.8 Rule 8081 Agricultural Sources

Source Category

Rule 8081 applies to “off-field” agricultural sources including, but not limited to, unpaved roads, unpaved vehicle/equipment traffic areas, and bulk materials. The rule contains requirements to limit visible dust emissions (VDE) and/or to comply with the conditions of a stabilized surface, and lists control techniques which could be implemented to limit VDE and to comply with the conditions of a stabilized surface.

In 2004, the District adopted amendments to Regulation VIII to upgrade existing RACM level rules to meet the more stringent BACM level required in serious PM10 nonattainment areas. The amendments added an exemption to the rule for vehicle/equipment traffic areas if they are less than one acre in size and more than one mile from an urban area; expanded rule applicability by updating the vehicle threshold from 75 vehicle daily trips to 50 annual average vehicle trips; and added a requirement specific to whenever 26 or more three-axle vehicle trips will occur on an unpaved vehicle/equipment traffic area.

Emission Inventory

Pollutant	2007	2012	2014	2015	2016	2017	2018	2019
	Annual Average - Tons per day							
PM2.5	1.27	1.23	1.22	1.21	1.21	1.20	1.20	1.19
NOx	0	0	0	0	0	0	0	0
SOx	0	0	0	0	0	0	0	0
	Winter Average - Tons per day							
PM2.5	1.62	1.56	1.55	1.54	1.54	1.53	1.53	1.52
NOx	0	0	0	0	0	0	0	0
SOx	0	0	0	0	0	0	0	0

Regulatory Evaluation

How does District Rule 8081 compare with federal rules and regulations?

Rule 8081, when compared to EPA rules, regulations, and guidelines that apply to fugitive dust, is found to meet or exceed these standards. Federal requirements are located in General Preamble for Title I of the Clean Air Act Amendments of 1990 Appendix (57 FR 13498, April 16, 1992) and Fugitive Dust Background Document and Technical Information Document for Best Available Control Measures (EPA-450/2-92-004).

How does District Rule 8081 compare to rules in other air districts?

Rule 8081, when compared to EPA rules, regulations, and guidelines that apply to fugitive dust, is found to meet or exceed these standards. Federal requirements are located in General Preamble for Title I of the Clean Air Act Amendments of 1990 Appendix (57 FR 13498, April 16, 1992) and Fugitive Dust Background Document and Technical Information Document for Best Available Control Measures (EPA-450/2-92-004).

Emission Reduction Opportunities

The District's analysis did not identify any potential opportunities to further reduce emissions from this source category. However, a potential opportunity to improve enforceability of this for this source category has been identified. Section 5.4 of the rule references California Vehicle Code section 23112-23113 for prevention of carryout and trackout. This section could be removed and replaced with specific language from the vehicle code, however, as previously stated, this amendment would not result in emissions reductions.

Risk-based Strategy Analysis

The emissions from this source category contribute to 2.8% of average winter PM2.5 emitted from stationary and area sources in the 2012 emission inventory. The particulate matter emissions are geological and the inventory is relatively small and consistent throughout the year, with no elevated emission levels in winter months. As discussed in Chapter 2, research indicates that the geologic fraction of PM2.5 in the Valley makes a relatively small contribution to overall PM2.5 mass in peak winter months, and by itself has a relatively low toxicity.

Control Measure Commitments

The following is a summary of recommended commitments for Rule 8081.

Regulatory Action

The District's analysis did not identify any additional technologically feasible and cost effective potential controls. Therefore, there are no recommendations for additional regulatory actions for Rule 8081.

Incentive Action

There are no recommendations for incentive actions to further reduce directly emitted particulate matter from agricultural sources subject to Rule 8081 at this time.

Technology Advancement Action

There is no recommendation for a new technology advancement project for this source category. Through its Technology Advancement Program, the District will continue to seek potential feasible and low-cost technologies that may provide for additional emission reduction opportunities in this category.

Policy Initiatives

As discussed previously, one of the key dust control measures that residents and operators in the Valley rely upon to control fugitive dust is wet suppression. Being mindful of this, the District currently supports legislative measures to provide reliable water supplies to the Valley. While there are no recommendations for new policy initiatives, the recommendation is to continue supporting legislative activities that aim to provide reliable water supplies to the Valley.

Education and Outreach

The District currently provides a robust education and outreach program for regulated sources through the Small Business Assistance program, Permit Stakeholder Meetings, Compliance Assistance Bulletins, and public notices for public workshops and public hearings. No new education and outreach efforts are recommended for these sources at this time. The District will continue to work closely with affected sources to ensure successful compliance.

D.7 ADDITIONAL SOURCE CATEGORIES

The Valley's ongoing air quality attainment challenges require the District to look beyond the successes of its stringent rules and innovative incentive programs for further emissions reductions. The following potential control measure source categories and programs represent the District's continuing efforts to consider and evaluate new and existing sources for potential emissions reductions.

Through its incentives program and its policy and legislative platform, the District is able to positively affect emissions reductions from non-regulated sources and sources that are outside of its jurisdiction. These efforts include educational programs and public outreach that encourage fuel and energy savings, funding for cleaner-running vehicles and engines, and the support of legislation that impacts air quality in the Valley.

For some of the source categories listed below, the District has made initial efforts through incentive and outreach programs to reduce emissions. This analysis will look beyond such efforts at refinements and new technology to potentially obtain additional emissions reductions for each of the source categories.

Table D-17 Additional Source Categories

Source Categories	
SC 001	Lawn and Garden Equipment
SC 002	Energy Efficiency
SC 003	Fireworks
SC 004	Sand and Gravel Operations
SC 005	Asphalt/Concrete Operations
SC 006	Almond Hulling/Shelling Operations
SC 007	Pistachio Hulling/ Shelling Operations
SC 008	Ag Material Screening/Shaking Operations
SC 009	Tub Grinding Operations
SC 010	Abrasive Blasting

Existing Control Strategies

Due to the degree of difficulty and enormity of the challenge that the Valley faces in meeting the National Ambient Air Quality Standards (NAAQS), the District recognizes that prohibitory rules alone are not enough to reduce emissions to meet attainment requirements and protect public health. The District's longstanding, progressive strategy for reducing emissions is a multifaceted effort that includes incentive programs and policy initiatives in addition to prohibitory rules. The following discussion summarizes existing District efforts to reduce emissions from sources under this category.

Incentive Programs

Incentive programs are an integral part of the emission reduction efforts of the District, especially where the District lacks direct jurisdiction in establishing emission control requirements. As a part of the District's continuing efforts to reduce emissions from sources through the use of incentive programs, the District has already implemented a successful incentive program aimed at replacing lawn care equipment with less polluting equipment and is in the process of launching a new program to test new technologies in the lawn and garden source category to determine if it is a viable alternative.

The District encourages the replacement of polluting gas powered lawn mowers with electric lawn mowers through The *Clean Green Yard Machine* grant program which has provided $1,472,977 in grant money toward the replacement of 8,600 gas-powered lawn mowers in the Valley.

Other air districts also have incentive programs for lawn and garden equipment. The corresponding programs are generally similar to the District's residential lawn and garden replacement program, using rebates or hosting events to replace lawn mowers. SCAQMD has a similar program incentivizing electric lawn mowers, but they have also extended the program to apply to leaf blowers. Currently, the SCAQMD 2-stroke gas leaf blowers are being replaced with lower emitting 4-stroke equipment.

The availability of zero-emitting or battery powered lawn equipment has been challenging, especially in the commercial sector due to the need for a longer battery life and durability to allow for more frequent and prolonged equipment use. Local operators have previously expressed concerns about the cost and reliability of cordless electric equipment, and how this equipment might affect productivity and competition with other operators. In May 2012, the District solicited proposals from interested equipment manufacturers and vendors to partner with the District and implement the Cordless Zero-Emission Commercial Lawn and Garden Equipment Demonstration Program (using Assembly Bill 118 funding from ARB). The District finalized a contract with the selected equipment manufacturers and vendors and released a Request For Applications in August. The demonstration program has generated significant interest and support from the commercial lawn and garden applicators, which include businesses that provide landscaping services and organizations that have their own maintenance team. District staff is currently working with 61 participants to complete the contract phase and order the cordless zero-emission commercial lawn and garden equipment for the Demonstration Program. Participants will begin using the equipment and provide feedback on the performance and durability of the cordless zero-emission commercial lawn and garden equipment. Based on suggestions from local lawn and garden operators, as a part of the demonstration program, the District will provide training for operators to learn how to use cordless electric equipment properly and efficiently. Incorporating cordless electric lawn equipment will provide emission reductions and should be evaluated further as equipment becomes more readily available to operators.

The District launched an incentive program in early 2012 for alternatives to professionally-managed pyrotechnic fireworks displays. The program committed to provide up to 50% of the cost of a laser-light based display to replace pyrotechnic fireworks displays at existing, annual July 4th events. The program will potentially be restructured to provide more outreach and a better incentive for replacing pyrotechnic fireworks in future years.

This past year, the District provided funding in support of several pilot programs examining the potential benefits of providing energy efficiency tools to Valley manufacturing facilities and other businesses. Early results from this program indicate significant potential opportunities for generating emission reductions from the manufacturing and industrial sectors through the promotion of “lean manufacturing” and other practices.

At this time, there are no incentive programs that directly impact the other source categories listed in the table above, but the District continues to seek out opportunities for other incentive programs to reduce emissions in the Valley.

Policy Initiatives

Similar to the Incentive Programs, the District’s policies and Legislative Platform are important components to the District’s strategy to attain federal ambient air quality standards. The District uses this platform to bring attention to major issues that impact air quality in the Valley, including energy efficiency and clean-energy alternatives and legislation that limits the District’s ability to regulate the installation and use of wood-burning devices in residences.

The District promotes energy efficiency and clean-energy alternatives as an additional means of emissions reductions in areas with well-established, strong regulatory measures on stationary sources, such as in the Valley. These extra efforts will help the District attain air quality standards as expeditiously as possible. As such, the District supports policies and initiatives that encourage renewable energy and energy efficiency including the following:

- Develop additional biomass capacity using agricultural waste materials
- Expand net metering and feed-in tariffs for the utilization of solar and other renewable energy sources
- Promote energy efficiency for energy end-users that will result in lower pollutant emissions and a more stable electric distribution system
- Encourage and incentivize low-emission technologies that use waste gas as an alternative to waste-gas venting or flaring.

California Senate Bill (SB) 1468 would allow the sale of fireworks for the period immediately before New Year’s Eve. Historically, the use of fireworks has been limited to the summer season (late June through early July); however, the proposed legislation now extends the use of fireworks to winter months, the period of time when the Valley experiences stagnation events that trap particulate matter for extended periods of time.

Particulate matter is the main pollutant of concern during the winter months, and the District uses the Check-Before-You-Burn program to reduce particulate matter emissions during winter months. If fireworks are allowed in conjunction with the New Year's Eve celebration, and the usage coincides with a stagnation event, Valley residents will likely be exposed to elevated and unhealthy particulate matter levels, and will likely result in additional fireplace curtailments. Therefore, given the potential for extreme adverse impact to public health, the District Governing Board has approved a policy in opposition to SB 1468.

Rules, Regulations, and Incentives

While rules and regulations are the cornerstone of the District's efforts in obtaining emissions reductions, incentive programs have proven to be a critical component in meeting the Valley's attainment goals. The source categories listed in Table D-17 are evaluated in light of their potential to further reduce emissions and achieve the attainment of federal air quality standards as expeditiously as possible.

D.7.1 SC 001 Lawn and Garden Equipment

Source Category

This source category includes the commercial and residential lawn and garden sectors. The commercial sector includes larger businesses that employ licensed contractors, public agencies and organizations that maintain their own properties or provide landscape services, and small businesses serving residential properties. The residential sector of lawn and garden equipment includes equipment purchased by the public for personal use. A survey conducted in 2003 by the California Air Resources Board (ARB) estimated that there are approximately 13 million pieces of lawn and garden equipment statewide: 12% in the commercial sector, and 88% in the residential sector. Although there are more pieces of equipment used by the residential sector, the survey showed that the commercial sector accounts for 68% of annual use of all lawn care equipment.

Lawn and garden equipment includes the following: chainsaws, chippers, commercial turf equipment, front mowers, lawn and garden tractors, lawn mowers, leaf blowers and vacuums, rear-engine riding mowers, shredders, snow blowers, tillers, trimmers, edgers, brush cutters, wood splitters, and other lawn and garden equipment.

Handheld lawn and garden tools (such as leaf blowers) typically use two-stroke engines, and most larger machines (such as lawn and garden tractors) use four-stroke engines. Lawn mowers are available with either type of engine. Two-stroke engines rely on oil mixed with the gasoline to lubricate the engine components. Much of this oil is not completely combusted by the engine thus creating high exhaust emissions. The major pollutants from a two-stroke engine, for example, are oil-based particulates, PM2.5, NOx, and a mixture of hydrocarbons, which combine with other gases in the atmosphere to form ozone, carbon monoxide, and other toxic air contaminants. Overall, four-stroke engines emit significantly lower emissions than their two-stroke counterparts, with significantly lower levels of hydrocarbons and particulate matter. Lawn care equipment, particularly leaf blowers, can also cause a significant amount of fugitive dust depending on the work practices employed such as blowing on bare dirt or very dusty paved surfaces. These types of activities would increase fugitive emissions including PM, toxic air contaminants (TAC) and ultrafine particles (UFP) resulting in a negative health impact on those in proximity to the activity.

Emission Inventory

The emissions inventory for lawn care includes exhaust and evaporative emissions from lawn care equipment. Exhaust emissions from lawn care engines (consisting of both unburned fuel and products of incomplete combustion), while high compared to on-road mobile sources on a per engine basis, are a relatively small part of the overall NOx and directly emitted PM2.5 emission inventory. However, these emissions can be highly concentrated geographically as well as within certain hours of the day.

Pollutant	2007	2012	2014	2015	2016	2017	2018	2019
	Annual Average - Tons per day							
PM2.5	0.12	0.11	0.11	0.11	0.11	0.11	0.11	0.11
NOx	1.02	0.89	0.88	0.88	0.87	0.87	0.87	0.87
SOx	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
	Winter Average - Tons per day							
PM2.5	0.11	0.10	0.10	0.10	0.10	0.10	0.10	0.10
NOx	0.98	0.85	0.84	0.83	0.83	0.82	0.82	0.82
SOx	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001

Efforts to improve the emission inventory

Based on the activity levels reported by ARB in their 2003 emissions inventory methodology for lawn care, it is expected that residential activity levels for lawn care equipment in the Valley have been underestimated. ARB is currently planning on conducting a survey of California residents to update and improve the inventory. Concurrently, the District will be conducting additional research to quantify Valley-specific lawn care activity levels to improve the emissions inventory.

Regulatory Evaluation

The District does not currently have any prohibitory rules specifically addressing lawn care emissions, though the Indirect Source Review (ISR) rule does account for lawn care emissions in the model that calculates emissions increases from new developments. Providing electric lawn equipment and incorporating convenient electric charging stations and outlets on the property are currently recognized on-site mitigation measures for meeting ISR requirements. The list of on-site mitigation measures could be expanded to include additional landscape measures such as zero or low-water landscaping. However, the emission reduction benefits would have to be quantified.

The District's innovative strategies to reduce emissions from the lawn care source category, as discussed previously, include funding the residential *Clean Green Yard Machine residential lawn mower* incentive program which replaces conventional mowers with electric lawn mowers, and increased outreach efforts to the community. Additionally, in March of 2012 the District hosted a conference on lawn care, landscaping, and air quality to discuss emerging low-emission technologies.

How would District SC 001 compare with federal rules and regulations?

EPA's small non-road spark-ignition engine rule applies to engines rated below 25 horsepower, including lawn care equipment. The EPA regulation requires exhaust emission standards by 2011 and 2012 depending on the class of the engine. New evaporative emission standards for both handheld and non-handheld equipment include requirements to control fuel tank permeation, fuel line permeation, and diffusion emissions.

ARB also has a rule addressing spark-ignition small off-road engines (SORE) less than 25 horsepower. It was originally adopted in 1990 and established tiered exhaust and evaporative emission standards. The rule requires manufacturers to meet these standards and obtain certification for the engines from ARB and EPA. The SORE rule is an attrition rule, which relies on natural turnover of lawn mowers for reductions to occur. While the rule establishes lower emissions, it does not push zero emissions technology. ARB recently amended the SORE rule in December 2011 to make it more consistent with EPA's test procedures.

There are no applicable federal standards and guidelines, such as New Source Performance Standards (NSPS), National Emission Standards for Hazardous Air Pollutants (NESHAP), and Maximum Achievable Control Technology (MACT) requirements, for this category. Additionally, there are no Control Techniques Guidelines (CTG), Alternative Control Technology (ACT), or Best Available Control Technology (BACT) guidelines requiring additional technologically feasible controls.

How would District SC 001 compare to rules in other air districts?

SCAQMD adopted Rule 1623 (Credits for Clean Lawn and Garden Equipment) in 1996, but it was not approved by EPA and it is currently not being implemented. There doesn't appear to be any other rules currently in place at other air districts.

Emission Reduction Opportunities

ARB and EPA have regulatory authority over engine standards. As described above, the ARB and EPA rules rely on natural turnover and do not push zero emissions technology; therefore, there are still opportunities to reduce emissions by closing the emissions gap and accelerating the use of zero emissions technology. While the District cannot establish new engine standards, it could regulate the use of lawn care and garden equipment. Given the Valley's air quality challenges and the potential benefits, the District may explore in-use regulatory options as a long-term strategy. The District's analysis of potential opportunities to reduce emissions includes evaluations of emerging technologies, potential control strategies such as an in-use rule or best management practices, episodic controls, and zoning. While these evaluations do not result in recommendations for regulatory action, further study is recommended for the evaluation of the emission inventory and of the results from current and future District technology demonstration activities.

Emerging Technologies

There has been recent improvement in the availability and applications of zero emissions lawn care technology. Manufacturers are producing more electric lawn care equipment options and are developing ways to allow for this equipment to be used in the commercial sector, such as carrying additional battery packs. Examples of more recent advances in new electric options include the following:

- Lawn mowers
  - Riding mowers
  - Robotic mowers
  - Self-propelled walk behind mowers
  - Cordless electric lawn mowers
- Battery powered leaf blowers
- Electric sweepers and backpack vacuums
- Battery powered chainsaws
- Electric line trimmers/edgers
- Electric hedge trimmers
- Stronger batteries and battery chargers

Though zero-emitting or battery operated lawn equipment has significantly improved in recent years, the viability of cordless electric technology has not been proven in the commercial sector. This is largely due to the need for a longer battery life and durability to allow for more frequent and prolonged equipment use. On March 21, 2012, the District hosted a conference on lawn care, landscaping, and air quality. The conference highlighted challenges operators face when using lower emitting equipment and commercial viability. Local operators expressed concerns about the cost and reliability of cordless electric equipment, and how this equipment might affect productivity and competition with other operators.

The District is actively pursuing demonstrations of new opportunities through its Technology Advancement Program, including the recent launch of the *Cordless Zero-Emission Commercial Lawn and Garden Equipment Demonstration Program*. The program is funded with State Air Quality Improvement Program and District program funds and would provide eligible cordless zero-emission commercial lawn and garden equipment to commercial landscape professionals who conduct business within the boundaries of the San Joaquin Valley. The District plans to continue to work with commercial operators to address the concerns with commercial viability through the implementation of this program. Technologies capable of reducing emissions in the Valley are being demonstrated, and if successful these demonstrations may provide an opportunity for the District to develop incentive programs to promote these technologies.

Potential Strategies to Reduce Emissions
In evaluating potential control strategies, the District's analysis identified a number of potential regulatory and outreach opportunities. However, there are no recommended regulatory actions at this time due to the need to revise the emissions inventory and complete the technology demonstration project. The District will continue its evaluation of which of the following regulatory approaches are feasible from a regulatory standpoint as well as from a public health standpoint.

In-Use Rule
One potential control strategy would be to require the use of the cleanest available equipment by prohibiting the use of gas combustion equipment. This could be achieved through a point-of-sale rule implementing a tiered approach or by phasing in restrictions as lower or zero-emissions technology becomes more available in the future. This type of control measure could potentially eliminate the portion of emissions resulting from the combustion of fuel. There might also be a need to bifurcate this type of regulation due to the varying availability of low or zero-emitting equipment in the residential sector versus commercial sector.

Best Management Practices
Another potential control strategy would be to require operators to implement Best Management Practices (BMPs) using a menu approach for the use of lawn and garden equipment in the commercial sector. Some examples of potential BMPs include:

- Restrictions near schools and other heavily populated areas
- Courtesy practices, e.g. don't point at people or open windows, don't blow material onto public roads, sidewalks, or neighboring properties
- Particulate prevention practices (no leaf blower use on bare dirt surfaces or very dusty paved surfaces, etc.)

This BMP option would focus on providing education on safety and more efficient use of equipment. Enforcing this type of rule could be challenging due to the large number of operators, variation in size of businesses, and the wide spread distribution of operator activities. Operators could be required to complete a certification course so that they can be educated on proper work practices. The District could also require operators to show a certificate of completion to purchase gas equipment after a certain date, to ensure contractors operating gas equipment are using the most effective work practices to protect public health and decrease emissions.

Episodic Control
Episodic control provides another potential control strategy where use of gas equipment could be limited or prohibited during high-pollution days. There has also been precedence set throughout California with numerous cities and counties adopting ordinances banning or prohibiting the use of leaf blowers on specified days, times, distances from residential areas, or noise levels. The District could create a model ordinance for cities and counties to adopt throughout the Valley to limit or prohibit the use of gas equipment and/or leaf blowers. One example was found where the city of Menlo Park prohibited the use of gas equipment on Spare the Air days in the Bay Area

Air Quality Management District (BAAQMD). This could be an option for future regulatory control in the Valley to reduce emissions, especially on high pollution days.

Table D-18 City Bans of Leaf Blowers

Cities	Ban Type
Dana Point San Diego	Decibel and hours of operations restrictions
Foster City Los Angeles Palo Alto	Restrictions on distance from residential unit and hours allowed to operate
Sacramento Sunnyvale	Restrictions on decibels, hours of operations, and distance from residential areas
Berkeley Beverly Hills Claremont Lawndale Los Altos Santa Barbara	Bans gas blowers
Burlingame	Restrict commercial use to one day per week dependent on determined city districts; Residential restricted by days and hours of operation
Menlo Park	Prohibited on Sundays, observed federal holidays and on "Spare the Air" days as declared by the BAAQMD
Laguna Beach Santa Monica	Bans all blowers

Zoning

Another potential opportunity to reduce emissions could be through the promotion of “zones,” where gas equipment would be prohibited or limited in designated zones, such as those close to schools, parks, etc. This approach, known as “greenzoning,” is currently being pioneered in Los Angeles County. Greenzoning could potentially be included as a part of the Healthy Air Living outreach program to individual businesses, schools, cities, and counties. A related option could be limiting gas powered equipment use in certain zones to designated days of the week, similar to days allowed to water residential yards. This approach was recently adopted by Burlingame for leaf blower use only. Cleaner electric equipment would have an advantage by still being able to be operated on the days or areas that gas powered equipment is limited. This strategy would also be a win-win by reducing noise nuisances in neighborhoods and near schools. The District could provide model ordinances to cities and counties to adopt to assist them in implementing this type of measure.

Risk-based Strategy Analysis

The emissions from this source category contribute 1.7% of average winter NOx emitted from stationary and area sources in the 2012 emission inventory. Lawn care emissions can have a potential health impact due to its widespread use in densely populated urban areas. The use of equipment and resultant emissions are typically more concentrated in areas of schools, parks, and commercial districts where lawn and garden upkeep require more frequent equipment use for a longer duration.

Lawn care emissions include criteria pollutants and their precursors, toxic air contaminants from engine emissions and fugitive sources, and PM 0.1 (ultrafine particles, or UFP) from engine emissions and work practices. As noted in Chapter 2 of this plan, PM 0.1 is a special concern for public health. In 2010, the District entered into a contract with UCSF-Fresno to conduct a pilot characterization of PM 0.1 and PM2.5 associated with emission plumes from vehicular traffic, lawn care equipment, and wood combustion in the Fresno/Clovis metro area. The pilot study found very high PM 0.1 emission concentrations from lawn care engines, indicating a higher than assumed risk to individuals near the engine exhaust plumes and a considerably higher risk to workers breathing these particles at the epicenter of the plumes. The District will be building upon this pilot study to provide exposure modeling and risk assessment. The extended project will measure PM2.5 generated by conventional lawn care equipment and speciate collected PM2.5 samples. The resultant mass and chemical species assessment will provide a much more solid assessment of the risk facing lawn care workers. It will also help establish a firmer empirical basis for estimating the contribution of small lawn care engines to ambient concentrations of PM2.5.

Health effects resulting from exhaust emissions, fugitive dust, and noise generated by lawn equipment range from mild to serious, depending on exposure and the sensitivity of the individual exposed. In particular, lawn and landscape operators are exposed to potentially hazardous concentrations of carbon monoxide (CO), PM2.5, and ultrafine particles intermittently throughout their work day. Noise exposures may be high enough that operators are at increased risk of developing hearing loss. While exposures to CO, PM, and noise may not have immediate, acute effects, the potential health impacts are potentially greater for chronic effects.

Describing the impacts on the public at large is more difficult than for workers because exposures, and reactions to those exposures, are much more variable. Exposure could occur from being in the vicinity or downwind of an operator of, for example, residents whose lawns are being serviced, persons in commercial buildings whose landscapes are being maintained or serviced, and persons within a few blocks of the source. In addition, some sensitive individuals may experience extreme physical reactions, mostly respiratory symptoms such as bronchial spasms, from exposure to bioaerosols found in fugitive dust emissions, which include pollen fragments, mold spores, and endotoxins. Lawn care emissions are also concentrated in areas where Valley residents live, work, and go to school. This proximity leads to a potentially high intake fraction from this equipment, defined as that fraction of engine emissions that are actually inhaled by individuals. The timing, proximity, and potency of emissions from lawn care equipment can thus pose a significant health risk to operators and the public.

Noise from lawn care equipment, especially leaf blowers, has the potential of causing hearing loss and other adverse health impacts. While the majority of the public is likely exposed to noise as bystanders, given the widespread use and the increasing density of cities and towns, there is presently no way of knowing for certain how many are actually exposed, because of the lack of studies. Regulating the use of lawn care equipment could prove to be a win-win from an emissions standpoint as well as for noise concerns.

Control Measure Commitments

The following is a summary of recommended commitments for SC 001.

Regulatory Action

There are no recommendations for regulatory action at this time. Further study of this source category through the noted emissions inventory review and control technology demonstration projects to determine if a regulatory approach is appropriate is recommended.

Incentive Action

There are no recommendations for new incentive programs at this time. The recommendation is to continue to run the *Clean Green Yard Machine residential lawn mower incentive program* as well as evaluate the commercial lawn care equipment technologies capable of reducing emissions in the Valley as they are being demonstrated as a part of the Cordless Zero-Emission Commercial Lawn and Garden Equipment Demonstration Program. The program participants will use the equipment in real world settings to verify equipment durability and performance, battery capacity, and battery charge time. In addition, the participants would be responsible for providing monthly data and feedback to the District. At the conclusion of the program, the District and the technology demonstrators would work together to complete a final report and submit the findings to ARB. Based on these findings and feedback from program participants, the District commits to developing more incentive program options for commercial operators to assist in deploying zero emissions lawn and garden technologies.

Technology Advancement Action
There are no recommendations for new technology advancement programs at this time. The recommendation is to continue the current technology advancement program for cordless zero-emission technologies. In May 2012, the District solicited proposals from interested equipment manufacturers and vendors to partner with the District and implement the *Cordless Zero-Emission Commercial Lawn and Garden Equipment Demonstration Program*. The District finalized a contract with the selected equipment manufacturers and vendors and released a Request For Applications in August. The demonstration program has generated significant interest and support from the commercial lawn and garden applicators, which include businesses that provide landscaping services and organizations that have their own maintenance team. District staff is currently working with 61 participants to complete the contract phase and order the cordless zero-emission commercial lawn and garden equipment for the Demonstration Program. Participants will begin using the equipment and provide feedback on the performance and durability of the cordless zero-emission commercial lawn and garden equipment.

Policy Initiatives
The District is not currently supporting any policy initiatives specific to lawn care equipment, and there are no recommendations for new policy initiatives for these sources.

Education and Outreach
The District currently provides education and outreach regarding the use of lawn care equipment through the Healthy Air Living program. The District also has a robust education and outreach program for regulated sources through the Small Business Assistance program, Permit Stakeholder Meetings, Compliance Assistance Bulletins, and public notices for public workshops and public hearings. There are no recommendations for new education and outreach programs beyond those that the District currently supports, as discussed above.

D.7.2 SC 002 Energy Efficiency

Source Category

This category does not include specific emissions inventory sources in the Valley, but, rather, the opportunity to reduce emissions from all Valley sectors through the promotion of energy efficiency and conservation measures. Generally, emissions reductions could be obtained from reductions in electrical power generation or fuel through the implementation of such measures. Potential areas of focus include residential and commercial buildings, manufacturing and industrial facilities, agricultural operations, and oil/gas production and processing facilities.

Emission Reduction Opportunities

Energy use is not a regulated activity; however, emissions from the generation of electricity are regulated at the power plant. Overall, electricity generation in California is relatively clean when compared to emission factors (criteria pollutants and greenhouse gases (GHG)) from other states. California has been on the forefront of developing renewable energy sources, and has implemented regulations to ensure cleaner non-renewable energy. Whereas coal-fired electricity generation provides a significant percentage of electricity in other parts of the country, especially the eastern states, California relies more heavily on natural gas-fired power plants, which have lower emission rates for criteria pollutants and GHGs.

California imports 31% of its electricity from surrounding states (2009 data from California Energy Commission (CEC)). The state's four major utility companies use this electricity, as well as resources from around the state to supply continuous, reliable electricity to its customers. The inter-related nature of California's electricity transmission leads to a complex relationship between local energy efficiency programs and emissions reductions. Energy dispatch for needed demand is time and market dependent; the closest plant does not necessarily supply energy to the closest demand. In some cases, peak energy demand is met for areas outside the Valley, including Los Angeles and San Diego, with marginal (peaker) power plants within the Valley. Likewise, Valley demand may be met with electricity from marginal power plants outside the Valley. To complicate matters, which marginal plant is used can depend on the time of day, the minute-by-minute energy market, or other highly variable factors.

In 2010, the CEC commissioned an evaluation of energy usage and potential reductions from energy efficiency and renewable energy measures. Using sophisticated dispatch modeling, Synapse Energy Economics Inc. (Synapse) was able to estimate NOx emissions reductions for renewable energy and energy efficiency projects within California and within each of the four major utility companies.[45] In preliminary model runs, Synapse showed that approximately 45 pounds of NOx could be reduced for each gigawatt of displaced base load electricity. Likewise, 76 pounds of NOx could be

[45] California Energy Commission. (2011, May). *Emission Reductions from Renewable Energy and Energy Efficiency in California Air Quality Management Districts: Final Project Report* (Draft). Synapse Energy Economics, Inc. for CEC Public Interest Energy Research (PIER) Program. CEC-XXX-XXX-XXX.

reduced for each gigawatt of displaced peak load electricity displaced by targeted energy efficiency efforts during peak demand hours.

Recently, EPA released a roadmap manual[46] to assist state, tribal, and local air agencies with quantifying and including emissions reductions from energy efficiency and renewable energy in State Implementation Plans (SIPs). The document focuses on emission benefits from energy policies and programs in the electric power sector. The District will focus its future efforts in realizing NOx emissions reductions for potential SIP credit during the upcoming ozone attainment planning process. The complex nature of electricity transmission and dispatch, combined with import and export of electricity in and out of the District and California, will require sophisticated energy modeling to pinpoint emissions reductions attributable to potential energy efficiency and renewable energy control measures.

The District's involvement in energy efficiency and renewable energy is guided by its Regional Energy Efficiency Strategy (REES), which was adopted in January 2010.[47] This policy document identifies the District's commitment to fostering energy efficiency and clean energy alternatives as opportunities for emissions reductions. The District has initiated several projects that exemplify this policy guidance.

Risk-based Strategy Analysis

The emission inventory for this source category is not quantified as discussed above.

Control Measure Commitments

The following is a summary of recommended commitments for SC 002.

Regulatory Action

The District's analysis did not identify any technologically feasible and cost effective potential controls. Therefore, there are no recommendations for regulatory actions.

Incentive Action

The District currently has incentive programs aimed at reduced energy use in the Valley. To date, the projects include the following:

- The administration of approximately $4 million in federal and state Energy Efficiency and Conservation Block Grant funds made available to 37 small jurisdictions in the Valley. The majority of the funding was used to retrofit municipal facilities with lighting and other cost effective energy efficiency retrofits;
- The funding of an innovative pilot program to assess the potential to operate more efficiently, thus saving money and using less energy; and

[46] U.S. Environmental Protection Agency: Incorporating Energy Efficiency/Renewable Energy in State and Tribal Implementation Plans. (2012). Retrieved July 10, 2012 from http://www.epa.gov/airquality/eere/

[47] San Joaquin Valley Air Pollution Control District. (2010). *Approval of the District's Regional Energy Efficiency Strategy*. Memorandum to the SJVAPCD Governing Board. Public Hearing, January 21, 2010. http://www.valleyair.org/Board_meetings/GB/agenda_minutes/Agenda/2010/January/Agenda_Item_7_Jan_21_2010.pdf

- The funding of an outreach program showing governmental and service organizations the benefits of "going green." This program started in Stockton through the Stockton Chamber of Commerce, and with the District's help has expanded to the central and southern San Joaquin Valley.

While there are no recommendations for new incentive programs at this time, the recommendation is to continue supporting existing incentive programs.

Technology Advancement Action

The District's Technology Advancement Program responds to the long-term need for the zero- and near-zero-emission transport of goods and people by informing near-term strategies to overcome the Valley's significant challenges. Two of the three focus areas for FY 2012–2013 are renewable energy and waste solutions, which take into account energy efficiency. The recommendation is to continue to pursue technology advancement programs that may result in further reducing emissions in the Valley.

Policy Initiatives

Consistent with the District's 2012 Legislative Platform, the recommendation is to continue to work with stakeholders and state agencies to expand net metering and feed-in tariffs for use of solar and other renewable energy sources, promote energy efficiency programs for energy end users that will result in lower emissions and a more stable electrical distribution system, and develop measures that incentivize and encourage low-emission technologies for use of waste gas as an alternative to waste-gas venting or flaring.

Education and Outreach

The District currently provides a robust education and outreach program for regulated sources through the Small Business Assistance program, Permit Stakeholder Meetings, Compliance Assistance Bulletins, and public notices for public workshops and public hearings. Many of the previously-identified actions and commitments rely heavily on the existing District outreach and communication efforts and will continue with those efforts.

D.7.3 SC 003 Fireworks

Source Category
This category consists of fireworks sold and/or used in the Valley. This includes consumer fireworks for home displays as well as professional products for use by licensed operators in public displays.

Emission Inventory
The emission inventory for this category has not been quantified.

Regulatory Evaluation

How would District SC 003 compare with federal or state rules and regulations?

State fireworks law is contained in the California Health and Safety Code, Section 12500 – 12759, and regulations are encoded as Title 19, California Code of Regulations, Chapter 6. The Health and Safety Code section 12505 requires the designation of "dangerous" for fireworks containing certain chemicals (such as arsenic sulfide), effectively prohibiting their use in consumer (i.e. "safe and sane") fireworks.

The Office of the State Fire Marshall (SFM) is the California agency with authority to classify fireworks in the state, including the classification of consumer fireworks. Pyrotechnic operators who discharge fireworks in public displays must apply to the SFM for the necessary license, and report in advance of and after completion of displays. The SFM also collects and disposes of seized illegal fireworks.

No federal guidance has been identified for this source category under the federal Alternative Control Techniques (ACT), New Source Performance Standards (NSPS), National Emission Standards for Hazardous Air Pollutants (NESHAP), Maximum Achievable Control Technology (MACT), and Control Techniques Guidelines (CTG).

How would District SC 003 compare to rules in other air districts?

SCAQMD Rule 219 (Equipment not Requiring a Written Permit Pursuant to Regulation II) exempts pyrotechnic equipment, special effects or fireworks paraphernalia equipment used for entertainment purposes from permit requirements. Additionally, fireworks and fireworks displays and pyrotechnics used for creation of special effects at theme parks are excluded from the open burning requirements of SCAQMD Rule 444 (Open Burning), and prohibitory Rule 401 (Visible Emissions) and Rule 402 (Nuisance) do not exempt fireworks displays.

No references to the use of fireworks or pyrotechnics for entertainment purposes were identified for the BAAQMD or the SMAQMD.

Emission Reduction Opportunities

Fireworks usage in the Valley is limited to occasional displays at a small number of entertainment venues (minor league sporting events, for example) and Independence Day/July 4th. On July 4th, with wide-spread consumer fireworks use, the Valley's air monitors typically show peak PM2.5 concentrations for several hours on the evening of July 4th and into July 5th. These hourly PM2.5 concentrations are much higher than normal PM2.5 concentrations during the summer, although 24-hour average PM2.5 concentrations on July 4th and 5th do not always go above the level of EPA's standard. In addition, exceedances of the National Ambient Air Quality Standards (NAAQS) due to fireworks qualify as an exceptional event under federal regulations and, with proper documentation and EPA concurrence, do not count against an area's attainment status.[48] However, the clear relationship between fireworks activity and ambient PM2.5 levels; the location of emissions in populated areas; and the fact that the PM2.5 species associated with fireworks are health-impacting metals and carbons all demonstrate the value of reducing emissions from fireworks as part of the District's Risk-based Strategy. Fireworks emissions are reduced by limiting the use of fireworks. For several years, the District has utilized public education to inform residents of the risks associated with firework emissions, and the dangers to sensitive populations. Enhancements to future outreach efforts may include partnering with other state and local agencies' outreach efforts.

Despite the strong public affinity for July 4th fireworks, many parts of the country are moving away from pyrotechnic fireworks displays and towards laser light-based shows – particularly in regions with severe drought conditions and extreme fire danger. According to the International Laser Display Association, laser-light-based shows are gaining steadily in popularity as more and more communities are moving in this direction. Several companies in California and throughout the country are engaged in the business of incorporating laser-light based shows into 4th of July celebrations.

In spring 2012, the District offered an incentive program to provide up to 50% of the cost of a municipal laser-light based display for existing annual 4th of July displays where the grantee is willing to commit to 100% elimination of pyrotechnic fireworks at the event. Due to the timing, the District was not able to fund any shows for 2012. The District is interested in reviewing and again providing the program in 2013.

Some fireworks are lower-emitting than others. Disneyland Theme Park started using a patented air launch pyrotechnics system in 2004 to reduce noise and pollution. Use of such a system appears to be limited, and is likely most effective in situations where fireworks displays are frequent enough to justify the cost and permanent installation.

[48] Treatment of Air Quality Monitoring Data Influenced by Exceptional Events, 40 C.F.R. § 50.14 (b)(2), (2011).

Risk-based Strategy Analysis

The emissions from this source category have not been quantified. Fireworks displays and their associated emissions are occasional and occur primarily in the summer time. Reducing these emissions will not significantly accelerate attainment because exceedances of the PM2.5 NAAQS occur during winter months.

However, the PM2.5 species associated with fireworks are primarily metals, which, as noted in Chapter 2, are relatively high in toxicity and health-impacting. During a professional display PM2.5 levels can be sustained above 1,000 µg/m³.[49] Particulate matter from ground-level fireworks includes aerosolized metals used as fuel and coloration, and may cause exposures exceeding occupational exposure guidelines for Barium, Strontium, Copper, and Lead.[50] Consumer fireworks emissions occur in populated areas. Although these emissions are not long-term, these emissions can be very high for a period of several hours. For these reasons, reducing emissions from fireworks and educating the public about the health impacts of fireworks is consistent with the District's Risk-based Strategy.

Control Measure Commitments

The following is a summary of recommended commitments for fireworks.

Regulatory Action

Fireworks use is infrequent and isolated to the summer months, and since there is a very strong public affinity for fireworks displays, there are no recommendations for regulatory action at this time.

Incentive Action

As discussed above, the District launched an incentive program for municipal laser-light shows to replace fireworks displays in 2012, but due to timing issues, was not able to fund any shows. Recommendations for incentive action are to continue this effort with continued research to make any needed program improvements, and making the program available again in future years. Another recommendation would be to seek partners earlier in the year, and consider sponsoring shows combining a small amount of fireworks with an otherwise predominantly laser driven show.

Technology Advancement Action

There are no recommendations for technology advancement actions at this time because the technologies discussed already exist and are in use in some areas. Through its Technology Advancement Program, the District will continue to seek potential feasible and low-cost technologies that may provide for additional emission reduction opportunities in this category.

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[49] Joly, A., Smargiassi, A. Kosatsky, T., Fournier, M., Dabek-zlotorzynska, E., Celo, V., Mathieu, D., Sevranckx, R., D'amours, R., Malo, A., and Brook, J. (2910) Characterization of particulate exposure during fireworks displays. Atmospheric Environment, 44, 4325-4329. doi:10.1016/j.atmosenv.2009.12.010

[50] Croteau, G., Dills, R., Beaudreau, M., and Davis M. (2010) Emission factors and exposures from ground-level pyrotechnics. *Atmospheric Environment*, 44, 3295-3303. doi:10.106/j.atmosenv.2010.05.048

Policy Initiatives
On August 16, 2012, the District Governing Board voted to adopt a position in opposition of California Senate Bill (SB) 1468 (Calderon), which would have allowed for the sale of safe and sane fireworks during the period of December 6th to January 2nd for two years, as a pilot for considering whether such an expanded use of fireworks should continue. This legislation would have thus expanded the use of fireworks to winter months when the Valley experiences stagnant conditions that trap particulates for extended periods of time. Given the potential for extreme adverse impact to public health, the District opposed SB 1468. Ultimately, the bill is not being enacted, likely for financial reasons associated with the data collection and analysis associated with the bill.

No additional policy initiatives are proposed at this time. The recommendation is to take a policy stance opposing any expansion of fireworks use in the Valley, particularly if such expansion were to affect the winter months when there are already high particulate levels.

Education and Outreach
The District currently has a robust education and outreach program, as discussed above, to encourage residents to avoid or reduce consumer fireworks use. The recommendation is to continue current education and outreach activities and possibly seek to partner with local police and fire departments in this messaging, since these entities also encourage residents to avoid or limit fireworks use (especially illegal fireworks use). Another recommendation is to generate interest in the District's municipal incentive program by sponsoring a technology demonstration of lasers at a pre-July 4th public event, such as a minor league sporting event, and invite staff and public representatives from Valley municipalities who might consider laser light shows for their local July 4th celebrations. Such a demonstration could showcase the laser technology before July 4th to improve public acceptance of reducing fireworks.

D.7.4 SC 004 Sand and Gravel Operations

Source Category

Particulate matter emissions from sand and gravel operations occur as excavated aggregate material is conveyed, screened, crushed, and stored. This source category is not subject to RACT because this is not a volatile organic compound (VOC) rule and is not a Control Techniques Guidelines (CTG) rule.

Emission Inventory

Pollutant	2007	2012	2014	2015	2016	2017	2018	2019
	Annual Average - Tons per day							
PM2.5	0.077	0.077	0.081	0.083	0.086	0.089	0.092	0.093
NOx	0	0	0	0	0	0	0	0
SOx	0	0	0	0	0	0	0	0
	Winter Average - Tons per day							
PM2.5	0.074	0.074	0.078	0.080	0.083	0.086	0.088	0.089
NOx	0	0	0	0	0	0	0	0
SOx	0	0	0	0	0	0	0	0

Regulatory Evaluation

How would SC 004 compare with federal rules and regulations?

"EPA promulgated its New Source Performance Standard (NSPS), 40 CFR Part 60, established under Section 111 of the Clean Air Act on December 16, 1975 (40 FR 58416) as means to regulate stationary sources of particulate matter (PM) emissions. Subpart OOO of the NSPS standard covers nonmetallic mineral processing, which includes regulations for emissions from operating equipment that was manufactured, modified or reconstructed after August 31, 1983. NSPS Subpart OOO was further revised on April 28, 2009. Processing equipment regulated under Subpart OOO affecting the crushed stone, sand and gravel industry includes crushers, grinding mills, screens, bucket elevators, bagging operations, storage bins, enclosed truck and railcars and transfer points on belt conveyors."[51] There are no other federal guidelines, including CTG, Maximum Achievable Control Technology (MACT), and National Emission Standards for Hazardous Air Pollutants (NESHAP), that apply to the control of particulate matter from sand and gravel operations.

[51] National Stone, Sand and Gravel Association: New Source Performance Standards, Subpart OOO. (2012). Retrieved April 4, 2012 from http://www.nssga.org/environment/nsps.cfm

How would SC 004 compare to rules in other air districts?

SCAQMD Rule 1157 (PM10 Emission Reductions from Aggregate and Related Operations) identifies requirements for general performance standards; loading, unloading, and transferring; conveyor; crushing equipment; screening equipment; storage piles; internal roads; and track-out. Such operations are also covered by SCAQMD Rule 403 (Fugitive Dust), which also identifies Best Available Control Measures (BACM) applicable to all construction activity sources. Other than new source review rules, specific rules were not identified in BAAQMD, SMAQMD, and VCAPCD. As described below, the District has regulated these sources under District Rules 8011, 2201, and 4101 for many years, including requiring Best Available Control Technology (BACT) for new and modified facilities.

Emission Reduction Opportunities

Generally, sand and aggregate materials are wet or moist when handled and emissions are often negligible. For processes where water is not an appropriate method for minimizing emissions, baghouse and filter technology and achieved-in-practice controls are generally sufficient to limit visible dust emissions to less than 20 percent opacity as required by District Rule 8011 (General Requirements for Regulation VIII) and District Rule 4101 (Visible Emissions).

While other districts have specific rules for aggregate and related operations (SCAQMD Rule 1157), the ultimate limits for dust emissions is the same as opacity and visible emissions standards used for District operations. SCAQMD provides guidance for specific activities (e.g. loading, conveying, crushing, screening, and storage), but the emissions limits are the same as the District’s limits. The District reviews any new or modified stationary source under Rule 2201 (New and Modified Stationary Source Review), which in most cases will trigger Best Available Control Technology (BACT) requirements, thus requiring operators to apply the best controls to reduce emissions during operational activities including crushing, screening, and conveying.

Risk-based Strategy Analysis

The emissions from this source category contribute 0.1% of average winter PM2.5 emitted from stationary and area sources in the 2012 emission inventory. As illustrated in the emission inventory table above, the emission inventory is relatively small and consistent throughout the year, with no elevated emission levels in winter months. Additionally, the emissions are geologic in nature, and, as described in Chapter 2, do not contribute significantly during the peak winter season, and are of low relative toxicity.

Control Measure Commitments

The following is a summary of recommended commitments for SC 004.

Regulatory Action

The District’s analysis did not identify any technologically feasible and cost effective potential controls. Therefore, there are no recommendations for regulatory actions.

Incentive Action
There are no incentive action recommendations for this sand and gravel operations.

Technology Advancement Action
There is no recommendation for a new technology advancement project for this source category. Through its Technology Advancement Program, the District will continue to seek potential feasible and low-cost technologies that may provide for additional emission reduction opportunities in this category.

Policy Initiatives
The District is not currently supporting any policy initiatives specific to sand and gravel operations and there are no recommendations for new policy initiatives for this source at this time.

Education and Outreach
The District currently provides a robust education and outreach program for regulated sources through the Small Business Assistance program, Permit Stakeholder Meetings, Compliance Assistance Bulletins, and public notices for public workshops and public hearings. There are no recommendations for new education and outreach efforts for these sources.

D.7.5 SC 005 Asphalt/Concrete Operations

Source Category

This source category includes emissions from asphalt and concrete production operations. Cement concrete production includes cement manufacturing and concrete production. There are only a few cement plants in California, but none within the Valley. However, many operations contribute to potential emissions associated with concrete production, which include the blending of cement powder, water, sand, and coarse aggregate. Similarly, there are operations producing asphalt concrete, which is primarily used for paving parking lots and on-road surfaces and is made by hot-mixing asphalt with size-graded aggregate in drums or batches. If a cement production plant were to be built within the Valley, it would be reviewed and evaluated under District Rule 2201 (New and Modified Stationary Source Review) and would trigger Best Available Control Technology (BACT) requirements for equipment and processes associated with the production of cement.

Emission Inventory

Pollutant	2007	2012	2014	2015	2016	2017	2018	2019
	Annual Average - Tons per day							
PM2.5	1.01	1.01	1.07	1.11	1.14	1.18	1.22	1.24
NOx	0.19	0.16	0.17	0.17	0.18	0.18	0.19	0.19
SOx	0.30	0.30	0.32	0.33	0.34	0.35	0.36	0.36
	Winter Average - Tons per day							
PM2.5	1.00	1.00	1.06	1.10	1.13	1.17	1.20	1.23
NOx	0.16	0.14	0.15	0.15	0.16	0.16	0.17	0.17
SOx	0.29	0.29	0.31	0.32	0.32	0.33	0.34	0.35

Regulatory Evaluation

How would SC 005 compare with federal rules and regulations?

Because many of the same processes are implemented at sand and gravel operations (crushing, grinding, conveying, mixing of aggregate), EPA's New Source Performance Standard (NSPS), 40 CFR Part 60 Subpart OOO, Standards of Performance for Nonmetallic Mineral Processing Plants, is also applicable to asphalt and concrete operations. NSPS Subpart I, Standards of Performance for Hot Mix Asphalt Facilities, and NSPS Subpart UU, Standards of Performance for Asphalt Processing and Asphalt Roofing Manufacturing, are also applicable to asphalt operations.

Asphalt processing is also subject to National Emission Standards for Hazardous Air Pollutants (NESHAPs), 40 CFR Part 63 Subpart LLLLL, Asphalt Processing and Asphalt Roofing Manufacturing (major sources), and Subpart AAAAAAA, Asphalt Processing and Asphalt Roofing Manufacturing (area sources).

How would SC 005 compare to rules in other air districts?

SCAQMD Rule 1157 (PM10 Emission Reductions from Aggregate and Related Operations) identifies requirements for general performance standards; loading, unloading, and transferring; conveyor; crushing equipment; screening equipment; storage piles; internal roads; and track-out. Such operations are also covered by SCAQMD Rule 403 (Fugitive Dust) which also identifies Best Available Control Measures (BACM) applicable to all construction activity sources. SCAQMD provides only guidance for minimizing emissions during these activities, but, ultimately, the emissions limits are the same as those being achieved under District rules. Similar rules were not identified in BAAQMD, SMAQMD, and VCAPCD.

Emission Reduction Opportunities

Emissions from concrete production operations and asphalt concrete operations are minimized by achieved-in-practice controls meeting the opacity requirements of District Rule 4101 (Visible Emissions) and Rule 2201 (New and Modified Stationary Source Review). For concrete production operations, this technology includes baghouses for screens, crushers, and concrete weight batchers; bin vent filters for concrete and fly ash silos; and water spray for other emissions points. For asphalt operations, achieved-in-practice controls include oil mist collectors and "blue smoke" control with electrostatic precipitators or filter packs. Dryers used for drying aggregate in the asphalt production process are regulated under District Rule 4309 (Dryers, Dehydrators, and Ovens), which limits NOx and CO to 4.3 and 42 ppmv, respectively, for gaseous-fuel fired units.

Specific to asphalt operations, warm-mix asphalt technologies show promise in reducing emissions associated with the production of asphalt for paving projects when compared to hot-mix asphalt. Both mechanical (foaming) and additive (chemical and organic) technologies "allow the producers of asphalt pavement material to lower the temperatures at which the material is mixed and placed on the road."[52] Lower temperatures—50 to 100 degrees Fahrenheit below what is necessary for hot-mix asphalt—result in lower fuel consumption, decreased production of greenhouse gases, lower criteria pollutant emissions, and lower fugitive VOC emissions during application. The amount of emissions reductions is dependent on the additive or process used[53], but one additive manufacturer claims reductions of 30% (VOC), greater than 30% (PM), and greater than 50% (NOx) in emissions measured at the plant stack.[54] The same manufacturer also claims more than 45% reduction in CO2 emissions.

Warm-mix asphalt, while widely used in Europe, is relatively new in the United States. There have been many demonstration projects throughout the U.S. and California, and

[52] National Asphalt Pavement Association, Warm Mix Asphalt Technical Working Group: Warm Mix Asphalt Takes Off. (2012). http://warmmixasphalt.com/

[53] Jones, D., Wu, R., Tsai, B, Barros, C.B., Peterson, J., (2011). *Key Results from a Comprehensive Accelerated Loading, Laboratory, and Field Testing Study on Warm-Mix Asphalt in California.* Proceedings, 2nd International Warm-Mix Conference, St. Louis, Missouri, October 11–13. http://www.asphaltpavement.org/big_files/11mwmx/Papers/WM19_Jones.pdf

[54] MeadWestvaco Corporation [MWV]: Evotherm® Warm Mix Asphalt (2012). http://www.meadwestvaco.com/SpecialtyChemicals/AsphaltAdditives/MWV002106

there is ongoing research to evaluate long-term durability, to verify emissions reductions, and to develop best practices for the use of warm-mix asphalt. The California Department of Transportation (Caltrans), in conjunction with the University of California, Davis, has been investigating implementation issues specific to the use of warm-mix asphalt in California. Caltrans already uses warm-mix asphalt for projects requiring nighttime work or application in cooler temperatures. Caltrans has also issued a contractor-permissive specification that allows the use of warm-mix asphalt for paving projects as conditions and requirements allow. Despite the general acceptance of warm-mix asphalt technologies by Caltrans, use by local jurisdictions has not been well-received; cost and unfamiliarity with the technology remain as barriers to technology penetration.

Of the emissions inventory for this category, approximately 50% of the PM2.5 emissions, 80% of the NOx emissions, and virtually all of the SO2 emissions are attributable to asphalt concrete production. As of August 2012, there are 22 permitted asphalt production plants in the Valley. While the inventory from these existing plants represents a small portion of the overall inventory, the co-benefits of using warm-mix asphalt (reduced fuel use, reduced worker exposure to on-site emissions, improved compaction, and the ability to extend the paving season and pave in cooler temperatures) may make its use cost effective.

Risk-based Strategy Analysis

The emissions from this source category contribute 3.5% of average winter SOx, and 1.8% of average winter PM2.5 emitted from stationary and area sources in the 2012 emission inventory. As illustrated in the emission inventory table above, the emissions from this source category consist of a relatively small portion of the Valley inventory and do not have elevated emission levels in winter months. Additionally, the emissions are geologic in nature, and, as described in Chapter 2, do not contribute significantly during the peak winter season, and are of low relative toxicity.

Control Measure Commitments

The following is a summary of recommended commitments for SC 005.

Regulatory Action

There are no recommendations for regulatory actions for asphalt and concrete operations. Further study to evaluate the potential of using warm-mix asphalt instead of hot-mix asphalt in the Valley is recommended.

Incentive Action

There are no recommendations for incentive actions for asphalt and concrete operations at this time.

Technology Advancement Action
There are no recommendations for new technology advancement actions at this time. Through its Technology Advancement Program, the District will continue to seek potential feasible and low-cost technologies that may provide for additional emission reduction opportunities in this category.

Policy Initiatives
The District is not currently supporting any policy initiatives specific to asphalt and concrete operations. There are no recommendations for new policy initiatives specific to asphalt and concrete operations.

Education and Outreach
The District currently provides a robust education and outreach program for regulated sources through the Small Business Assistance program, Permit Stakeholder Meetings, Compliance Assistance Bulletins, and public notices for public workshops and public hearings. There are no recommendations for new education and outreach efforts for these sources.

D.7.6 SC 006 Almond Hulling/Shelling Operations

Source Category

This control measure source category would apply to almond hulling and shelling operations. Almonds are harvested from orchards and transported to almond processing facilities, where the almonds are hulled and shelled leaving the nut, or meat. Orchard debris, soil, and pebbles represent 10- 25% of the field weight of material brought to the almond processing facility. Clean almond meats are obtained as about 20% of the field weight. Processes for removing the debris and almond hulls and shells are potential sources of air emissions. The Valley harvests 86% of the almonds produced in California. Production has roughly doubled in the last decade, with the 2010/2011 crop year reaching 1.4 billion pounds.[55]

Emission Inventory

The emission inventory for this control measure source category includes the emissions from the SC 007 (Pistachio Hulling/Shelling Operations) source category for pistachio hulling and shelling operations.

Pollutant	2007	2012	2014	2015	2016	2017	2018	2019
	Annual Average - Tons per day							
PM2.5	0.075	0.081	0.084	0.086	0.087	0.089	0.091	0.093
NOx	0	0	0	0	0	0	0	0
SOx	0	0	0	0	0	0	0	0
	Winter Average - Tons per day							
PM2.5	0.049	0.052	0.054	0.056	0.057	0.057	0.059	0.060
NOx	0	0	0	0	0	0	0	0
SOx	0	0	0	0	0	0	0	0

Regulatory Evaluation

How would SC 006 compare with federal rules and regulations?

There are no specific federal guidelines applying to almond hulling/shelling operations in terms of Control Techniques Guidelines (CTG), Alternative Control Techniques (ACT), New Source Performance Standards (NSPS), National Emission Standards for Hazardous Air Pollutants (NESHAP), Best Available Control Technology (BACT), and Maximum Achievable Control Technology (MACT) for this category.

[55] The Tioga Group. (2012). *SJV Nut Industry Profile Preliminary Draft.* http://www.sjvcogs.org/pdfs/2012/Nut%20Industry%20030612.pdf

How would SC 006 compare to rules in other air districts?

No rules or Best Available Control Technology (BACT) guidelines were identified in other California air districts for this source category. Air districts researched included SCAQMD, BAAQMD, VCAPCD, and SMAQMD.

Emission Reduction Opportunities

Evaluation of emission reduction opportunities for almond hulling and shelling operations included a review of on-going research efforts, and the technologicial feasibility and cost effectiveness of Poly Tetra Fluoro Ethylene bags.

On-Going Research Efforts

Research is currently being conducted by Texas A&M University in partnership with almond harvesting equipment manufacturers, almond farmers, United States Department of Agriculture-Natural Resources Conservation Service (USDA-NRCS), and the District to compare "low dust" almond harvesters and an exhaust abatement device to conventional harvesters in the harvesting of almonds at a Valley farm. No differences were detected in the particle size distribution (PSD) characteristics of PM emitted from each harvester, with the exception of the exhaust abatement device, where large particles were efficiently captured by the cyclone. Emissions of total suspended particulates (TSP) and PM10 trended lower for all new harvesters and were significantly lower for most harvesters. There were significant reductions of PM2.5 ranging from 61-69% observed from the harvesters and a 95% reduction in PM2.5 from the Clean Air Concept cyclone. The results of these tests imply that new harvest technologies are able to reduce PM emissions without affecting product quality.

Poly Tetra Fluoro Ethylene Bags

District BACT guidelines for almond hullers and shellers require the use of a baghouse, which controls PM by moving the contaminated flow of air through bag type filters. The technology has been achieved in practice in the District. Standard polyester bags are the most commonly used type of bag for baghouses in the almond hulling/shelling industry. A layer of dust (dust cake) collects on the upstream side of these bags and filtering efficiency increases as the layer grows; however, they are not designed to provide high PM2.5 control. On the other hand, membrane type bags treated with Poly Tetra Fluoro Ethylene (PTFE) contain extremely small pores and filtering occurs on the bag surface instead of in a dust cake. These types of filters are capable of controlling 99.9%[56] of PM2.5 emissions, whereas baghouses with polyester bags control PM2.5 emissions by 95%-99%[57].

The costs of using baghouses with PTFE bags rather than standard polyester bags were calculated. The pressure drop across polyester and PTFE bags is about the same

[56] Baghouse: PTFE Filters. (2012). Retrieved March 15, 2012 from http://www.baghouse.com/products/dust-collector-filters/baghouse-filter/ptfe-filters/ as supported by EPA Air Pollution Control Technology Center, Verified Technologies. (2012).

[57] Roberts, C. (2009). *Information on Air Pollution Control Technology for Woody Biomass Boilers.* Northeast States for Coordinated Air Use Management and the EPA Office of Air Quality Planning and Standards.

so there should not be a significant increase in electrical costs by using one bag over another. Additionally, existing baghouses would not require modifications to accommodate PTFE bags so the increased cost lies solely in the cost of the bags. A PTFE bag typically costs $23, whereas a polyester bag costs $12. The lifetime of both bags is approximately 2 years. The following cost differential was calculated, with knowledge that some facilities in the Valley have up to 2-3 baghouses, each with 500 bags. District permits also require facilities to have replacement bags accounting for 10% of the total number of bags; therefore 550 bags will be used for the following calculations.

Additional Costs for using PTFE bags

550 bags x ($23/ PTFE bag - $12/ polyester bag) / 2 years = **$3,025/ year** (per baghouse)

3 baghouses x $3,025/ year = **$9,075/ year** (for 3 baghouses)

Potential PM2.5 Emission Reductions from using PTFE bags

The control efficiency for PM2.5 for polyester bags is assumed to be equivalent to the control efficiency for PM10.
(99.9% control efficiency from PTFE bags – 99% control efficiency of polyester bags)
= 0.9% additional control efficiency

2012 emission inventory is 0.081 tons/day
(0.081 tons/day PM2.5) x (0.9% additional control from using PTFE bags)
= **0.000729 tons/day reduced**

(0.000729 tons/day reduced from using PTFE bags) x (365 days/year)
=**0.266 tons/year reduced**

Potential Cost Effectiveness of using PTFE bags

101 baghouses in the Valley

(101 baghouses) x (PTFE bag costs $3,025/ year) = **$305,525/year**

($305,525/year) / (0.266 tons/year reduced) = **$1,148,590/ton**

The cost effectiveness of replacing polyester bags was also calculated at the lower end of the emission control efficiency scale (95%) with the PTFE bags to determine what a more conservative cost effectiveness analysis would reveal; the cost effectiveness from 95% polyester bags to 99.9% PTFE bags is $210,898/ton PM2.5 reduced.

Although the initial annual capital cost may seem relatively low; in terms of cost effectiveness, PTFE bags are not a cost effective alternative to standard bags. The additional control efficiency gains are in the fractions of tons of incremental emissions reductions. Additionally, as mentioned above, the emission inventory used in these calculations (0.081 tons/day PM2.5) includes the emissions of both almond hulling and pistachio hulling, meaning the actual inventory is smaller, and making the actual cost effectiveness even higher than calculated.

The cyclone is another technology in common use at Valley facilities for PM control in almond hulling/shelling; however, like baghouses with polyester bags, the technology primarily provides PM10 control. Additionally, cyclones typically achieve 80-85% control efficiency. Approximately 37 facilities in the Valley use cyclones to control PM emissions. Therefore, if these facilities were required to replace cyclones with baghouses, the cost effectiveness would be as follows:

Potential PM2.5 Emission Reductions for replacing cyclones with Baghouses with PTFE

The PM2.5 control efficiency for cyclones is assumed to be equivalent to the control efficiency for PM10
(99.9% control efficiency of baghouse – 85% control efficiency of cyclone)
= 14.9% additional control efficiency

2012 emission inventory is 0.081 tons/day
(0.081 tons/day PM2.5) x (14.9% control with use of baghouse)
= **0.012 tons/day reduced**

(0.012 tons/day reduced) x (365 days/year)
= **4.38 tons/year reduced**

Potential Cost Effectiveness

37 facilities to install baghouses at a minimum of $150,000 each

With a 10 year amortization factor and 10% interest, the annualized cost for a $150,000 baghouse would be:

(0.1627) x ($150,000) = **$24,405/year**

(37 facilities) x (capital cost of baghouse $24,405/year) = **$902,985/year**

($902,985/year) / (4.38 tons/year reduced) = **$206,161/ton**

Replacing the existing cyclones with baghouses with PTFE bags would cost $206,161/ton, which does not include additional costs of installation, electrical system upgrades, ductwork, demolition or disposal of the cyclone. Therefore, replacing cyclones with baghouses is not a cost effective control option. As previously stated, the emission inventory used in these calculations (0.081 tons/day PM2.5) includes the emissions of both almond hulling and pistachio hulling, meaning the actual inventory is smaller, and making the actual cost effectiveness even higher than stated.

At this time, the District's analysis indicates that there are no feasible opportunities for additional emission reduction regulatory strategies for this source category.

Risk-based Strategy Analysis

The PM2.5 emissions from this source category include the emissions from pistachio hulling and shelling operations (refer to SC 007). The emissions from these two source categories combined contribute 0.1% of average winter PM2.5 emitted from stationary and area sources in the 2012 emission inventory. As illustrated in the emission inventory table above, the emissions from this source category are relatively small throughout the year, with peak emissions occurring in summer months. Additionally, the emissions are geologic in nature, and, as described in Chapter 2, do not contribute significantly during the peak winter season, and are of low relative toxicity.

Control Measure Commitments

The following is a summary of recommended commitments for SC 006.

Regulatory Action

The District's analysis did not identify any technologically feasible and cost effective potential controls. Therefore, there are no recommendations for regulatory actions.

Incentive Action

The District does not currently fund any incentive programs specific to almond hulling operations; there are no recommendations for new incentive programs for almond hulling activities at this time. One potential opportunity was identified to reduce emissions, which was found to be not cost effective for current practices. The District could potentially fund the replacement of existing particulate matter control devices with baghouses that use the PTFE bags; however, an incentive program would be unlikely due to the high cost effectiveness and low emissions reductions.

Technology Advancement Action

There is no recommendation for a new technology advancement project for this source category. Through its Technology Advancement Program, the District will continue to seek potential feasible and low-cost technologies that may provide for additional emission reduction opportunities in this category.

Policy Initiatives

The District is not currently supporting any policy initiatives specific to almond hulling operations and there are no recommendations for new policy initiatives for these sources.

Education and Outreach

The District currently provides a robust education and outreach program for regulated sources through the Small Business Assistance program, Permit Stakeholder Meetings, Compliance Assistance Bulletins, and public notices for public workshops and public hearings. There are no recommendations for new education and outreach efforts for these sources.

D.7.7 SC 007 Pistachio Hulling/Shelling Operations

Source Category

This control measure source category would apply to pistachio hulling and shelling operations within the Valley. Pistachio hulling operations are permitted together under the same permit with the pistachio receiving and pre-cleaning portions of the operation. These operations use 1D-3D cyclones to control PM emissions from the pre-cleaning portion of the process, which is the Best Available Control Technology (BACT) standard. Typically pistachio processing equipment, located after the pre-cleaning section and prior to the pistachio dryers, is of a wet-process design; PM emissions from this portion of the operation are assumed to be negligible. California produces 98.5% of U.S. pistachios and production has expanded greatly in the last decade. Pistachio acreage doubled between 1997 and 2010, and production looks like it will continue to increase in the near future.[58] In the interest of identifying every possible strategy to reduce PM2.5 emissions, pistachio hulling and shelling operations were evaluated for potential opportunities to reduce emissions, see the discussion below.

Emission Inventory

The emission inventory for this category is included as a part of the emission inventory for the control measure source category for almond hulling. Refer to the emission inventory table presented in SC 006 for this combined inventory.

Regulatory Evaluation

How would SC 007 compare with federal rules and regulations?

There are no specific federal guidelines applying to pistachio hulling/shelling operations in terms of New Source Performance Standards (NSPS), Control Techniques Guidelines (CTG), Alternative Control Technology (ACT), Maximum Achievable Control Technology (MACT) and National Emission Standards for Hazardous Air Pollutants (NESHAP). Additionally, there are currently no EPA BACT determinations for pistachio hulling and shelling operations.

How would SC 007 compare to rules in other air districts?

This source category was compared to other air districts in California including SCAQMD, BAAQMD, SMAQMD, and VCAPCD; no rules were identified in other air districts regarding pistachio hulling and shelling operations.

[58] The Tioga Group. (2012). *SJV Nut Industry Profile Preliminary Draft.* http://www.sjvcogs.org/pdfs/2012/Nut%20Industry%20030612.pdf

Emission Reduction Opportunities

Pistachio shelling operations are served by a baghouse, which is the industry standard for shelling operations. While there is no specific BACT guideline for shelling operations, baghouses are typically attributed to a PM2.5 control efficiency of 95-99%. As discussed above in SC 006 (Almond Hulling/Shelling Operations), Poly Tetra Fluoro Ethylene (PTFE) bags have the potential to provide additional PM2.5 control when used in baghouses but are not cost effective due to the already high control efficiency of existing practices. Refer to SC 006 (Almond Hulling/Shelling Operations) for the cost effectiveness analysis.

Unlike almonds which are shaken on the ground and vacuumed off the soil during harvesting, pistachios are caught with a canvas catcher before they hit the ground, which allows for a very small amount of dust and debris in addition to the pistachios. Much of the PM emissions associated with the processing of pistachios occur during the pre-cleaning stage, which is controlled by cyclones. The hulling stage is a wet process as the nuts are floated on water; PM emissions from this portion of the operation are assumed to be negligible. At this time, the District's analysis indicates that there are no feasible opportunities for additional emission reduction regulatory strategies for this source category.

Risk-based Strategy Analysis

The PM2.5 emissions from this source category include the emissions from almond hulling and shelling operations (refer to SC 006). The emissions from these two sources combined contribute 0.1% of average winter PM2.5 emitted from stationary and area sources in the 2012 emission inventory. The emissions from this source category are relatively small throughout the year, with peak emissions occurring in summer months. Additionally, the emissions are geologic in nature, and, as described in Chapter 2, do not contribute significantly during the peak winter season, and are of low relative toxicity.

Control Measure Commitments

The following is a summary of recommended commitments for SC 007.

Regulatory Action

The District's analysis did not identify any technologically feasible and cost effective potential controls. Therefore, there are no recommendations for regulatory actions.

Incentive Action

The District does not currently fund any incentive programs specific to pistachio hulling operations; there is no recommendation for a new incentive program specific to pistachio hulling activities. One potential opportunity to reduce emissions was identified, but was found to be not cost effective for current practices (refer to the potential opportunities analysis for almond hulling for the cost effectiveness analysis). The District could potentially fund the replacement of existing PM control devices with baghouses that use the PTFE bags; however, an incentive program would be unlikely due to the high cost effectiveness and low emissions reductions.

Technology Advancement Action
There is no recommendation for a new technology advancement project for this source category. Through its Technology Advancement Program, the District will continue to seek potential feasible and low-cost technologies that may provide for additional emission reduction opportunities in this category.

Policy Initiatives
The District is not currently supporting any policy initiatives specific to pistachio hulling operations and there are no recommendations for new policy initiatives for these sources.

Education and Outreach
The District currently provides a robust education and outreach program for regulated sources through the Small Business Assistance program, Permit Stakeholder Meetings, Compliance Assistance Bulletins, and public notices for public workshops and public hearings. There are no recommendations for new education and outreach efforts for these sources.

D.7.8 SC 008 Agricultural Material Screening/Shaking Operations

Source Category

This control measure source category would be applicable to the handling and processing of agricultural materials in biomass, composting, and other agricultural material handling facilities.

Emission Inventory

The emission inventory for this category is accounted for in other control measure source categories. Refer to Appendix B for the emission inventory.

Regulatory Evaluation

How would SC 008 compare with federal rules and regulations?

There are no applicable federal standards and guidelines, such as Control Techniques Guidelines (CTG), Alternative Control Techniques (ACT), New Source Performance Standards (NSPS), National Emission Standards for Hazardous Air Pollutants (NESHAP), and Maximum Achievable Control Technology (MACT) for this source category. EPA Best Available Control Technology (BACT) requirements were also evaluated for potential opportunities; however no standards were listed for this category.

How would SC 008 compare to rules in other air districts?

SCAQMD Rule 1131.1 (Chipping and Grinding Activities) is the only rule in California identified to be applicable to agricultural material screening and shaking operations. Rule 1133.1 contains provisions to ensure that greenwaste is chipped or ground and used within 48 hours to prevent inadvertent decomposition. Biomass facilities are exempt from most requirements if the material temperature is maintained below 122 degrees Fahrenheit and the moisture content is less than 30%. Greenwaste kept with moisture content less than 30% is also exempt from these requirements. The limits of this rule are targeted at controlling volatile organic compound (VOC) emissions rather than NOx or PM2.5. District analysis did not identify similar rules, regulated categories, or BACT requirements at BAAQMD and SCAQMD.

Emission Reduction Opportunities

District analysis of potential emission reduction opportunities includes an evaluation of feasibility of wet suppression systems and enclosing conveyors and transfer points.

Wet Suppression System

A wet suppression system can achieve between 40-65% control of PM2.5[59]. In a wet suppression system, water is generally applied to all emissions units, transfer points, and raw material stockpiles to ensure that adequate moisture is provided to the operation to successfully reduce PM emissions. No emissions would be reduced by requiring a wet suppression system because this control is currently in use at all identified facilities in the Valley and would be required at any new facility triggering BACT under the New Source Review Rule 2201.

Enclosed Conveyors and Transfer Points

Enclosing conveyors and transfer points to limit the emissions of PM is a practice used in addition to water spray at seven facilities in the Valley. This control option would potentially reduce emissions at the drop or transfer points on the conveyors. However, in addition to the control efficiency of enclosed conveyors being unknown, conveyors are already operated so that they move very slowly to avoid entraining dust and limit visible emissions. Therefore, the potential to reduce emissions is minimal and reduced emissions would not be quantifiable.

At this time, the District's analysis indicates that there are no feasible opportunities for additional emission reduction regulatory strategies for this source category.

Risk-based Strategy Analysis

The emissions from this source category are accounted for in the emission inventory of other control measures. However, the emissions are geologic in nature, and, as described in Chapter 2, do not contribute significantly during the peak winter season, and are of low relative toxicity.
Refer to Appendix B for the emission inventory.

Control Measure Commitments

The following is a summary of recommended commitments for SC 008.

Regulatory Action

The District's analysis did not identify any technologically feasible and cost effective potential controls. Therefore, there are no recommendations for regulatory actions.

[59] Environmental Protection Agency [EPA]. (1995). *Compilation of Air Pollutant Emission Factors, Table B.2-3.* Research Triangle Park, NC.

Incentive Action
The District does not currently fund any incentive programs specific to reducing PM emissions from agricultural material screening and shaking operations. There are no recommendations for new incentive actions to reduce PM emissions from this source category.

Technology Advancement Action
There is no recommendation for a new technology advancement project for this source category. Through its Technology Advancement Program, the District will continue to seek potential feasible and low-cost technologies that may provide for additional emission reduction opportunities in this category.

Policy Initiatives
The District is not currently supporting any policy initiatives specific to the control of PM emissions from agricultural material screening and shaking operations, and there are no recommendations for new policy initiatives for PM control of these operations.

Education and Outreach
The District currently provides a robust education and outreach program for regulated sources through the Small Business Assistance program, Permit Stakeholder Meetings, Compliance Assistance Bulletins, and public notices for public workshops and public hearings. There are no recommendations for new education and outreach efforts for these sources.

D.7.9 SC 009 Tub Grinding

Source Category

This control measure source category would apply to operations using a tub grinder for agricultural material processing. Tub grinders are used to grind organic materials such as wood and agricultural materials for biomass fuel processing facilities, composting facilities, landscape material manufacturing (e.g. wood bark, mulch, etc.), or agricultural waste grinding (e.g. orchard removal, land clearing, etc.). These units are typically powered by diesel-fired internal combustion engines (ranging from 100 horse power (hp) to 1,600 hp) and mounted on wheels to be transportable, which allows the units to be towed to the jobsite where the piles of material are to be ground. In addition, these units may also be self-propelled and track-mounted; in this case the diesel engine powering the equipment is also used for motive power and is exempt from District permits since it is considered to be mobile equipment. The diesel engines powering the transportable units are subject to District Rule 4702 (Internal Combustion Engines) and Best Available Control Technology (BACT) Guideline 3.2.11. This control measure source category discussion addresses the particulate matter (PM) emissions from the loading, grinding, and conveying of the process materials.

Emission Inventory

Emissions generated by the engines of the tub grinders are accounted for as a part of the inventory for District Rule 4702 (Internal Combustion Engines). The fugitive particulate emissions from these units are accounted for as a part of the stationary and area inventory. See Appendix B.

Regulatory Evaluation

How would SC 009 compare with federal rules and regulations?

There are no specific federal guidelines applying to wood chipping and stump grinding operations in terms of New Source Performance Standards (NSPS), National Emission Standards for Hazardous Air Pollutants (NESHAP), Maximum Achievable Control Technology (MACT), Control Techniques Guidelines (CTG) or Alternative Control Techniques (ACT) for this category.

How would SC 009 compare to rules in other air districts?

Upon comparing this source category to other California air districts' rules, the only similar rule found was SCAQMD Rule 1131.1 (Chipping and Grinding Activities). Rule 1133.1 contains provisions for biomass facilities to maintain the material temperature below 122 degrees Fahrenheit and the moisture content to less than 30%; however, these limits are targeted at controlling volatile organic compound (VOC) emissions rather than NOx or PM2.5. Portable chipping and grinding, agricultural chipping and grinding, land clearing chipping and grinding, wood waste chipping and grinding, and palm chipping and grinding activities are exempt from Rule 1133.1. Analysis determined that no other air district regulates this source category. Air districts analyzed include BAAQMD, SMAQMD, and VCAPCD.

Emission Reduction Opportunities

No technologically feasible or alternative basic equipment are identified in the District's Best Available Control Technology (BACT) guidelines.

Currently, fugitive particulate emissions from transportable and self-propelled tub grinders are controlled with a water sprinkler system during loading, grinding, and unloading of the process materials to prevent visible emissions in excess of 5% opacity per Rule 2201 (New Source Review) and BACT guideline 6.4.2. Water sprinkler systems achieve between 40-65% control of PM2.5[60]. It is standard practice to use water spray on this type of equipment to meet the visible emission requirements of Rule 4101 (Visible Emissions); therefore, requiring water control for tub grinding operations would not result in additional emission reductions from this source category. A potential control option considered would be to require a baghouse to be installed onto the trailer of the equipment to capture fugitive PM emissions. Due to the large size of the additional equipment required to be installed onto the trailer and the limited space available, a baghouse is not technologically feasible for a transportable unit.

Risk-based Strategy Analysis

The emissions from this source category are accounted for in the emission inventory of other control measures. Refer to Appendix B for the emission inventory. The NOx emissions from this source category are from the engines used to power these units and are currently controlled by Rule 4702 (Internal Combustion Engines). Due to the nature of tub grinding activities, it is assumed that there are no elevated emission levels in the winter months. Additionally, the emissions are geologic in nature, and, as described in Chapter 2, do not contribute significantly during the peak winter season, and are of low relative toxicity.

Control Measure Commitments

The following is a summary of recommended commitments for SC 009.

Regulatory Action

The District's analysis did not identify any technologically feasible and cost effective potential controls. Therefore, there are no recommendations for regulatory actions.

[60] Environmental Protection Agency [EPA]. (1995). *Compilation of Air Pollutant Emission Factors, Table B.2-3.* Research Triangle Park, NC.

Incentive Action
The District does not currently fund any incentive programs specific to reducing PM emissions from tub grinding operations. There are no incentive action recommendations to reduce PM emissions from tub grinders at this time. The District analysis did not identify new technologies that could potentially reduce emissions from this source category.

Technology Advancement Action
There is no recommendation for a new technology advancement project for this source category. Through its Technology Advancement Program, the District will continue to seek potential feasible and low-cost technologies that may provide for additional emission reduction opportunities in this category.

Policy Initiatives
The District is not currently supporting any policy initiatives specific to the control of PM emissions from tub grinding operations and there are no recommendations for new policy initiatives for PM control of tub grinding operations.

Education and Outreach
The District currently provides a robust education and outreach program for regulated sources through the Small Business Assistance program, Permit Stakeholder Meetings, Compliance Assistance Bulletins, and public notices for public workshops and public hearings. There are no recommendations for new education and outreach efforts for these sources.

D.7.10 SC 010 Abrasive Blasting

Source Category

Abrasive blasting involves the cleaning or preparing of a surface by forcibly propelling a stream of abrasive material against such surface. Abrasive blasting can occur in a confined or an unconfined area, depending on the type of surface or application. Abrasive materials commonly used are walnut shells, various mineral or metal products, garnet, sand or aggregate, slag, steel grit abrasive, or steel shot.

Emission Inventory

Pollutant	2007	2012	2014	2015	2016	2017	2018	2019
	Annual Average - Tons per day							
PM2.5	0.22	0.22	0.24	0.24	0.25	0.26	0.26	0.27
NOx	0	0	0	0	0	0	0	0
SOx	0	0	0	0	0	0	0	0
	Winter Average - Tons per day							
PM2.5	0.22	0.22	0.23	0.24	0.25	0.25	0.26	0.27
NOx	0	0	0	0	0	0	0	0
SOx	0	0	0	0	0	0	0	0

Regulatory Evaluation

How would SC 010 compare with federal rules and regulations?

EPA promulgated management practices, and monitoring, recordkeeping, and reporting requirements for dry abrasive blasting within 40 CFR 63, Subpart XXXXXX–National Emission Standards for Hazardous Air Pollutants Area Source Standards for Nine Metal Fabrication and Finishing Source Categories.

Air pollution standards for abrasive blasting operations, or sandblasting, are set by statewide regulations, specifically California Code of Regulations, Title 17, Subchapter 6, Sections 92000 through 92530 (Abrasive Blasting). Furthermore, California Health and Safety Code (CH&SC), Section 41904 stipulates that no air district regulation can be stricter than the state standard. The state standard limits visible emissions from sandblasting operations to 20% opacity if within a permanent structure or 40% if outside a permanent structure.

How would SC 010 compare to rules in other air districts?

No rule from another air district has requirements beyond what is already required in state standards. BAAQMD Regulation 12, Rule 4 (Sandblasting), SCAQMD Rule 1140 (Abrasive Blasting), and VCAPCD Rule 74.1 (Abrasive Blasting) regulate abrasive blasting operations and activities, but all simply conform to the state standards.

Emission Reduction Opportunities

Achieved-in-practice Best Available Control Technology (BACT) controls for sandblasting include baghouses, filters, or cartridge dust collectors. With such technologies, 99% control efficiency can be achieved. As emissions sources, sandblasting operations within the District are subject to District Rule 4102 (Nuisance) and the standards of 17 California Code of Regulations (CCR) Section 92200 (opacity) and 17 CCR Section 92500 (performance standards such as CARB-certified abrasives).

Opportunities for further emissions reductions are limited because of the CH&SC stipulation that air districts cannot impose stricter rules on sandblasting operations. The District's analysis has determined that there are no feasible opportunities for additional emission reductions for this source category.

Risk-based Strategy Analysis

The emissions from this source category contribute 0.4% of average winter PM2.5 emitted from stationary and area sources in the 2012 emission inventory. As illustrated in the emission inventory table above, the emissions from this source category are consistently relatively small throughout the year, with no elevated emission levels in the winter months.

Control Measure Commitments

The following is a summary of the recommended commitments for SC 010.

Regulatory Action

The District's analysis did not identify any technologically feasible and cost effective potential controls. Therefore, there are no recommendations for regulatory actions.

Incentive Action

The District does not currently have an incentive program specific to abrasive blasting operations. There is no recommendation for a new incentive program for abrasive blasting operations at this time.

Technology Advancement Action

There is no recommendation for a new technology advancement project for this source category. Through its Technology Advancement Program, the District will continue to seek potential feasible and low-cost technologies that may provide for additional emission reduction opportunities in this category.

Policy Initiatives

The District is not currently supporting any policy initiatives specific to abrasive blasting and there are no recommendations for new policy initiatives for these sources.

Education and Outreach

The District currently provides a robust education and outreach program for regulated sources through the Small Business Assistance program, Permit Stakeholder Meetings, Compliance Assistance Bulletins, and public notices for public workshops and public hearings. There are no recommendations for new education and outreach efforts for these sources.

D.8 EMISSION INVENTORY CODES

Table D-19 Emission Inventory Codes

Control Measure	Emission Inventory Codes
Rule 4103 (Open Burning)	670-660-0262-9842; 670-660-0262-9856; 670-660-0262-9862; 670-660-0262-9874; 670-660-0262-9884; 670-660-0262-9888; 670-660-0262-9892; 670-662-0262-9866; 670-662-0262-9878; 670-662-0262-9882; 670-668-0200-9858; 670-668-0200-9872; 670-668-0200-9886; 670-995-0240-9848; 670-668-0200-9894
Rule 4104 (Reduction of Animal Matter)	420-995-6004-0000
Rule 4106 (Prescribed Burns)	670-666-0200-0000; 670-667-0200-0000; 670-664-0200-0000; 670-670-0200-0000
Rule 4203 (Particulate Matter Emissions from the Incineration of Combustible Refuse)	010-005-0243-0000
Rule 4204 (Cotton Gins)	420-418-6028-0000; 420-420-6028-0000
Rule 4307 (Boilers, Steam Generators and Process Heaters 2 – 5 MMBtu/hr)	010-005-0110-0000; 010-005-0124-0000; 010-005-0130-0000; 010-005-0300-0000; 010-005-1220-0000; 020-005-0110-0000; 030-005-0110-0000; 030-005-0124-0000; 030-005-0130-0000; 030-005-1220-0000; 030-005-1530-0000; 030-010-0110-0000; 030-010-0130-0000; 030-010-1220-0000; 030-010-1600-0000; 030-015-0110-0000; 030-015-0130-0000; 040-005-0110-0000; 040-005-1530-0000; 040-010-0100-0000; 040-010-0110-0000; 040-010-0120-0000; 040-010-0130-0000; 040-010-1000-0000; 050-005-0110-0000; 050-005-0122-0000; 050-005-0124-0000; 050-005-0130-0000; 050-005-0320-0000; 050-005-1100-0000; 050-005-1220-0000; 050-005-1510-0000; 050-005-1520-0000; 050-005-3220-0000; 050-010-0110-0000; 050-010-0120-0000; 050-010-0320-0000; 050-010-1220-0000; 050-010-1500-0000; 052-005-0110-0000; 052-005-0124-0000; 052-005-1220-0000; 052-010-0110-0000; 052-010-0120-0000; 052-010-1224-0000; 060-005-0110-0000; 060-005-0122-0000; 060-005-0124-0000; 060-005-0130-0000; 060-005-0142-0000; 060-005-0144-0000; 060-005-0320-0000; 060-005-1220-0000; 060-005-1510-0000; 060-005-1520-0000; 060-010-0100-0000; 060-010-0110-0000; 060-010-0120-0000; 060-010-0142-0000 The EICs are the same for Rules 4306/4320, 4307, and 4308; the three rules share a combined emission inventory. Baseline emissions from the 2008 and 2009 rule amendments of these rules were used to determine the percentage of emissions for each rule. Those respective percentages are applied to the combined inventory to get the individual emission inventories.
Rule 4308 (Boilers, Steam Generators and Process Heaters 0.075 to less than 2.0 MMBtu/hr)	The EICs are the same for Rules 4306/4320, 4307, and 4308; the three rules share a combined emission inventory. Baseline emissions from the 2008 and 2009 rule amendments of these rules were used to determine the percentage of emissions for each rule. Those respective percentages are applied to the

Control Measure	Emission Inventory Codes
	combined inventory to get the individual emission inventories. See Rule 4307 for the EICs.
Rule 4309 (Dryers)	430-422-7078-0000; 430-424-7006-0000; 430-995-7000-0000; 499-995-0000-0000; 499-995-5630-0000
Rule 4311 (Flares)	110-132-0130-0000; 110-132-0146-0000; 120-132-0136-0000; 130-132-0110-0000; 130-132-0136-0000; 310-320-0010-0000; 310-320-0110-0000; 310-320-0120-0000; 310-320-0130-0000; 320-320-0010-0000; 320-320-0110-0000; 320-320-0120-0000; 320-320-0130-0000
Rule 4313 (Lime Kilns)	Lime kilns are not included in the ARB emissions inventory. There are no lime kilns currently operating in the Valley.
Rule 4320 (AERO for Boilers, Steam Generators, and Process Heaters >5 MMBtu/hr)	The EICs are the same for Rules 4306/4320, 4307, and 4308; the three rules share a combined emission inventory. Baseline emissions from the 2008 and 2009 rule amendments of these rules were used to determine the percentage of emissions for each rule. Those respective percentages are applied to the combined inventory to get the individual emission inventories. See Rule 4307 for the EICs.
Rule 4352 (Solid Fuel Fired Boilers, Steam Generators, and Process Heaters)	010-005-0214-0000; 010-005-0218-0000; 010-005-0220-0000; 010-005-0240-0000; 010-005-0243-0000; 010-005-0254-0000; 020-005-0218-0000; 020-005-0230-0000; 030-005-0214-0000; 050-005-0214-0000; 050-005-0240-0000; 050-005-0254-0000; 052-005-0240-0000; 060-005-0240-0000; 060-005-0264-0000
Rule 4354 (Glass Melting Furnaces)	460-460-7037-0000; 460-460-7038-0000; 460-460-7039-0000
Rule 4550 (Conservation Management Practices)	620-614-5400-0000; 620-615-5400-0000;650-650-5400-0000; 650-651-5400-0000
Rule 4692 (Commercial Charbroiling)	690-680-6000-0000
Rule 4702 (Internal Combustion Engines)	010-040-0110-0000; 010-040-1200-0000; 020-040-0110-0000; 020-040-1200-0000; 030-040-0110-0000; 030-040-0124-0000; 030-040-1200-0000; 030-040-1210-0000; 040-040-0110-0000; 050-040-0012-0000; 050-040-0110-0000; 050-040-0124-0000; 050-040-1200-0000; 052-040-0110-0000; 052-040-1200-0000; 052-042-0110-0000; 052-042-1200-0000; 052-042-1200-0010; 052-042-1200-0011; 060-040-0110-0000; 060-040-0124-0000; 060-040-0142-0000; 060-040-0146-0000; 060-040-1100-0000; 060-040-1200-0000; 060-040-1210-0000; 060-995-1220-0000; 099-040-1200-0000
Rule 4703 (Stationary Gas Turbines)	010-045-0110-0000; 010-045-1200-0000; 020-045-0110-0000; 030-045-0110-0000; 040-045-0134-0000; 050-045-1200-0000; 060-045-0110-0000; 060-045-1200-0000
Rule 4802 (Sulfuric Acid Mist)	410-400-2058-0000
Rule 4901 (Wood Burning Fireplaces and Wood Burning Heaters)	610-600-0230-0000; 610-602-0230-0000
Rule 4902 (Residential	610-608-0110-0000

Control Measure	Emission Inventory Codes
Water Heaters)	
Rule 4905 (Natural Gas – Fired, Fan Type Residential Central Furnace)	610-606-0110-0000
Rule 8011 (General Requirements)	There is no specific emissions inventory associated with Rule 8011.
Rule 8021 (Construction, Demolition, Excavation, Extraction, and Other Earthmoving Activities)	630-622-5400-0000; 630-624-5400-0000; 630-626-5400-0000; 630-628-5400-0000; 630-634-5400-0000
Rule 8031 (Bulk Materials)	430-436-7006-0000; 430-436-7078-0000; 430-995-7064-0000
Rule 8041 (Carryout and Trackout)	The EICs are included in Rule 8061 (Paved and Unpaved Roads).
Rule 8051 (Open Areas)	650-652-5400-0000
Rule 8061 (Paved and Unpaved Roads)	640-635-5400-0000; 640-637-5400-0000; 640-639-5400-0000; 640-641-5400-0000; 640-643-5400-0000; 645-638-5400-0000; 645-640-5400-0000; 645-644-5400-0000; 645-648-5400-0000
Rule 8071 (Unpaved Vehicle Traffic)	645-645-5400-0000; 645-647-5400-0000. The ARB Emissions Inventory database does not contain emissions data on unpaved vehicle and equipment traffic areas.
Rule 8081 (Ag Sources)	645-646-5400-0000
SC 001 (Source Category: Lawn Care Equipment)	860-901-1100-1152; 860-901-1100-1153; 860-901-1100-1166; 860-901-1100-1167; 860-901-1100-1168; 860-901-1100-1169; 860-901-1100-1174; 860-901-1100-1175; 860-901-1100-1184; 860-901-1100-1185; 860-901-1100-1332; 860-901-1100-1333; 860-901-1100-1344; 860-901-1100-1345; 860-901-1100-1362; 860-901-1100-1363; 860-901-1100-1374; 860-901-1100-1375; 860-901-1100-2984; 860-901-1100-2985; 860-901-1100-2994; 860-901-1100-2995; 860-901-1100-4044; 860-901-1100-4045; 860-901-1100-4064; 860-901-1100-4065; 860-901-1100-4094; 860-901-1100-4095; 860-901-1100-4102; 860-901-1100-4103; 860-901-1100-4112; 860-901-1100-4113; 860-901-1100-4124; 860-901-1100-4125; 860-901-1100-5672; 860-901-1100-5673; 860-901-1100-5684; 860-901-1100-5685; 860-901-1100-5692; 860-901-1100-5693; 860-901-1100-5704; 860-901-1100-5705; 860-901-1100-5724; 860-901-1100-5725; 860-901-1100-7604; 860-901-1100-7605; 860-901-1100-7614; 860-901-1100-7615; 860-901-1100-8104; 860-901-1100-8105; 860-901-1100-8112; 860-901-1100-8113; 860-901-1100-8344; 860-901-1100-8345; 860-901-1100-8352; 860-901-1100-8353; 860-901-1100-8364; 860-901-1100-8365; 860-901-1100-8372; 860-901-1100-8373; 860-901-1100-8384; 860-901-1100-8385; 860-901-1100-9074; 860-901-1100-9075; 860-901-1100-9542; 860-901-1100-9543; 860-901-1100-9554; 860-901-1100-9555; 860-901-1100-9834; 860-901-1100-9835; 860-902-1100-1152; 860-902-1100-1153; 860-902-1100-1166; 860-902-1100-1167; 860-902-1100-1168; 860-902-1100-1169; 860-902-1100-1174; 860-902-1100-1175;

Control Measure	Emission Inventory Codes
	860-902-1100-1184; 860-902-1100-1185; 860-902-1100-2984; 860-902-1100-2985; 860-902-1100-2994; 860-902-1100-2995; 860-902-1100-4044; 860-902-1100-4045; 860-902-1100-4064;
SC 001 (Source Category: Lawn Care Equipment)	860-902-1100-4065; 860-902-1100-4094; 860-902-1100-4095; 860-902-1100-4102; 860-902-1100-4103; 860-902-1100-4112; 860-902-1100-4113; 860-902-1100-4124; 860-902-1100-4125; 860-902-1100-5672; 860-902-1100-5673; 860-902-1100-5684; 860-902-1100-5685; 860-902-1100-5692; 860-902-1100-5693; 860-902-1100-5704; 860-902-1100-5705; 860-902-1100-5724; 860-902-1100-5725; 860-902-1100-7604; 860-902-1100-7605; 860-902-1100-7614; 860-902-1100-7615; 860-902-1100-8104; 860-902-1100-8105; 860-902-1100-8112; 860-902-1100-8113; 860-902-1100-8344; 860-902-1100-8345; 860-902-1100-8352; 860-902-1100-8353; 860-902-1100-8364; 860-902-1100-8365; 860-902-1100-8372; 860-902-1100-8373; 860-902-1100-8384; 860-902-1100-8385; 860-902-1100-9074; 860-902-1100-9075; 860-902-1100-9542; 860-902-1100-9543; 860-902-1100-9554; 860-902-1100-9555; 860-902-1100-9834; 860-902-1100-9835; 860-903-1100-1394; 860-903-1100-1395; 860-903-1100-1404; 860-903-1100-1405; 860-903-1100-4084; 860-903-1100-4085; 860-903-1100-5744; 860-903-1100-5745; 860-903-1100-5754; 860-903-1100-5755; 860-903-1210-1190; 860-903-1210-1200; 860-903-1210-1210; 860-903-1210-1220; 860-903-1210-1230; 860-903-1210-1240; 860-903-1210-1250; 860-903-1210-1350; 860-903-1210-1380; 860-903-1210-4050; 860-903-1210-4070; 860-903-1210-4130; 860-903-1210-4140; 860-903-1210-4150; 860-903-1210-5710; 860-903-1210-5730; 860-903-1210-8390; 860-903-1210-8400; 860-903-1210-8410
SC 002 (Energy Efficiency)	None
SC 003 (Fireworks)	None
SC 004 (Sand and Gravel Operations)	430-422-7078-0000; 430-426-0210-0000; 430-426-7078-0000; 430-426-7092-0000
SC 005 (Asphalt/Concrete Operations)	430-424-7006-0000; 430-424-7050-0000; 430-429-7016-0000; 430-430-7016-0000; 430-430-7018-0000; 430-436-7006-0000; 430-995-7006-0000; 430-995-7012-0000; 430-995-7016-0000; 430-995-7018-0000; 430-995-7050-0000; 430-995-7072-0000
SC 006 (Almond Hulling/Shelling Operations)	420-418-6003-0000
SC 007 (Pistachio Hulling/Shelling Operations)	The EIC is included in SC 006
SC 008 (Agricultural Material Screening/Shaking Operations)	None
SC 009 (Tub Grinding Operations)	None
SC 010 (Abrasive Blasting)	430-428-6084-0000; 430-428-7000-0000; 430-428-7036-0000; 430-428-7078-0000; 430-428-7084-0000; 430-428-7088-0000; 430-428-7090-0000

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Appendix E

BenMAP Health Benefit Analysis

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Appendix E: BenMAP Analysis

This section of the report presents the empirical results of the District's estimation of the health benefits from the *2012 PM2.5 Plan* via application of the BenMAP model developed by US EPA. BenMAP is a sophisticated computer software model that is well-suited for estimating the regional health benefits from improved air quality resulting from controls and incentives put in place by the *2012 PM2.5 Plan* as well as concurrent controls on PM2.5 originating from other plans.[1] [2] The timeframe for the analysis extends from the base year of 2007 until the attainment date of 2019. In short, the BenMAP analysis seeks to answer two questions: First, given the reductions in population exposure to PM2.5 by 2019 that will result from this combined body of control and incentive measures, how much reduction in specific measures of disease and premature mortality (such as daily hospital admissions for asthma) will occur by 2019 when compared to what was observed in 2007? And second, what is the economic value of those avoided cases of disease, aggravated symptoms, lost work, and premature mortality?

E.1 Background

Over course of the past decade, ongoing progress in the fields of epidemiology and geographic information systems (GIS) have resulted in the development of computer models that are capable of estimating the health benefits of improved air quality with reasonable accuracy when properly applied. These models estimate the number of avoided cases of certain diseases and other health impairment categories, known as health endpoints, which result from a specified reduction in exposure to criteria air pollutants, e.g. ozone and fine particulates (PM2.5). This reduction could be the result of an individual emission control rule with a substantial reduction in annual population exposure or, in this case, a set of controls comprising a regional component of a SIP.

For example, a BenMAP application to an individual rule has been conducted by the Central Valley Health Policy Institute, California State University, Fresno under contract to the District.[3] The study isolated the reduction in annual PM 2.5 exposure in the Bakersfield and Fresno/Clovis metro areas that results from daily restrictions in

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[1] See Abt Associates Inc. (2012) BenMAP Environmental Benefits Mapping and Analysis Program: User's Manual. Prepared for the Office of Air Quality Planning and Standards, U.S. EPA, Research Triangle Park, NC (October). Available at: http://www.epa.gov/air/benmap/models/BenMAPManualOct2012.pdf. See http://www.epa.gov/air/benmap/ for more information on BenMAP, downloading the program, and for technical documents. BenMAP version 4.0 was used in this analysis.

[2] SJVAPCD Health Science Advisor, David Lighthall, Ph.D., received BenMAP training from the Community Modeling and Analysis System in Chapel Hill, NC under contract to the U.S. EPA. Additional technical assistance for this analysis was provided to the District by Charles Fulcher and Neal Fann, EPA Office of Air Quality Planning and Standards.

[3] Lighthall, D., D. Nunes, and T. Tyner. (2008) Environmental Health Evaluation of Rule 4901: Domestic Wood Burning in the San Joaquin Valley. Central Valley Health Policy Institute, California State University, Fresno. Conducted for and funded by the San Joaquin Valley Air Pollution Control District. See http//www.cvhpi.org

domestic wood burning imposed by Rule 4901 and the resultant health benefits. Rule 4901's restrictions in wood burning were estimated to provide a large (13% or more) reduction in annual exposure to PM 2.5 in the study areas, resulting in substantial estimated reductions in premature mortality and other health endpoints such as asthma attacks and chronic bronchitis. A comparable health benefit estimation model was employed by Hall et al. (2008) to estimate the health and economic benefits of achieving federal ozone and PM2.5 standards in the San Joaquin Valley and South Coast air basins.[4]

E.2 How BenMAP Works

There are two central objectives in BenMAP analyses. First, the program estimates reductions in the incidence rates[5] of what are known as health endpoints (i.e. avoided cases of disease, premature death, impaired health, and aggravation of symptoms) based on a specified improvement in ambient air quality for a target area and its population. The degree of improvement is based on statistical relationships between exposure to a given criteria pollutant and health that are derived from previously published epidemiological studies (see further discussion below). The second objective involves assigning an economic value to those avoided cases of health problems, again based on previously published economic analyses of the health endpoints in question.

For example, in order to accurately estimate reductions in daily asthma ER admissions attributable to improved air quality, it is necessary to determine the incremental decrease in the incidence rate for asthma ER admissions that occurs in response to an incremental decrease in exposure to PM2.5. This metric, known as a concentration response function or CRF, is derived from studies that compare daily or annual rates of disease with variations in exposure to PM2.5. Examples of CRFs derived from various epidemiological studies are depicted in Figure E-1 below. Note that, for the most part, the relationship between PM2.5 concentrations and incidence levels are linear, meaning that each incremental increase in PM2.5 results in the same incremental increase in the disease incidence rate irrespective of the PM2.5 concentration. EPA has incorporated into BenMAP CRFs for a range of health endpoints selected from among the top peer-reviewed epidemiological studies in the U.S. As a result, BenMAP users are able to estimate with reasonable accuracy the reductions in daily or annual incidence of a given health endpoint that would be expected from a given reduction in exposure to PM2.5.

Key elements of the BenMAP analytical process include the following: First, BenMAP users must specify the percentage improvement in ambient air quality for the area in question, typically counties. PM2.5 or ozone concentration data is either imported from external modeling sources or generated from a national set of air pollution monitoring data that is pre-loaded into BenMAP. The latter was used in this analysis. Rather than

[4] Hall, J., V. Brajer, and F. Lurmann. (2008) The Benefits of Meeting Federal Clean Air Standards in the South Coast and San Joaquin Valley Air Basins. California State University--Fullerton, Institute for Economic and Environmental Studies. See http://business.fullerton.edu/centers/iees/

[5] The incidence rate is defined by the percentage of a given population, e.g. 10,000 or 100,000 people, who experience the health endpoint on a given day, year, or other time period.

rely on a single monitor to determine average county exposure, BenMAP also has the ability to estimate overall county PM2.5 exposure by averaging observed concentrations from all monitors in the county. At the same time, this averaging takes into consideration any differences in population density surrounding each monitor in the county. The net result are two air quality grids or population exposure surfaces for each county. First, a baseline grid is created that contains the pre-existing pollutant exposure level and baseline incidence rates for health endpoints as well as a control grid containing reductions in average pollutant exposure as specified by the analyst.

Next, the BenMAP analyst must select appropriate CRFs for target endpoints prior to estimating the reduction in negative health effects that results from reduced county-level exposure to ozone or PM 2.5. This requires the analyst to select CRFs from one or more prior health studies for each health endpoint. With technical assistance from EPA staff, the District has been able to import into BenMAP the CRFs for five endpoints that are derived from the 2010 San Joaquin Valley epidemiological study (based on the combined populations of Bakersfield, Fresno, and Modesto).[6] The endpoints, depicted in shaded boxes in Table E-1, include myocardial infarction, asthma ER admissions for ages 0-19, asthma ER admissions for ages 20+, asthma hospital admissions for ages 0-19, and asthma hospital admissions for ages 20+.

In the next step, BenMAP estimates the county-level reduction in health effects, as defined by incidence reductions for each health endpoint, for the target county populations and timeframe that results from the specified decline in PM2.5 exposure. Custom demographic information can be employed or default population data contained within BenMAP can be used for past, current, and future years based on population growth functions in the program. A simplified example of estimating the health effect can be summarized as follows:

Health Effects = Health Baseline Incidence × Air Quality Change × Health Effect Estimate × Exposed Population

1. Health Baseline Incidence: The health incidence rate is an estimate of the average number of people that die or become ill over a given period of time and for a standard population unit that exists prior to any change in air quality, e.g. 220 cases of asthma per 1,000 individuals per year.
2. Air Quality Change (Delta): The air quality change is the difference between the starting air pollution level (i.e. the baseline), and the air pollution level due to reduced exposure (i.e. the control).
3. Health Effect Estimate: The health effect estimate is an estimate of the percentage reduction in adverse health effects due to unit reductions in ambient air pollution. CRFs from prior epidemiological studies provide the source for effect estimates in BenMAP.

[6] Capitman, J.A., & Tyner, T.R. (2011). *The Impacts of Short-Term Changes in Air Quality on Emergency Room and Hospital Use in California's San Joaquin Valley*. Fresno, CA: Central Valley Health Policy Institute for the San Joaquin Valley Air Pollution Control District. Retrieved from http://www.fresnostate.edu/chhs/cvhpi/publications/index.html

4. Exposed Population: The exposed population is the number of people affected by the improvement in air quality.

Finally, BenMAP calculates the economic value of avoided health effects due to reduced ozone or PM2.5. To summarize:

Economic Value = Health Effect × Value of Health Effect

There are several ways to calculate the economic value of health effect changes depending on the nature of the health endpoint. For example, the value of an avoided premature death is generally calculated using the Value of a Statistical Life (VSL). The VSL is an economic estimate of the social value of premature death that is used to guide policy makers in making public investments in public health or safety. VSL estimates range from $3.8 to $8.9 million per case.[7] VSL estimates are based on either contingent valuation surveys or wage risk studies.[8] In the case of non-fatal health endpoints, the economic benefits are based on (1) cost of illness (COI) estimates from national healthcare datasets, (2) lost wages based on San Joaquin Valley wage rates, or (3) estimates from survey research regarding what individuals are willing to pay to avoid an illness such as acute bronchitis, known as willingness to pay (WTP). These economic valuation functions for key health endpoints are contained within BenMAP and can also be imported for custom analyses.

E.3 Summaries of Health Endpoints Used in the Analyses

1. Acute Bronchitis (Children 8-14): Acute bronchitis is an inflammation of the large bronchi (medium-size airways) in the lungs that is usually caused by viruses or bacteria and may last several days or weeks.[9] PM 2.5 exposure has the effect of increasing vulnerability to infection. Health savings in BenMAP are based on health surveys of patients' willingness to pay (WTP) estimates for their child avoiding a six day illness.
2. Acute Myocardial Infarction (AMI or non-fatal heart attack; Adults over 19; *Valley-Based CRF*): Reflecting the large body of experimental, clinical, and epidemiological evidence of cardiovascular (CV) impacts from elevated PM2.5, AMI is a key health endpoint in assessing the health benefits from reduced PM2.5. AMI results from reduced blood supply to the heart, typically from a

[7] For a further discussion of the VSL, see BenMAP Technical Appendices. Office of Air Quality Planning and Standards, U.S. EPA. Prepared by Abt Associates, Inc. September 2008. Available at: http://www.epa.gov/air/benmap/docs.html

[8] Contingent valuation studies are based on surveys that ask how much individuals would be willing to pay to avoid a given health problem. Wage risk studies estimate the value of a single life by looking at the premium paid to workers in occupations that face an increased risk of occupational mortality. For example, a high rise steel worker accepts a 1 in 1,000 (0.001 probability) greater chance of occupational mortality in return for an annual wage premium of $5,000. The VSL in this situation is then based on multiplying that incremental risk to equal a probability of 1, i.e. 1,000 X $5,000 = $5,000,000.

[9] Wenzel RP, Fowler AA (2006). "Clinical practice. Acute bronchitis". *N. Engl. J. Med.* **355** (20): 2125–30. doi:10.1056/NEJMcp061493.

blocked coronary artery. In this case, the CRF was based on the 2011 Valley Epidemiological Study referenced above, which relied on observed hospital admissions in Bakersfield, Fresno, and Modesto. Valuation estimates for AMI are based on lost wages and cost of illness (COI).

3. Acute Respiratory Symptoms (Adults 18-64): Individuals with pulmonary vulnerability such as asthmatics often experience respiratory impairment that does not result in medical treatment or lost work but are nonetheless results in a restriction of activity or other impairment. Studies have shown that the frequency of these symptoms, including wheezing, coughing, and shortness of breath, is relatively high. Valuation is based on WTP to avoid symptoms for a day.
4. Asthma Exacerbation (Children 6-18): This endpoint is defined by incidence of shortness of breath and/or experiencing an asthma attack. The valuation estimate is based on parents' WTP for their child avoiding one or more symptoms on a given day.
5. Emergency Room Visits, Asthma (Ages 0-19 and 20-99, *Valley-Based CRF*): The incidence reduction estimate is divided into two age groups. However, these age groups are combined in the valuation (health savings) estimate. Health savings are derived from COI surveys.
6. Hospital Admissions, Asthma (Ages 0-19 and 20-99, *Valley-Based CRF*): The incidence reduction estimate is divided into two age groups. However, these age groups are combined in the valuation (health savings) estimate. Health savings are derived from COI surveys.
7. Hospital Admissions, Cardiovascular (Adults 18-99): This endpoint is based on increases in admission rates for all CV cases except acute myocardial infarction for ages 18-99. Valuation results are based on COI and wage loss estimates.
8. Hospital admissions, Respiratory (Adults 18-64): This endpoint is based on admissions due to chronic lung disease. Health costs are based on average COI.
9. Lower Respiratory Symptoms (Children 7-14): This endpoint is defined by the existence of two or more symptoms including chest tightness, coughing up phlegm, and wheeze. The valuation estimate is based on parents' WTP for their child avoiding two or more symptoms on a given day.
10. Upper Respiratory Symptoms (Children 9-11): This endpoint is defined by the existence of two or more symptoms including throat congestion, coughing, shortness of breath, wheezing, and several others. The valuation estimate is based on parents' WTP for their child avoiding two or more symptoms on a given day.
11. Work Loss Days (Adults 18-64): This is an estimate of work days lost due to short-term illness, most typically due to respiratory impairment. Valuation is based on the county median daily wage.
12. Premature Mortality (Adults 30-99): Premature death is defined in epidemiological studies as a death from an air pollutant-related cause prior to

their expected age of death, the latter based on actuarial research. Typically this period falls between 10 and 15 years before normal life expectancy. There are a number of epidemiological studies that have analyzed the mortality impact of elevated PM2.5 exposure in relatively large samples of the U.S. urban population. Because the most robust statistical relationships with premature mortality have been found with ischemic heart disease[10] and lung cancer, CRFs for these endpoints were selected. Conversely, there is less compelling statistical evidence regarding elevated PM2.5 and all-cause mortality and this CRF option was not selected. BenMAP valuation of the social cost of avoided mortality was based on the average of 26 VSL studies.

E.4 Incidence Results

Mean 2019 annual incidence reductions by county for the full set of endpoints used in the analysis are presented in Table E-1.[11] The results for the non-fatal endpoints are displayed in Figure E-2 and E-3 and the avoided fatality results are shown in Figure E-4. These reductions are based on county by county estimates of reduced annual daily exposure to PM2.5 that are derived from ARB's modeling estimates of cumulative emission reductions and lower design values resulting from control measures in the *2012 PM2.5 Plan* and related controls from previously adopted plans. As noted, the base year for estimating reduced annual daily exposure is 2007. Differences across county estimates reflect the combined effect of (1) population differences ranging from a high in Fresno County to a low in Madera County and (2) different percentage reductions in annual daily PM2.5 for each county depending on the ARB modeling results. In general, counties with the highest design values experienced proportionally higher percentage reductions in annual daily PM2.5 by 2019.

Of note is the BenMAP estimate of 671avoided cases of pre-mature mortality. This estimate is roughly consistent with comparable estimates of mortality reductions from PM2.5 reductions that were conducted by ARB (2010) and Hall et al. (2008; cited above).[12] It should be noted that for several of the health symptom endpoints, incidence reductions are based on the relatively narrow age ranges—reflecting the studies upon which the CRF was based. As a result, these endpoint results reflect a proportional underestimation of health benefits for the entire Valley population, both in terms of the actual incidence reductions and the corresponding economic benefits.

[10] Ischemic heart disease is characterized by reduced blood supply to the heart muscle usually due to coronary artery disease (atherosclerosis of the coronary arteries). Its risk increases with age, smoking, hypercholesterolaemia (high cholesterol levels), diabetes, and hypertension (high blood pressure), and is more common in men and those who have close relatives with ischemic heart disease. See: http://en.wikipedia.org/wiki/Ischaemic_heart_disease

[11] Standard deviations for incidence estimates are not included here but are available upon request.

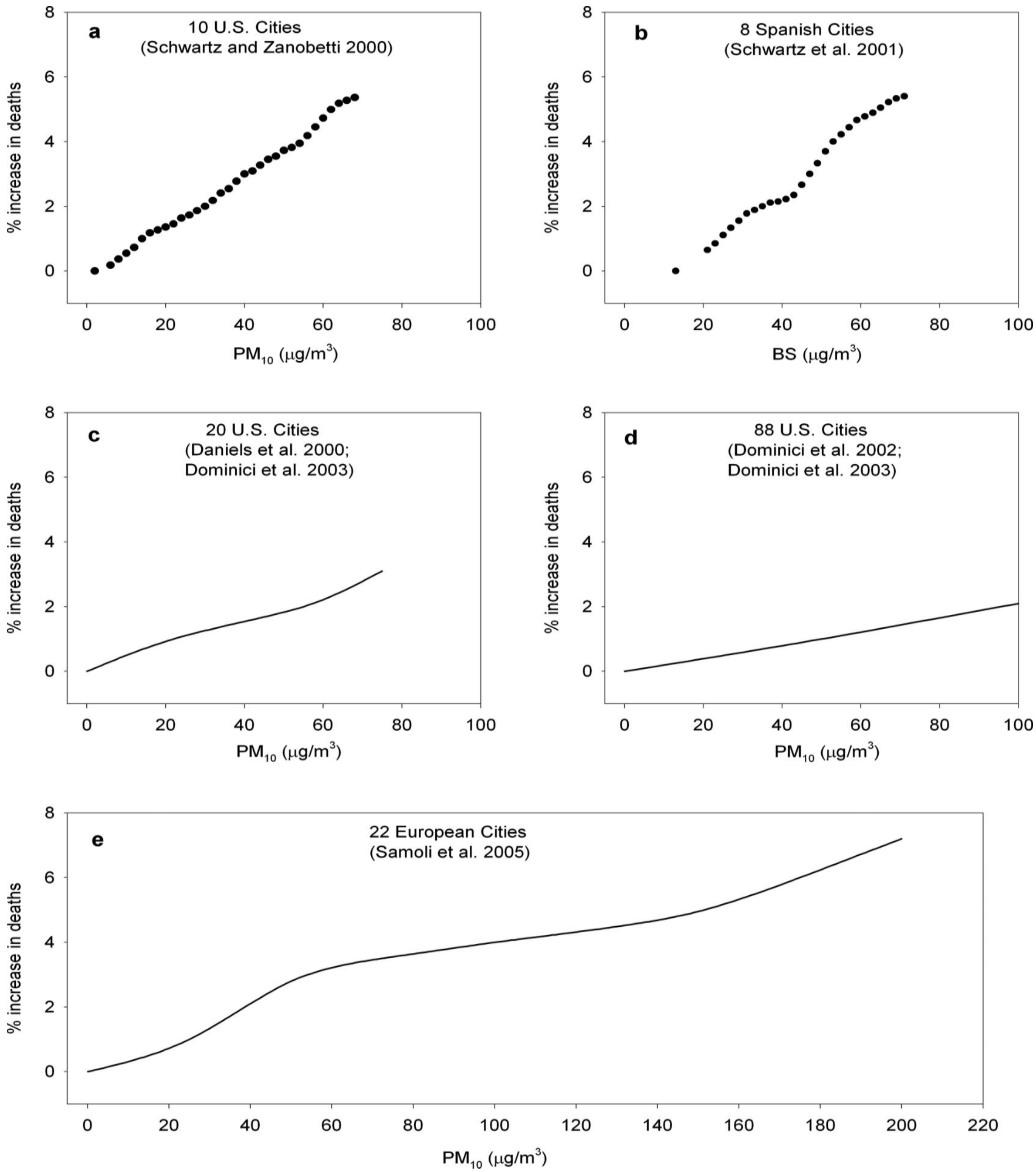
[12] CARB (2010) *Estimate of Premature Deaths Associated with Fine Particle Pollution (PM2.5) in California Using a U.S. Environmental Protection Agency Methodology.* Sacramento, CA: California Air Resources Board. Available at: http://www.arb.ca.gov/research/health/pm-mort/pm-report_2010.pdf

E.5 Valuation Results

Subsequent to estimating the annual reductions in incidence of the selected health endpoints, BenMAP assigns a dollar value to each endpoint for each county based on the cost factors applicable to the endpoint in question. The valuation results for the non-fatal endpoints are displayed in Table E-2 and the county fatality valuation is shown in Figure E-5. By 2019, county by county reductions in PM2.5 attributable to total emission reductions from the *2012 PM2.5 Plan* and related PM2.5 control measures are estimated to result in over $102.15 million in annual avoided health costs associated with non-fatal health endpoints. Because BenMAP cannot capture the full range of health impacts and costs, such as foregone career or recreational benefits due to impaired health, as well as the constricted age range for some symptom-related endpoints as discussed above, this figure most certainly underestimates the full benefits of attaining the 2006 PM2.5 standard in 2019 by a substantial margin.

In the case of premature mortality, a VSL of $7.99 million per case in 2010 dollars was used. The estimated social benefit from the 671 cases of avoided deaths is approximately $5.36 billion. Irrespective of the logic of assigning a dollar value to each case of avoided death in BenMAP, the intrinsic value of saving over 600 lives annually by 2019 is arguably the single most compelling justification for the *2012 PM2.5 Plan*.

Figure E-1 Selected Concentration Response Functions



Reprinted from Pope, C.A., and D. Dockery (2006, p. 720) *Health Effects of Fine Particulate Air Pollution: Lines that Connect.* Journal of Air and Waste Management Association 56: 709-742.

Table E-1 BenMAP Estimates of Mean Annual Reductions in Health Effects Under the Plan by 2019

Health Endpoint	**Totals**	Fresno	Kern	San Joaquin	Stanislaus	Tulare	Merced	Kings	Madera
Acute Myocardial Infarction	**93**	29	25	9	7	11	3	4	4
HA, Asthma 0-19	**131**	56	28	9	11	13	4	4	6
HA, Cardiovascular	**175**	47	51	16	14	26	6	10	5
HA, Asthma 20-99	**246**	64	77	30	16	35	11	7	6
ER Visits, Asthma 20-99	**407**	123	94	48	28	53	22	23	16
ER Visits, Asthma 0-19	**699**	252	160	47	44	90	36	35	37
Acute Bronchitis	**1,498**	404	406	149	127	222	72	64	54
Upper Respiratory Symptoms	**15,523**	4,206	4,294	1,482	1,260	2,334	728	667	552
Lower Respiratory Symptoms	**19,011**	5,093	5,207	1,887	1,595	2,829	912	807	681
Asthma Exacerbation	**114,376**	31,144	31,124	11,269	9,469	17,037	5,445	4,867	4,021
Work Loss Days	**125,138**	34,816	35,300	11,752	10,077	16,882	5,367	6,303	4,641
Mortality	671	172	207	72	61	86	26	23	24

Note: Shaded health endpoints are based on concentration response functions (CRF) derived from the 2011 Valley Epidemiological Study conducted by CSU Fresno and UCSF-Fresno.

Figure E-2 Avoided Disease Incidence by 2019 due to Lower PM2.5 Exposure

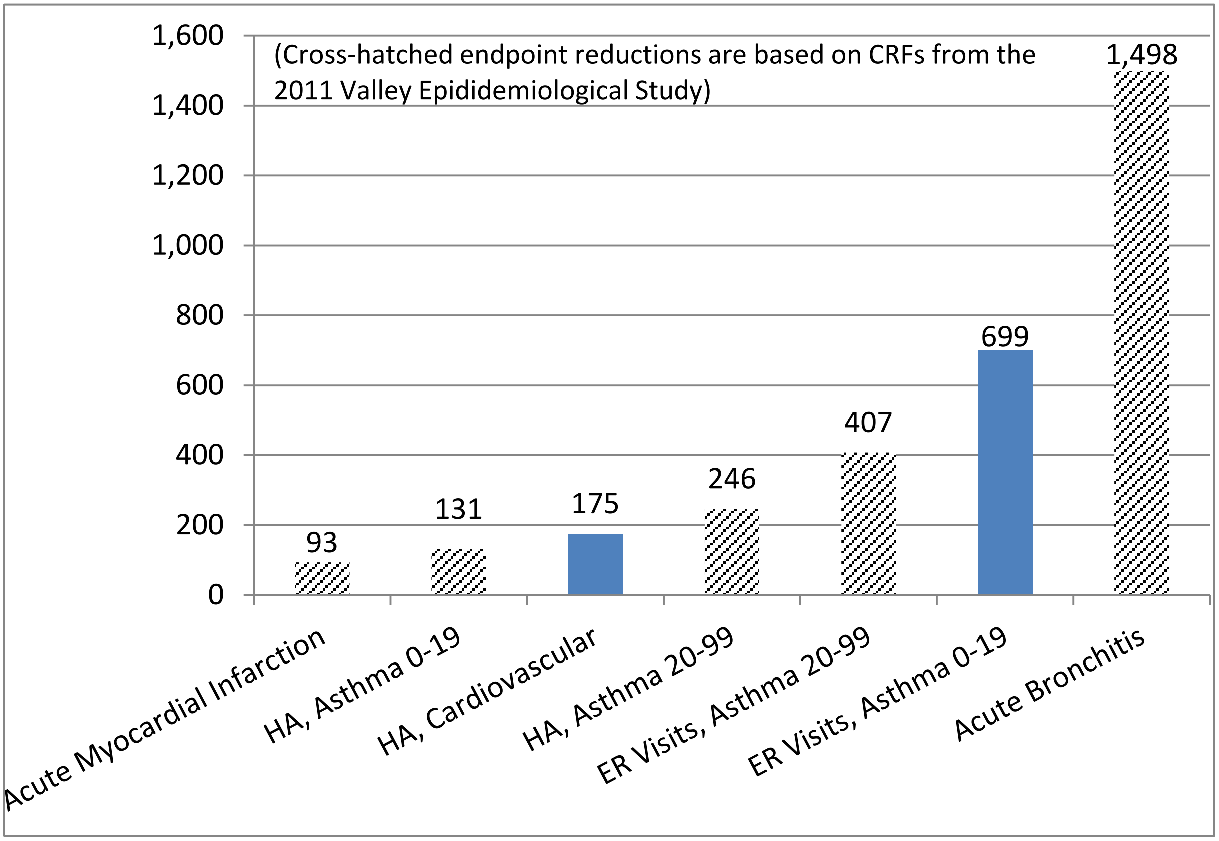


Figure E-3 Reduced Disease Symptoms and Lost Work by 2019

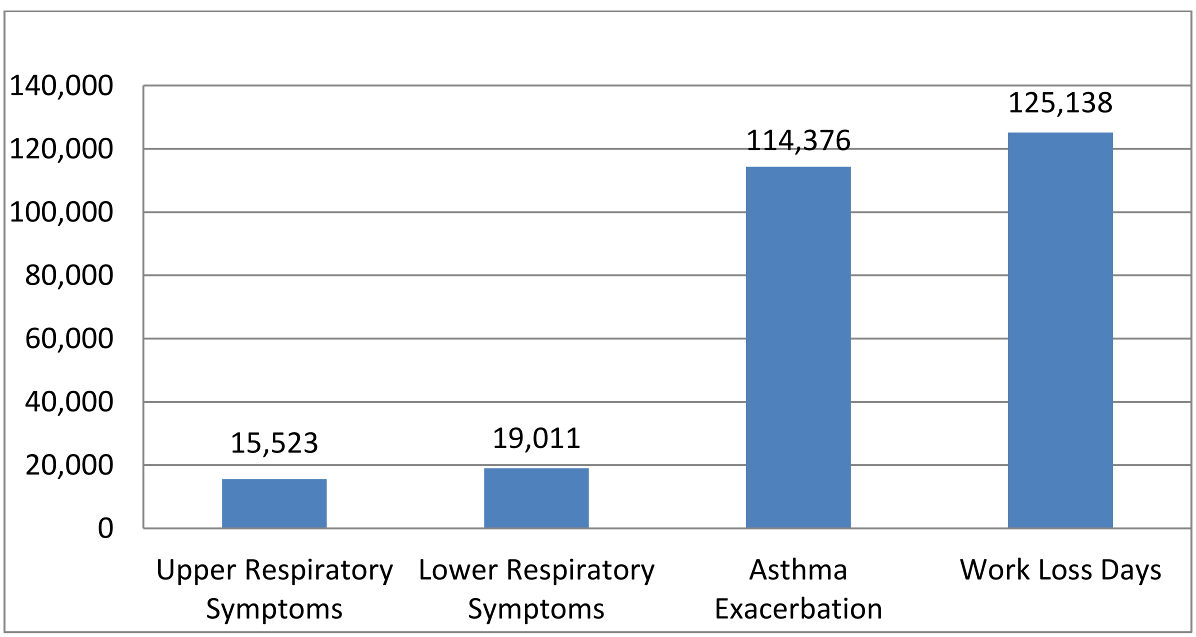


Figure E-4 County Annual Avoided Deaths due to Premature Mortality by 2019

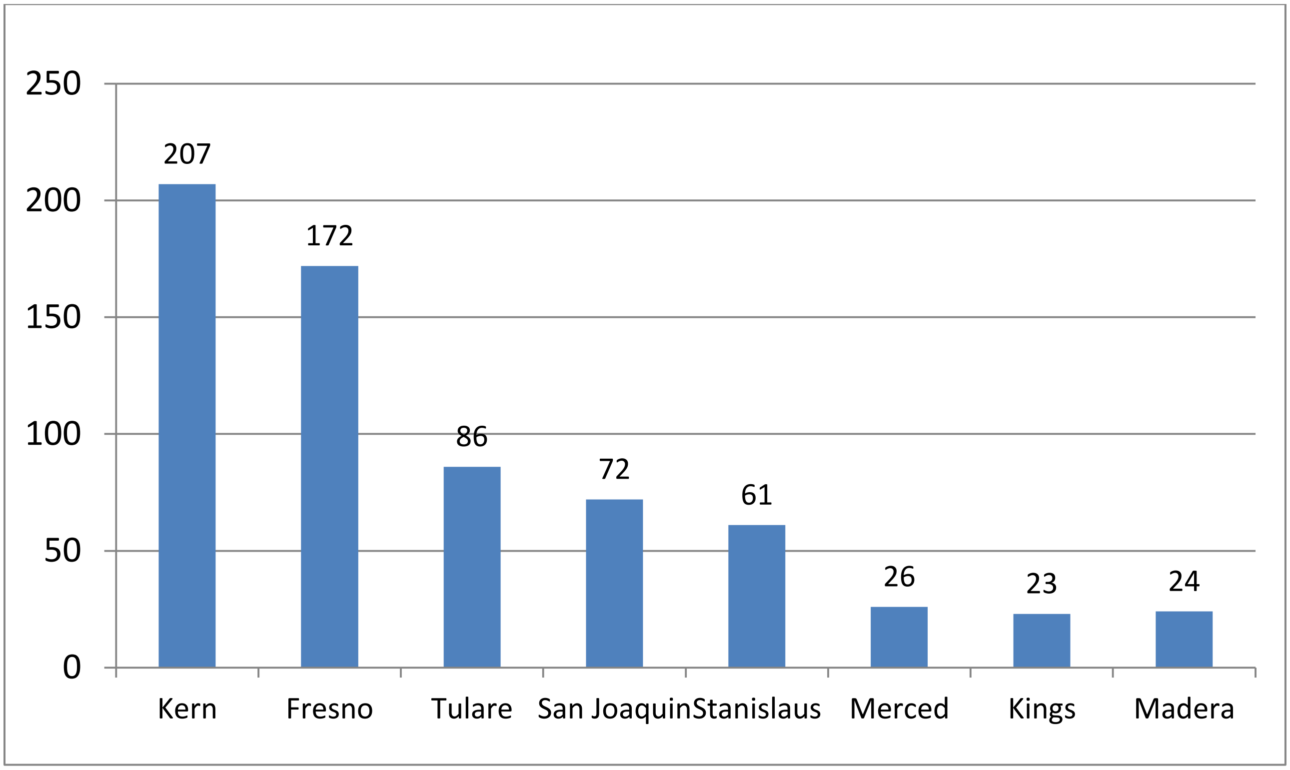
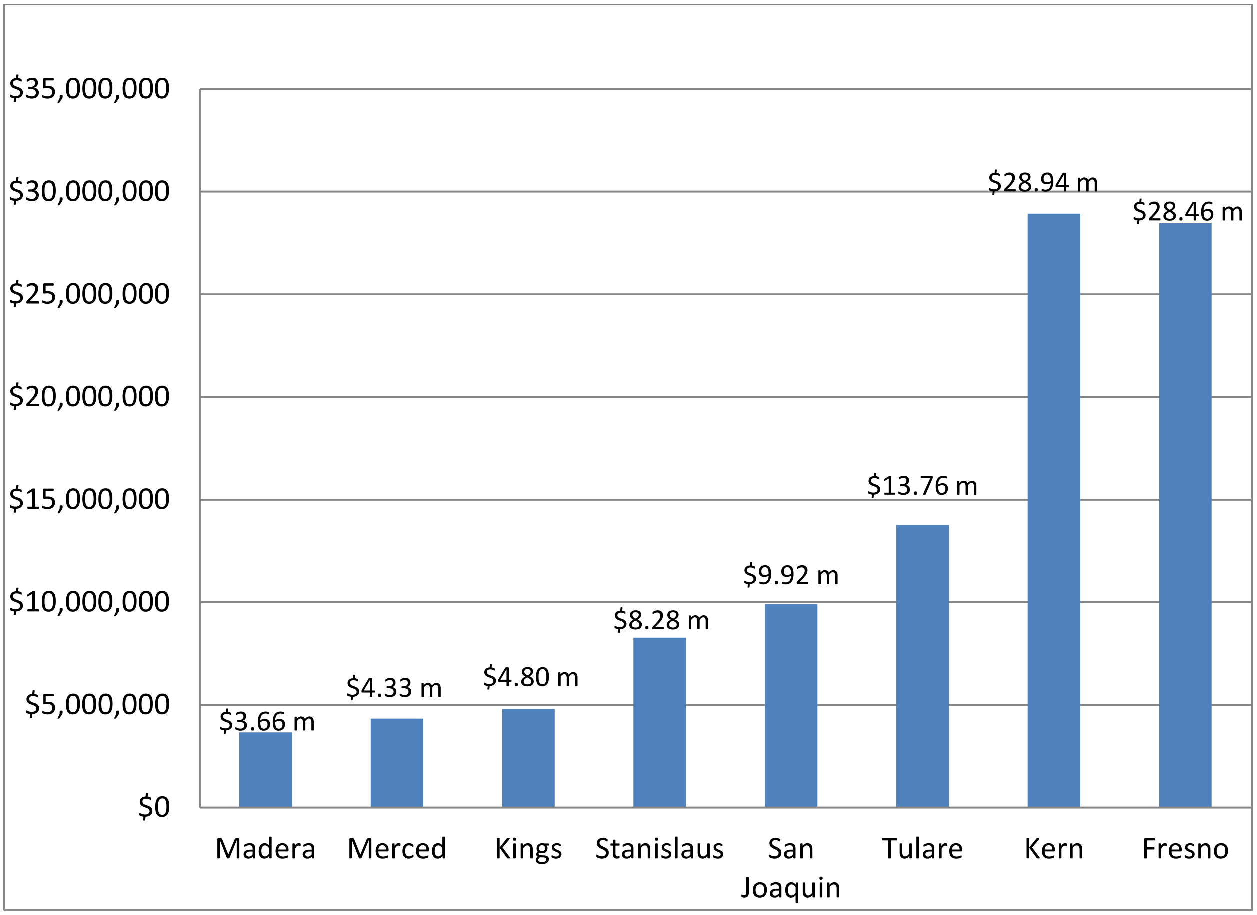


Table E-2 Annual Estimated Reductions in Non-Fatal Health Costs by 2019 for Each Health Endpoint

	Madera	Merced	Kings	Stanislaus	San Joaquin	Tulare	Kern	Fresno	Endpoint Totals
Hospital Admissions, Respiratory	$11,977	$8,624	$10,620	$30,716	$34,483	$53,035	$168,286	$69,212	$386,955
Emergency Room Visits, Asthma	$20,191	$22,534	$22,412	$27,826	$37,031	$55,680	$98,426	$145,396	$429,496
Acute Bronchitis	$25,948	$34,690	$30,587	$60,626	$71,573	$106,243	$194,735	$193,358	$717,759
Acute Myocardial Infarction	$135,234	$116,189	$137,330	$236,316	$292,119	$357,647	$842,946	$963,904	$3,081,686
Upper Respiratory Symptoms	$130,833	$172,385	$157,888	$298,416	$351,078	$552,944	$1,017,185	$996,355	$3,677,083
Lower Respiratory Symptoms	$161,316	$215,913	$191,203	$377,829	$446,874	$670,151	$1,233,296	$1,206,413	$4,502,994
Hospital Admissions, Asthma	$199,604	$255,334	$192,114	$446,696	$655,726	$787,629	$1,749,358	$1,992,572	$6,279,033
Hospital Admissions, Cardiovascular	$204,764	$247,980	$374,376	$548,160	$607,102	$987,523	$1,969,346	$1,828,704	$6,767,955
Asthma Exacerbation	$374,797	$507,524	$453,618	$882,581	$1,050,305	$1,587,928	$2,900,901	$2,902,789	$10,660,442
Work Loss Days	$695,183	$767,170	$909,471	$1,641,778	$2,010,104	$2,391,386	$5,810,543	$5,313,370	$19,539,004
Acute Respiratory Symptoms	$1,704,678	$1,981,334	$2,324,078	$3,728,577	$4,360,359	$6,209,217	$12,950,455	$12,850,859	$46,109,557
County Totals	$3,664,525	$4,329,677	$4,803,697	$8,279,521	$9,916,754	$13,759,382	$28,935,476	$28,462,931	$102,151,964

Figure E-5 County Annual Avoided Non-Fatal Health Costs by 2019



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Appendix F

Modeling Protocol

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Modeling Protocol

Photochemical Modeling for the 24-Hour $PM_{2.5}$ State Implementation Plan in the San Joaquin Valley

Prepared by

California Air Resources Board

San Joaquin Valley Air Pollution Control District

Prepared for

United States Environmental Protection Agency Region IX

August 2, 2012

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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

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

FDDA – Four-Dimensional Data Assimilation

FEM – Federal Equivalence Monitors

FRM – Federal Reference Monitors

HNO_3 – Nitric Acid

IMPROVE – Interagency Monitoring of Protected Visual Environments

IMS-95 – Integrated Monitoring Study of 1995

LIDAR – Light Detection And Ranging

MADRID – Model of Aerosol Dynamics, Reaction, Ionization, and Dissolution

MM5 – Mesoscale Meteorological Model Version 5

MOZART – Model for Ozone and Related chemical Tracers

NASA – National Aeronautics and Space Administration

NCAR – National Center for Atmospheric Research

NH_3 – Ammonia

NIOSH – National Institute for Occupational Safety and Health

NOAA - National Oceanic and Atmospheric Administration

NO_x – Oxides of nitrogen

OC – Organic Carbon

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

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

SIP – State Implementation Plan

SJV – San Joaquin Valley

SJVAPCD – San Joaquin Valley 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

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

1. Introduction

The purpose of this modeling protocol is to detail and formalize the procedures for conducting the 24-hour $PM_{2.5}$ State Implementation Plan photochemical modeling for the San Joaquin Valley. The protocol is intended to communicate up front how the modeling attainment test will be performed. In addition this protocol discusses additional analyses that are intended to help corroborate the modeled attainment test.

Recent History of SIPs in SJV and the Need for a 24-hour $PM_{2.5}$ SIP

Over the past decade, the San Joaquin Valley Air Pollution Control District (SJVAPCD or District) has adopted State Implementation Plans (SIPs or Plans) that set forth State and local emission reduction strategies to bring the San Joaquin Valley (SJV) into attainment for federal ozone (O_3) and particulate matter (PM) air quality standards (standards) by specified dates. In 2004, SJVAPCD adopted the 1-hour O_3 SIP. In addition, SJVAPCD adopted the 2007 Ozone Plan to address the 8-hour standard of 0.08 parts per million (ppm) set by U.S. EPA in 1997. On March 1, 2012, U.S. EPA finalized its approval this SIP (76 FR 57846).

Implementation of State and local control measures mapped out in the SJV 2003 PM_{10} Plan, resulted in the Valley reaching attainment of the PM_{10} standard ahead of schedule. In November 2008, the San Joaquin Valley was officially re-designated to attainment for PM_{10} (73 FR 66759). To ensure continued maintenance of PM_{10} attainment, SJVAPCD adopted and U.S. EPA approved the SJV 2007 PM_{10} Maintenance Plan. In 1997, U.S. EPA adopted their first $PM_{2.5}$ standard, which set two levels, an annual standard of 15 $\mu g/m^3$ and a 24-hour standard of 65 $\mu g/m^3$. The SJV 2008 $PM_{2.5}$ Plan adopted by SJVAPCD sets the course for the Valley to attain the 1997 annual standard in 2014. The plan focused on the annual standard, as in 2008, the Valley already met the 24-hour $PM_{2.5}$ standard of 65 $\mu g/m^3$. On September 30, 2011*,* U.S. EPA officially approved the SJV 2008 $PM_{2.5}$ Plan and the approval will be effective on January 9th 2012 (76 FR 69896).

In 2006, U.S. EPA tightened the 24-hour $PM_{2.5}$ standard to 35 µg/m^3, but left the annual standard unchanged. Based on 2006-2008 air quality data, U. S. EPA designated the SJV as nonattainment for the 2006 24-hour $PM_{2.5}$ standard effective December 14, 2009. Per the federal Clean Air Act (Act), the corresponding SIP is due to U.S. EPA three years after designation. Thus, the SJV SIP addressing the 2006 24-hour $PM_{2.5}$ standard is to be submitted to U.S. EPA by December 14, 2012.

1.1. Modeling Roles for the Current SIP

The Act establishes the planning requirements for those areas that routinely exceed the health-based air quality standards. As discussed above, 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; 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.

For the current SIP, the SJVAPCD and ARB will jointly develop the emission inventories which are an integral part of the modeling. Working closely with the district, the ARB will perform the meteorological and air quality modeling. The SJVAPCD will then develop and adopt their local air quality plan. Upon approval by the ARB, the SIP will be submitted to U.S.EPA for approval.

1.2. Stakeholder Participation in the SIP Modeling Process

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, SJVAPCD 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 SJVAPCD’s Governing Board 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.

1.3. Involvement of External Scientific/Technical Experts and Their Input on the Photochemical Modeling

The California Air Resource Board (ARB) and the San Joaquin Valley Air Pollution Control District (SJVAPCD) plan to engage a group of experts on prognostic meteorological modeling and photochemical particulate matter modeling to help prepare the modeling protocol document (protocol) , which is the blueprint for the air quality modeling portion of the SIP. ARB and district staff will then carry out the work described in the protocol as part of the SIP development.

The structure of the proposed group of technical experts is:

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

This technical consultant group will provide technical consultations/guidance to the staffs of the ARB and SJVAPCD during the development of the protocol. This group is expected to provide 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 of 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 specific tasks for this group include:

- Attending regular meetings with ARB and SJVAPCD staff (in person or via teleconference) as needed during protocol development. These meeting are expected to take place monthly starting approximately in November 2011.

1.4. Schedule for Completion of the Plan

Final area designations kick-off the three year SIP development process. For the first two years, efforts center on updates and improvements to the Plan's technical and scientific underpinnings. These include the development of emission inventories, selection of modeling periods, model selection, model input preparation, model performance evaluation and supplemental analyses. During the last year, modeling, further supplemental analyses and control strategy development proceed in an iterative manner and the public participation process gets under way. After thorough review the District Board and subsequently the ARB Board consider the Plan. The Plan is then submitted to U.S. EPA. The table below summarizes the overall anticipated schedule for Plan completion:

Table 1-1: The Timeline for Completion of the Plan.

Timeline	Action
November 2011	Emission Inventory Completed
Summer 2012	Modeling Completed
Spring/Summer 2012	Public Workshop(s) on the Draft Plan
October 2012	San Joaquin Valley Governing Board Hearing to consider the Draft Plan
November 2012	ARB Board Hearing to consider the SJV Adopted Plan
December 14, 2012	Plan is due to U.S. EPA

2. Description of the Conceptual Model for the Nonattainment Area

2.1. History of Field Studies in the Region

The San Joaquin Valley (SJV) airshed is perhaps the second most studied airshed in the world, in terms of the number of publications in peer-reviewed international scientific/technical journals and other major reports. The Los Angeles airshed is the first. Major field studies that have taken place in the SJV and surrounding areas are listed in Table 2-1. A comprehensive listing of publications (reports and peer-reviewed journal articles) up to 2005, compiled by Professor John Watson of the Desert Research Institute, can be found at http://www.arb.ca.gov/airways/crpaqs/publications.htm.

The first major air quality study in the SJV, dubbed Project Lo-Jet, took place in 1970 and resulted in the identification of the Fresno Eddy (Lin and Jao, 1995 and references therein). The first Valley-wide study that formed the foundation for a SIP was the San Joaquin Valley Air Quality Study/Atmospheric Utilities Signatures Predictions and Experiments (SJVAQS/AUSPEX) study, also known as SARMAP (SJVAQS/AUSPEX Regional Modeling Adaptation Project). A 1-hour Extreme Ozone Attainment Demonstration Plan based on the SARMAP Study was submitted to the U.S. EPA in 2004 and was approved in 2009 (74 FR 33933; 75 FR 10420). The next major study was the Integrated Monitoring Study in 1995 (IMS-95), which was the pilot study for the subsequent California Regional PM_{10}/$PM_{2.5}$ Air Quality Study (CRPAQS) in 2000 (Solomon and Magliano, 1998). IMS-95 formed the technical basis for the 2003 PM_{10} SIP which was approved by the U.S. EPA in 2006 (71 FR 63642). The area was re-designated as attainment in 2008 (73 FR 66759). The first annual field campaign in the SJV was CRPAQS, and embedded in it was the Central California Ozone Study (CCOS) that took place during the summer of 2000 (Fujita et al., 2001). CRPAQS was a component of the technical foundation for the 2008 annual $PM_{2.5}$ SIP which was approved by the U.S. EPA in 2011 (76 FR 41338; 76 FR 69896), and CCOS was part of the technical basis for the 2007 8-hour O_3 SIP (76 FR 57846).

While CRPAQS is still very relevant to the current 24-hour $PM_{2.5}$ SIP, there are four subsequent studies that are noteworthy for several different reasons. Any of these studies would not form the technical basis for a future SIP itself, but they contributed significantly to our understanding of various atmospheric processes. The first involved NASA making airborne LIDAR measurements in the SJV in June 2003 (Rosen et al., 2006; De Yong, et al., 2006; Lewis et al., 2010). While the $PM_{2.5}$ concentrations are not high in the SJV during non-winter periods, this study demonstrated the utility of airborne LIDARs in studying $PM_{2.5}$ loadings in the SJV.

The second was the U.S. EPA Advanced Monitoring Initiative, which involved flying an aircraft fitted with a high-resolution aerosol LIDAR in the San Joaquin Valley in January 2005 (Lewis et al. 2010). NASA's B200 King Air aircraft equipped with an airborne high-spectral- resolution LIDAR (HSRL) was flown in the SJV for several days. The downward-looking HSRL measured the aerosol optical depth. These vertically-resolved measurements were very useful in determining the horizontal and vertical structure of the $PM_{2.5}$ loadings along the flight paths. This study confirmed that high aerosol loadings occur in urban areas near the surface. This study also provided a sound data set to evaluate the performance of air quality models (Ying, Jackson, and Kaduwela, 2011). Together, this study and the previous NASA study, provide the first example of the applicability of airborne LIDARs in the SJV to study $PM_{2.5}$ loadings.

The third was the California portion of the Arctic Research of the Composition of the Troposphere from Aircraft and Satellites (ARCTAS-CARB) which took place during May-July 2010 (Jacob, et al., 2010).This involved two instrumented aircraft. As Jacob et al. (2010) describe, the planning for the ARCTAS-CARB flights were based on the following questions:

- How good is our current understanding of the HO_x-NO_x-O_3-aerosol photochemical system over the Los Angeles Basin as represented in air quality models?
- How should upwind boundary conditions for simulating air quality in California be specified?

- How do ship emissions and long-range transport affect the sulfur budget in southern California?
- What are the state's emissions of VOCs and greenhouse gases from urban and industrial activities, agricultural operations, and wildfires?

The analyses of ARCTAS-CARB data are still in progress, but some of the findings could be applicable to the current 24-hour $PM_{2.5}$ SIP (Kaduwela and Cai, 2009, Huang et al., 2010; Singh et al, 2010; Pfister et al., 2011a,b; Huang et al., 2011; D'Allura et al., 2011). Note, however, that the ARCTAS-CARB field work was conducted during June-July, 2008 but the high $PM_{2.5}$ loadings in SJV occur during winter months.

The ARCTAS-CARB campaign was considered to be the pilot phase for a more comprehensive multi-platform study known as CalNex 2010 (Research at the Nexus of Air Quality and Climate Change conducted in 2010)(www.esrl.noaa.gov/csd/calnex/). This campaign was coordinated by NOAA and CARB together with researchers from several universities and national laboratories. It involved several instrumented aircraft, an instrumented ship, two surface supersites (one in Bakersfield and another in Pasadena), and networks of meteorological and ozonesonde measurements. It was designed to answer a much broader set of questions than ARCTAS-CARB did, however the data analysis phase is still in progress and only very preliminary air quality modeling has been conducted to date (Cai and Kaduwela, 2011; Kelly et al., 2011).

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 $PM_{2.5}$ and PM_{10} 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
1984	Southern SJV Ozone Study	First major characterization of O_3 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 $PM_{2.5}$ and PM_{10}
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 O_3 and $PM_{2.5}$
July and August 1991	California Ozone Deposition Experiment	Measurements of dry deposition velocities of O_3 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	California Regional PM_{10}/$PM_{2.5}$ Air	First year-long, regional-scale effort to measure

1999-February 2001	Quality Study (CRPAQS) and Central California Ozone Study	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
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.

2.2. CRPAQS Relevance to SIP

As discussed in the previous section, CRPAQS has provided key technical information to support SIP development in the San Joaquin Valley. CRPAQS was a public/private partnership designed to advance our understanding of the nature of $PM_{2.5}$ in the Valley and guide development of effective control strategies. The study included monitoring at over 100 sites as well as data analysis and modeling, results of which have been published in over 60 papers and presented at national and international conferences. The field campaign was carried out between December 1999 and February 2001. The key findings remain relevant to the development of the current 24-hr $PM_{2.5}$ SIP. The Study improved our understanding of the spatial and temporal distribution of $PM_{2.5}$ in the Valley, its chemical composition, transport and transformation, and contributing sources. More details on CRPAQS can be found at the following link: http://www.arb.ca.gov/airways/ccaqs.htm

Key findings include the interplay between local and regional components and the resulting concentrations at urban versus rural sites, the sources of carbonaceous material, and identification of limiting precursors for ammonium nitrate formation. A brief description of these findings is provided in sections 2.6 and 2.7. More detailed results will be discussed in the SIP documentation.

2.3. Description of $PM_{2.5}$ Monitoring in the SJV

The San Joaquin Valley nonattainment area (the Valley) is an agricultural region encompassing approximately 64,000 km^2 and with a total population approaching four million. The majority of the population is centered in the large urban areas of Bakersfield, Fresno, Modesto, and Stockton. The nonattainment area includes seven full counties and one partial county. The full counties are San Joaquin, Stanislaus, Merced, Madera, Fresno, Kings, and Tulare. Kern is the partial county with only western Kern County included in the $PM_{2.5}$ nonattainment area. The Valley is bordered on the west by the coastal mountain ranges and on the east by the Sierra Nevada range. These ranges converge at the southern end of the basin at the Tehachapi Mountains.

There are 21 monitoring sites collecting $PM_{2.5}$ data in the San Joaquin Valley (see Table 2-1). These include seven Federal Reference Monitors (FRMs), four $PM_{2.5}$ speciation monitors, and 19 continuous monitors (eleven Federal Equivalence Monitors (FEMs) and eight non-FEMs). Several sites include multiple monitoring instruments running in parallel.

The FRM sampling frequency varies from daily to one in six days. Two monitoring sites, Bakersfield-California and Fresno-1st, collect daily FRM samples. All other FRM monitors operate on a one in three days schedule, with the exception of Corcoran and Fresno-Hamilton which operate on a one in three days schedule during the high season, but reduce frequency to one in six days during the low season.

Table 2-2: $PM_{2.5}$ monitoring sites in the San Joaquin Valley nonattainment area.

AQS SiteID	Site Name	FRM	FEM	non-FEM	Speciation
Fresno County					
060195001	Clovis-N Villa Avenue		1		
060190008	Fresno-1st Street	1		1	1
060195025	Fresno-Hamilton and Winery	1			
060192008	Huron-16875 4th Street			1	
060192009	Tranquillity		1		
Kern County					
060290016	Bakersfield-410 E Planz Road	1			
060290014	Bakersfield-5558 California Avenue	1		1	1
060292009	Lebec-Beartrap Road			1	
Kings County					
060310004	Corcoran-Patterson Avenue	1	1		
060311004	Hanford		1		
Madera County					
060392010	Madera-28261 Avenue 14		1		
Merced County					
060470003	Merced-Coffee		1		
060472510	Merced-2334 M Street	1			
Stockton County					
060772010	Manteca-530 Fishback Rd		1		
060771002	Stockton-Hazelton Street		1		
060773005	Tracy-Airport			1	
Stanislaus County					

060990005	Modesto-14th Street		1		1
060990006	Turlock-S Minaret Street		1		
Tulare County					
061072010	Porterville-1839 Newcomb Street		1	1	
061070009	Sequoia-Ash Mountain			1	
061072002	Visalia-N Church Street	1		1	1
Total		**7**	**11**	**8**	**4**

2.4. $PM_{2.5}$ Air Quality Trends

Table 2-3 lists 98th percentiles and design values for FRM and FEM sites with at least one year of data. All sites in the $PM_{2.5}$ nonattainment area exceed the 24-hour standard, with 2010 design values ranging from 41 µg/m^3 at Stockton-Hazelton to 65 µg/m^3 at Bakersfield-Planz. However, over the last ten years, the San Joaquin Valley has experienced an improvement in $PM_{2.5}$ air quality, although different rates of progress have occurred across the Valley. The biggest decreases, on the order of 25 percent to 45 percent, occurred in the northern and central Valley. The southern San Joaquin Valley, which includes the Bakersfield area, showed lesser improvement in $PM_{2.5}$ concentrations of 17 percent to 35 percent. These design values reflect a three year average of the individual year 98th percentiles. The 98th percentile values for 2010, the most recent year of data, provide a further indication of continuing progress, with values ranging from 34.5 µg/m^3 to 56.2 µg/m^3.

It is important to note that the aforementioned air-quality improvements in the SJV are not entirely due to changes in meteorology. In order to understand the effectiveness of emission control strategies and regulations on ambient air pollution levels, it is important to investigate air quality trends and link them to the impacts from meteorology versus changes in emissions. The strong linkage between meteorological conditions and air pollutant levels can obscure the effects of the change of emission levels over time. Therefore, the meteorological effects need to be removed so that the emissions-related trends may be studied. The Classification and Regression Trees (CART) method was used to define the relationship between $PM_{2.5}$ concentrations and meteorological conditions in both the Bakersfield and Fresno areas of the San Joaquin Valley. Three years (2004-2006) were selected as base years to define these relationships. The CART model was able to explain approximately 75-80 percent of the variation in daily $PM_{2.5}$ concentrations during these years based on the local meteorological conditions. Based on the CART-defined relationships, daily $PM_{2.5}$ concentrations were predicted for all the other years using the observed meteorological data and assuming the emissions stayed constant (i.e. the predicted concentrations only represent the $PM_{2.5}$ conduciveness of meteorology). The measured $PM_{2.5}$ concentrations were then corrected for the influences of meteorology to estimate the meteorologically adjusted trends. For example, in a year with meteorology conditions that were more conducive to $PM_{2.5}$ formation, $PM_{2.5}$ concentrations were adjusted downward. Conversely, $PM_{2.5}$ concentrations were adjusted upward in years with meteorological conditions that were less conducive.

The meteorology-adjusted trend at Bakersfield indicates a greater decline than the unadjusted trend, while the two trends are generally similar at Fresno. Overall, the meteorology-adjusted trends indicate that the $PM_{2.5}$ annual averages decreased about 40-50 percent in both the Bakersfield and Fresno areas from 1999 to 2010, with an average rate of decrease of approximately 0.8 ug/m^3 per year. These meteorology-adjusted trends provide a more robust indicator of the impacts of emission reductions from on-going control programs

Table 2-3: 98th Percentiles and 24-hour Design Value.

Site Name	98th Percentiles (µg/m³)													24-hr Design Values (µg/m³)										
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Bakersfield-410 E Planz Road		76.5	90.6	66.8	47.5	47.6	66.4	64.7	72.2	72.3	65.5	56.2	43.2		78	68	54	54	60	68	70	70	65	55
Bakersfield-5558 California Avenue	98	92.7	94.9	73	48.3	61.5	63.2	60.5	73	64.5	66.7	53.3	65.5	95	87	72	61	58	62	66	66	68	62	62
Clovis-N Villa Avenue	59.2	72.5	71.5	53.2	48.1	52.4	63	51.3	60.9	49	49	44.3	68.5	68	66	58	51	55	56	58	54	53	47	54
Corcoran-Patterson Avenue	53	55.1	89.5	65.1	42.2	49.4	74.5	50.1	57.9	47.9	53.4	46.8		66	70	66	52	55	58	61	52	53	49	
Fresno-1st Street	120	90	75	75	56	52	71	51	67	57.4	55.8	48.8	69.5	95	80	69	61	60	58	63	58	60	54	58
Fresno-Hamilton and Winery		64.8	61.5	71.9	49.7	49.4	71.2	55	57.4	44.5	48.2	37	59.6		66	61	57	57	59	61	52	50	43	48
Merced-2334 M Street	91.9	60	49.3	55.1	44.2	43	48.3	43.8	52.7	54	45.2	35.5	35.4	67	55	50	47	45	45	48	50	51	45	39
Modesto-14th Street	100	71	69	69	47	45	55	52	57.4	53.9	54.5	38.9	54.7	80	70	62	54	49	51	55	54	55	49	49
Stockton-Hazelton Street	79	55	58	50	41	36	44	42	48	61.6	40.4	34.5	44.8	64	54	50	42	40	41	45	51	50	46	40
Turlock-S Minaret Street											53.1	39	57.4											51
Visalia-N Church Street	114	103	96	70	47	54	65	50	59.7	62.1	53.9	36.3	50.7	104	90	71	57	55	56	58	57	59	51	47

2.5. Major $PM_{2.5}$ Components

Four monitoring sites collect $PM_{2.5}$ chemical composition data in the San Joaquin Valley: Bakersfield-California, Fresno-1st, Modesto, and Visalia. The Bakersfield and Fresno speciation monitors are part of the national Speciation Trends Network (STN) while Modesto and Visalia are part of the State and Local Air Monitoring Stations (SLAMS) network. All four sites use SASS samplers (Spiral Aerosol Speciation Sampler, Met One, Grants Pass, OR.) for data collection. The STN data are analyzed by the Research Triangle Institute and the SLAMS data are analyzed by ARB. In recent years, changes were made to the carbon sampling and analysis method. The collection method changed from the MetOne SASS to the URG3000N sampler, which is very similar to the IMPROVE module C sampler. The analytical method was changed from the NIOSH-like thermal optical transmittance method to IMPROVE_A thermal optical reflectance. At Bakersfield, Modesto, and Visalia these changes were implemented in May of 2007. Consequently, these sites have over three years of data collected using the new sampling and analysis method. The Fresno site switched to the new carbon system in April of 2009, so there is less than two years of new data.

Figure 2-1 illustrates the average chemical composition on exceedance days at each of the four speciation sites. Widespread ammonium nitrate is the major contributor to wintertime $PM_{2.5}$ episodes, accounting for 50 percent to 67 percent of $PM_{2.5}$ mass on a typical exceedance day. Carbonaceous aerosol contributions range from 16 percent at Bakersfield to 33 percent at Fresno. Ammonium sulfate, geological material, and elements are smaller components of $PM_{2.5}$.

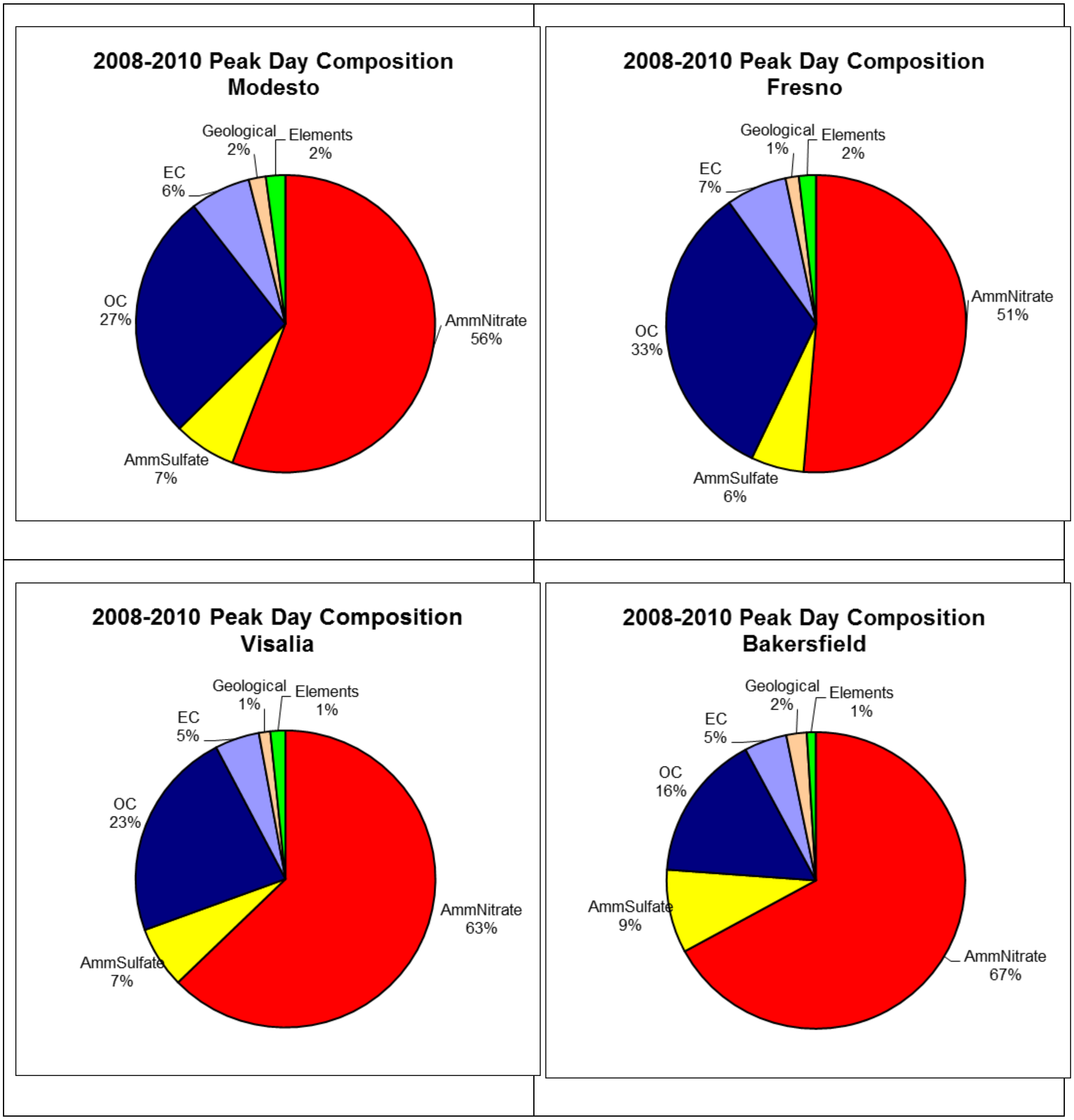


Figure 2-1: PM2.5 composition on an average exceedance day

2.6. Conditions Leading to $PM_{2.5}$ Exceedances

$PM_{2.5}$ concentrations in the San Joaquin Valley exhibit a strong seasonal variability, with highest concentrations during the months of November through February. The highest

$PM_{2.5}$ concentrations occur almost exclusively during multiday pollution episodes under stagnant winter weather when a high pressure system (the Great Basin High) reduces the ventilation in the Valley (Ferreria et al., 2005). These stagnation events, sandwiched between two weather systems, are characterized by low wind speeds, moderate temperatures, vertical atmospheric stability, and high relative humidity. This stable atmosphere prevents precursor gases and primary (or directly emitted) $PM_{2.5}$ released at the surface in the Valley from rapidly dispersing. The moderate temperatures and high relative humidity also enhance the formation of secondary particulate matter, especially ammonium nitrate and sulfate.

$PM_{2.5}$ episodes can last for many days, resulting in multiple exceedances of the 24-hour $PM_{2.5}$ standard. At the beginning of an episode, concentrations are low but increase daily because of both the accumulation of primary pollutants and formation of secondary pollutants (Watson et al, 2002). Concentrations continue to build until there is a change in the weather significant enough to wash out particles through rainfall or increased ventilation of the Valley. The two main episodes captured during CRPAQS had up to 18 days with $PM_{2.5}$ concentrations exceeding 65 µg/m^3 (Turkiewicz et al., 2006). During episodes, urban sites recorded elevated concentrations earlier than rural sites, and as a consequence, had a greater number of days with high concentrations. However, due to the buildup of $PM_{2.5}$ concentrations, rural sites can achieve concentrations of similar magnitude as urban sites by the end of an episode.

$PM_{2.5}$ particles can be either directly emitted (known as primary particulate matter) or formed via atmospheric reactions (known as secondary particulate matter). Ammonium nitrate, the dominant $PM_{2.5}$ component throughout the Valley, is formed in the atmosphere as a result of chemical reactions between precursor pollutants such as NO_x, VOC, and ammonia. Carbonaceous aerosol, the second most abundant component, is mostly directly emitted, and is the result of contributions from wood combustion, mobile sources, and cooking.

As shown earlier in Figure 2-1, carbonaceous aerosols and ammonium nitrate together comprise approximately 85 to 90 percent of the $PM_{2.5}$ mass during an episode. Each episode has a local component (primarily carbonaceous aerosols) and regional component (primarily ammonium nitrate). The relative proportions between ammonium nitrate and carbonaceous material differ among urban and rural sites. Since most of the carbonaceous aerosol is emitted into the atmosphere as directly emitted particles, its transport is much more limited compared to gaseous precursors of ammonium nitrate. Concentrations of carbonaceous material are two to three times higher at urban sites than at rural, corresponding to the higher emission density of primary carbon sources in urban areas (Turkiewicz et al., 2006). Ammonium nitrate can be formed both at the surface and aloft. Concentrations of ammonium nitrate, which result from more regional-scale secondary formation and mixing of emissions, can be fairly uniform across urban and rural sites. The spatial homogeneity of ammonium nitrate is influenced by higher wind speeds aloft (which allow more efficient transport), and the diurnal variation in mixing heights (which allow entrainment of ammonium nitrate down to the surface).

Ammonium nitrate is also formed via both daytime and nighttime chemistry. The amount of ammonium nitrate produced will be limited by the relative abundance of its precursors in the atmosphere. In the San Joaquin Valley, the nighttime formation is considered to be the most important pathway (Lurmann et al., 2006). The nighttime pathway involves gas-phase oxidation of NO_2, followed by reaction with ammonia to form ammonium nitrate. Since ammonia is abundant in the Valley in the winter, NO_x is considered to be the limiting precursor. In contrast, the daytime pathway also involves VOCs. Modeling studies that investigated winter episodes in the Valley estimated that reductions in VOC emissions have a small impact on nitrate concentrations only at very high $PM_{2.5}$ concentrations (Pun, Balmori, and Seigneur, 2009). However, at current $PM_{2.5}$ levels the impact was very limited, and in some cases VOC reductions lead to an increase in $PM_{2.5}$ concentrations (Kleeman, et al., 2005). The results of these studies are discussed in greater detail in the following section.

2.7. Past Modeling Efforts and Results

The first peer-reviewed journal article on photochemical simulation in the SJV was conducted using a photochemical box model to study conversion of NO_x to nitrate (Stockwell et al., 2000). That study found that about 33% of emitted moles of NO_x were converted to nitrate. The study also found that about 80% of the nitric acid (HNO_3) produced was in the particle phase, suggesting an ammonia rich environment. These observations were found to be in reasonable agreement with observations. Stockwell et al., (2000) also reported that while increasing NO_x emissions led to increased production of particle nitrate, the reduction of VOC had no appreciable effect on nitrate production. However, increases in VOC emissions led to reduction in nitrates. Taken together, these three observations suggest that the PM nitrate in the SJV is NO_x limited. Pun and Seigneur (2001) also employed a photochemical box model that covered urban Fresno, and determined that VOC controls would be more effective than NO_x controls in reducing $PM_{2.5}$ nitrate. This finding is in conflict with that of Stockwell et al., (2000). However, box modeling approaches have a number of limitations, including lack of transport in/out of the box, robust vertical transport, and use of older chemical mechanisms. In addition, in the work done by Pun and Seigneur (2001), the VOC emissions were increased by a factor of two to improve model performance. As such the box modeling does not fully represent the complete scope of atmospheric variations and has limited usefulness in assessing the responsiveness to VOC controls.

The first published application of a full-scale photochemical grid model with diagnostic meteorological data to simulate PM concentrations in the SJV, which was also the first study outside of the Los Angeles area to include complete PM model performance statistics, was conducted by Held et al. (2004). In this study, the source-oriented external mixture CIT-UCD model was applied during the January 4-6, 1996 episode of the IMS-95 (Solomon and Magliano, 1998). As Held et al., (2004) reported, the CIT-UCD model was able to capture many key air quality features of the January 4–6, 1996 episode including (1) regional ozone, (2) regional PM mass, (3) chemically speciated mass at core stations, and (4) the size distribution of major PM species. Given the robust model agreement with both gas and condensed phase measurements, it appeared that the CIT-UCD model adequately captured the fundamental chemistry and transport in the IMS-95 domain, suggesting that this model could be used to explore various control scenarios designed to improve the air quality in the SJV. The results reported in this publication also confirmed previous unpublished findings based on the application of UAM-Aero to the same IMS-95 episode (Kaduwela, 2003). These findings were a part of the SJV's 2003 PM_{10} SIP. In a follow-up analysis, Held et al. (2005) compared the source apportionment $PM_{2.5}$ obtained using the CIT-UCD model with that obtained using the Chemical Mass Balance method and concluded that the model was able to predict source contributions to airborne particulate matter at all locations and times throughout the study domain.

Investigation of precursor limitations for the January 4-6, 2006 IMS-95 episode using the CIT-UCD model revealed that NO_x controls were the most effective control strategy to reduce $PM_{2.5}$ concentrations (Kleeman, Ying, and Kaduwela, 2005). A 50 percent reduction in NO_x in the SJV resulted in a 25 percent reduction in total nitrate, while a 50 percent reduction in VOCs resulted in a 17.5 percent reduction. A 50 percent reduction in ammonia resulted in a 10 percent reduction in total nitrate. However, to evaluate the significance and effectiveness of VOC controls in the context of control strategy design, the study's isopleths of $PM_{2.5}$ nitrate response to combined NO_x/VOC emission reductions provide more in-depth information. Modeled isopleths show that, based on the shapes of the graphs, NO_x controls are the most effective approach to reduce $PM_{2.5}$ nitrate concentrations at Fresno and the location of the highest modeled $PM_{2.5}$ nitrate concentration. Once NO_x controls are taken into consideration, VOC emission reductions produce essentially no benefit, and in some instances, may actually lead to an increase in $PM_{2.5}$ nitrate formation. Nitrogen-containing molecules such as PAN can act as temporary sinks for NO_2. When VOCs are controlled, the reduced availability of certain radicals which are generated from VOCs reduces the amount of NO_2 that is sequestered, thereby increasing the availability of NO_2 and enhancing ammonium nitrate formation (Meng et al., 1997). This may be generally true not only for PAN, but also for organic nitrates which can lead to increases in NO_x and ozone concentrations if emissions of specific VOC compounds are controlled (Farmer et al., 2011).

It was also revealed in a subsequent analysis of the same episode that approximately 45-57 percent of the $PM_{2.5}$ nitrate and 34-40 percent of the $PM_{2.5}$ ammonium ion in the SJV were formed from precursor gaseous species released from sources upwind of the modeling domain (Ying and Kleeman, 2006). However, it is important to note that the modeling domain did not include the entire Valley, with the domain starting just north of Fresno.

Longer periods were simulated as a part of CRPAQS (Solomon and Magliano, 1998) using the Community Multi-scale Air Quality (CMAQ) model (Liang and Kaduwela, 2005; Liang et al., 2006; Fahey et al., 2006; Livingstone et al., 2009), CMAQ-UCD model (Zhang et al., 2005), UCD/CIT model (Ying et al., 2008a,b; Ying et al., 2009a,b; Ying, 2011), and the CMAQ-MADRID model (Pun, Balmori, and Seigneur, 2009; Zhang et al., 2010). The UCD/CIT model is an improved version of the CIT-UCD model with significant modifications made at the University of California at Davis.

The first group of simulations for the December 2000-January 2001 episode of CRPAQS were focused on revisions to the CMAQ model (Liang and Kaduwela, 2005), comparison of the standard and UC Davis versions of the CMAQ model (Zhang et al., 2005), and a detailed CMAQ model performance analysis (Liang et al., 2006). This was followed by an annual simulation of the CRPAQS period using the CMAQ model (Fahey et al., 2006). These simulations established the ability of the CMAQ model to satisfactorily simulate the $PM_{2.5}$ concentrations in the SJV, and the results were used in the 2008 annual $PM_{2.5}$ SIP (76 FR 41338; 76 FR 69896).

The first published $PM_{2.5}$ modeling in the SJV using the UCD/CIT model at 4 km horizontal grid spacing (Ying et al., 2008a) found general agreement between simulated and observed concentrations for both gaseous and PM species. The UCD/CIT model was able to simulate the major observed features of this 22 day severe particulate pollution event. The over-prediction of $PM_{2.5}$ at the rural site of Angiola was due to excessive emissions of fugitive dust. The model was able to reproduce the observed

PM nitrate during the first half of the episode, but the performance degraded during the second half due to issues with the meteorological fields.

The source apportionment of primary $PM_{2.5}$ in the SJV (Ying et al., 2008b) found elemental and organic carbon (EC and OC) to be the two major components. Higher concentrations of these two pollutants occur in urban areas and the concentrations were lower in rural areas. Wood burning and emissions from diesel engines were the two major sources of EC and OC. The source apportionment of secondary $PM_{2.5}$ revealed that diesel engines are the largest contributor to PM nitrate, while catalyst equipped gasoline engines also contributed significantly. The major ammonia source that contributed to the ammonium ion concentrations was agriculture. Sharp gradients of $PM_{2.5}$ concentrations were observed in urban areas.

The apportionment of PM OC to primary and secondary components is a very active area of current research. The oxidation of emitted organic compounds make gaseous, semi-volatile, and non-volatile products depending on the vapor pressure of the products. Using the UCD/CIT model, the apportionment of PM OC was investigated for the same 22 day period that was discussed above (Chen et al., 2010). It was found that, of the total predicted PM OC at Fresno, Angiola, and Bakersfield, 6 percent, 37 percent, and 4 percent were secondary in nature, respectively. On a SJV-wide basis ~20 percent of the total PM OC was secondary. The major precursors of secondary organic aerosol (SOA) were long-chain alkanes followed by aromatic compounds. The sources of these precursors were solvent use, catalyst gasoline engines, wood smoke, non-catalyst gasoline engines, and other anthropogenic sources, in that order.

In contrast, air quality modeling exercises conducted as part of the San Joaquin Valley 2008 $PM_{2.5}$ SIP using the CMAQ model showed that primary $PM_{2.5}$ emissions are the main contributor to organic aerosols and SOA contribute to only a small extent. Furthermore, SOA are primarily formed during the summertime, when total $PM_{2.5}$ concentrations are low, and are mainly derived from biogenic emission sources. Simulations of the CRPAQS wintertime episode conducted using CMAQ-MADRID (Pun et al., 2009) a model with an enhanced secondary organic aerosol formation mechanism, also found that organic aerosol concentrations were dominated by directly emitted $PM_{2.5}$. Because of the dominance of directly emitted $PM_{2.5}$ organic matter, overall a 50 percent reduction in anthropogenic VOC emissions had limited effects on the modeled $PM_{2.5}$ organic matter concentrations.

The transport of gaseous precursors and $PM_{2.5}$ from upwind areas has to be taken into account when developing effective control strategies for a given region. The UCD/CIT model was employed to investigate such transport in the SJV during the 22-day CRPAQS modeling period (Ying and Kleeman, 2009b). It was found that transport distances for $PM_{2.5}$ diminish as the air mass moves from north to south in the SJV due to diminishing wind speeds. The gaseous precursors transport longer distances compared to directly emitted $PM_{2.5}$, but the rate of active nitrogen partitioning into the particle phase increases as the air masses move towards the central and southern portions of the SJV. This is mainly due to the increased availability of ammonia in the central and southern SJV. Thus, the transported $PM_{2.5}$ impacts are the least in the southern SJV where the design values are the highest. For example, nearly 70 percent of the ammonium nitrate in the most polluted areas of the SJV is of local origin.

The CRPAQS winter period was also simulated using the CMAQ-MADRID model (Pun, Balmori, and Seigneur, 2009). Their main finding was that NO_x controls were the most effective strategy, followed by VOC and ammonia. This finding was consistent with that for the 1995 IMS-95 episode (Kleeman, Ying, and Kaduwela, 2005). They also found that VOC controls tend to reduce the oxidant concentrations, but had a relatively small effect on PM nitrate concentrations, indicating that background oxidant concentrations were sufficient to sustain the PM nitrate production. They observed that NO_x reductions can, in some cases, increase the night-time PM nitrate concentrations. This was due to the fact that reduced NO_x would lead to increased O_3 at the end of the day enhancing the N_2O_5 formation leading to increased PM nitrate formation. But, in general a 50 percent NO_x reduction resulted in ~30-50 percent reduction in PM nitrate.

Pun, Balmori, and Seigneur (2009) also found VOC and ammonia controls to be beneficial at some locations at certain times. However, the response of $PM_{2.5}$ nitrate to a 50 percent reduction in VOC emissions increased as $PM_{2.5}$ levels rose during the episode. The difference in the VOC response on the days with the higher $PM_{2.5}$ concentrations as compared to those days with lower concentrations may be due to a difference in the chemical formation regime for nitrate. In general, there is sufficient background ozone to generate enough free radicals to initiate and propagate the chemistry of nitrate formation (Ying et al., 2009). However, on days with high $PM_{2.5}$ concentrations, the daytime photochemistry may have contributed to a rapid increase in nitrate, resulting in higher VOC and NO_x sensitivity. It does not appear that VOCs contributed significantly to the free radical budget on the simulated days, mainly because rapid increases in ozone were not observed. The effect of VOC levels on nitrate formation may also have a diurnal pattern since the hydroxyl and hydroperoxyl radical levels are high during the daytime and negligible at night. In addition, more reactive VOCs react quickly during the day and there is a minimal carryover to the next day. Therefore it is reasonable to assume that the higher response to VOC and NO_x at higher concentrations may be due to the nitrate formation mechanisms rather than the $PM_{2.5}$ accumulation due to the length of the episode. Overall, nitrate was only responsive to a 50 percent reduction in VOCs at $PM_{2.5}$ concentration levels that are no longer reached in the San Joaquin Valley.

Pun at al., 2009 also shared Ying et al.'s (2008a) concern regarding the need for improved meteorological fields by stating that "… misprediction in the timing and coverage of the meteorological phenomenon can put a stop to PM accumulation in key areas of the SJV. Therefore, weaknesses in the meteorological models for simulating calm wintertime conditions would necessarily translate into performance issues pertaining to the air quality simulation."

The issues related to meteorological fields were further investigated by developing three alternative meteorological fields (Hu et al, 2010). In this study the Weather and Research Forecast (WRF) model was used to generate two meteorological fields, with and without four dimensional data assimilation. The third field was generated using a diagnostic wind model. After using all three models to simulate air quality with the UCD/CIT model, it was concluded that the "diagnostic wind fields based on a dense measurement network are the preferred choice for air quality model studies during stagnant periods in locations with complex topography." This finding is also consistent with that of a previous investigation of O_3 production in the SJV (Jackson et al., 2006). However, at this time, there is no preprocessor to process diagnostic wind fields for the CMAQ model and the diagnostic wind fields do not have all the quantities required by the CMAQ model. Therefore, we will continue to use the prognostic meteorological fields developed using both the MM5 and WRF models for this SIP.

For a shorter CRPAQS period (December 25-31, 2000) $PM_{2.5}$ mass, number, and size distributions were simulated using CMAQ-MADRID model (Zhang et al., 2010). While the model was able to reproduce the observed 24-hour $PM_{2.5}$ mass well, the prediction of component mass and time evolutions needed improvements. This study also highlighted the difficulties in simulating particle numbers and size distributions due to inaccuracies in model inputs and uncertainties in model formulations.

Recently, the UCD/CIT model was updated to include a process analyses scheme (Ying, 2011). Application of this updated UCD/CIT model to the same 22-day CRPAQS period indicated that, during the day, PM nitrate is photochemically formed within a few hundred meters above ground. This formation is more pronounced in urban areas where NO_x concentrations are higher relative to rural areas. During the early afternoon, the temperatures may be high enough to evaporate some of the PM nitrate. During the night, PM nitrate is formed via the N_2O_5 pathway within a few hundred meters above the surface. This formation is enhanced in the rural areas due to relatively higher O_3. During stagnant days, in which PM nitrate concentrations are generally higher, the PM nitrate concentrations build up aloft and lead to rapid increases in surface PM nitrate concentrations due to vertical diffusion.

The post-2000 applications of photochemical models in the SJV include the February 10-18, 2007 U.S. EPA Advanced Monitoring Initiative to measure the aerosol optical depth in the SJV (Rosen et al., 2006; Lewis et al., 2010; Ying, Jackson, and Kaduwela, 2011), the California portion of the Arctic Research of the Composition of the Troposphere from Aircraft and Satellites (ARCTAS-CARB) which took place during

May-July 2008 (Kaduwela and Cai, 2009; Jacob, et al., 2010; Huang et al., 2010; Singh et al, 2010; Pfister et al., 2011a,b; Huang et al., 2011; D'Allura et al., 2011), and CalNex 2010 (Research at the Nexus of Air Quality and Climate Change conducted in 2010,http://www.arb.ca.gov/research/calnex2010/calnex2010.htm, www.esrl.noaa.gov/csd/calnex/) for which only very preliminary air quality modeling has been conducted to date (Cai and Kaduwela, 2011; Kelly et al., 2011).

3. Selection of the Modeling Periods

3.1. Reference Year Selection and Justification

From an air quality perspective, ARB and the District have selected 2007 baseline design values for the modeled attainment test. These baseline concentrations values will serve as the anchor point for estimating future year projected concentrations. The selection of 2007 is based on the following considerations:

- The extensive wild fires that occurred in the San Joaquin Valley and throughout Northern California during 2008, adversely impacted air quality and the resulting $PM_{2.5}$ design values from 2008 through 2010. Therefore, this period is not suitable for air quality modeling purposes due to the atypical conditions;

- The design values recorded in 2007 were some of the highest in recent years. Analysis of the impacts of meteorology on $PM_{2.5}$ levels in the Valley over the last ten years indicate that the 2007 meteorology was one of the most conducive to $PM_{2.5}$ formation. Thus, the selection of 2007 represents a conservative approach to the attainment demonstration modeling.

Thus, 2007 will be used as both the base case and baseline year. A 2007 base case inventory will be used, together with 2007 meteorology fields, for model performance evaluation. The same emissions, without day-specific information, will then be projected to the future year for the calculation of Relative Response Factors (RRF).

3.2. Future years and justifications

As specific U.S. EPA guidance for the implementation of the 2006 $PM_{2.5}$ standard is not yet available, we have used the framework set forth in the original $PM_{2.5}$ Implementation Rule to determine appropriate deadlines for attainment. The $PM_{2.5}$ Implementation Rule requires areas to achieve attainment within five years from the date of designation, with the potential for up to a five year extension. The Valley was designated nonattainment on December 14, 2009. For the 2006 $PM_{2.5}$ standard, these dates would be December

14, 2014 and December 14, 2019. Given the severity of the San Joaquin Valley's $PM_{2.5}$ problem, initial modeling will be focused on evaluating attainment in the ten year timeframe.

December 14th is for all practical purposes the end of the year; we will conduct the attainment year modeling for the calendar year January 1, 2019 through December 31, 2019. This is consistent with U.S. EPA guidance published on March 2, 2012.

3.3. Justification for Quarterly Modeling instead of Several Episodes

One of the key observations made in the revised modeled attainment test for 24-hour $PM_{2.5}$ is that the temporal distribution of high days in the base and future periods will not remain the same (Fox, 2011). This requires that we simulate at least eight high $PM_{2.5}$ days per quarter for each year we simulate. It is possible that these eight high days will not come from a single episode and, thus, more than one, and perhaps several, episodes would need to be simulated. If that is the case, it is simpler to simulate the whole quarter in one attempt than to keep track of simulations for several episodes. It is possible, however, that there will be no high $PM_{2.5}$ days in quarters other than winter months for the San Joaquin Valley. In that case, modeling the 4th and 1st quarters (that include winter months) would suffice. In fact, preliminary modeling has verified that this is the case. Therefore, we propose to simulate only the first and fourth quarters instead of all four quarters, since this will not affect the attainment modeling outcome.

3.4. Identification of Exceptional Events to be excluded from Base/Reference/Future Year Modeling

Exceptional events are unusual or natural events that can overwhelm existing control strategies for man-made pollution. If such an event occurs, U.S. EPA allows states to exclude these values from use in SIP air quality modeling since these events cannot be controlled. Projecting these events into the future is not representative of an area's ability to attain the $PM_{2.5}$ standard. ARB and the district will review the data proposed for use in the modeling and identify exceptional events. Examples of exceptional events that will be evaluated include (but are not limited to): wildfires, high winds and dust, and fireworks. For each event identified, documentation will be included justifying exclusion.

4. Development of Emissions Inventories

In support of the various SIPs across California to meet the federal 24-hour $PM_{2.5}$ standard, emission inputs for modeling (commonly and interchangeably referred to as 'modeling inventories' or 'gridded inventories') have been developed by ARB and district staff. The following sections of this document describe how base case and future year emissions estimates for modeling were prepared.

A document that provides a more detailed description of the emission inventory will be prepared separately and submitted to U.S. EPA as a part of the SIP documentation.

4.1. $PM_{2.5}$ Emissions Inventory Development

In support of emissions inventory development, the Air Resources Board convened two inventory coordination groups:

- The $PM_{2.5}$ SIP Emission Inventory Working Group. This group was focused on annual average emission estimates for each county, air basin, and district. ARB maintains an electronic database of emissions and other useful information for these aggregate emission estimates, which provide a foundation for the development of a more refined (hourly, grid-cell specific) set of emission inputs that are required by air quality models. ARB's database is called the California Emission Inventory Development and Reporting System (CEIDARS). This group was focused on improving ARB-District emission estimates in ARB's CEIDARS database. Participants included district staff from the Bay Area, Imperial, Sacramento, San Joaquin, Butte, South Coast, El Dorado, Yolo-Solano, Shasta, Northern Sierra, Feather River and Placer regions. The purpose of this group was to update the 2005 CEIDARS inventory (emissions and other needed data) in preparation for the SIPs.

- The SIP Gridded Inventory Coordination Group (SIP-GICG). This group was focused on more refined emissions estimates to be used in air quality modeling (e.g. for a specific grid cell and hour). The purpose of the SIP-GICG is to conduct quality assurance of the associated data, and to distribute and coordinate the development of emission inputs for SIP modeling. Local air districts that participated included San Joaquin Valley Unified APCD, Bay Area AQMD, Sacramento Metropolitan AQMD, South Coast AQMD, Ventura County APCD, San Diego County APCD, Imperial County APCD, Mojave Desert AQMD, Northern Sierra AQMD, Yolo/Solano AQMD, Placer County APCD, El Dorado County APCD, San Luis Obispo County APCD, and Santa Barbara County APCD.

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 consists of two studies: 1) the Central California Ozone Study (CCOS); and 2) the California Regional $PM_{10}/PM_{2.5}$ Air Quality Study (CRPAQS).

The sections below provide details as to how the emissions inputs required by air quality modeling are created.

4.1.1. Background

In order to understand how the modeling inventories are developed, it is necessary to understand the basics of how an annual average emission inventory is developed. 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 of hundreds of millions of applications of other products such as paint and consumer products. The development and maintenance of the inventory is a multi-agency effort involving the ARB, 35 local air pollution control and air quality management districts (Districts), regional transportation planning agencies (RTPAs), and the California Department of Transportation (Caltrans). The ARB is responsible for the compilation of the final, statewide emission inventory, and maintains this information in a complex electronic database. Each emission inventory reflects the best information available at the time.

To produce regulatory, countywide emissions estimates, the basic principle for estimating 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 model year based on dynamometer tests of a small sample of that vehicle type and applied to all applicable vehicles. The usage of those vehicles is based on an estimate of such activities as a typical driving pattern, number of vehicle starts, typical miles driven, and ambient temperature. It is assumed that all vehicles of this type in each region of the state are driven under similar conditions.

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. 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 point sources are measured in such terms as the amount of product produced, solvent used, or fuel used.

ARB maintains an electronic database of emissions and other useful information. Annual average emissions are stored for each county, air basin, and district. The database is CEIDARS. Emissions are stored in CEIDARS for criteria and toxic pollutants. The criteria pollutants are total organic gases (TOG), carbon monoxide (CO), oxides of nitrogen (NO_x), oxides of sulfur (SO_x), and total particulate matter (PM). Emissions may also be reported for reactive organic gases (ROG), particulate matter 10 microns in diameter and smaller (PM_{10}) and particulate matter 2.5 microns in diameter and smaller ($PM_{2.5}$) in CEIDARS. However, for modeling inventories, ROG, PM_{10} and $PM_{2.5}$ are calculated from TOG and PM, respectively. Modeling inventories require speciated emissions that are calculated from total organics or total particulate matter. Ammonia emissions are also estimated for some sources. Following are more details on how emissions are estimated for point and area sources, on-road motor vehicles, and biogenic sources. Additional information on emission inventories can be found at: http://www.arb.ca.gov/ei/ei.htm

4.1.2. Terminology

Emission Source Type 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 4-1 summarizes the difference in the terms. Both sets of terms are used in this document. In modeling terminology, "point sources" refers to elevated emission sources that exit from a stack and have a potential plume rise. "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. In the development of the $PM_{2.5}$ inventories, all point sources were treated as possible elevated sources. Processing of the inventory for the air quality model will determine which vertical layer the emissions from a process will be placed into. So, for the modeling inventories, the use of the term "point sources" is the same whether using the modeling or emission inventory definition.

Table 4-1: Inventory Terms for Emission Source Types

Modeling Term	Emission Inventory Term	Examples
Point	Stationary – Point Facilities	Stacks at Individual Facilities
Area	Off-Road Mobile	Industrial Equipment, Construction Equipment, Vessels, Trains
Area	Area-wide	Fugitive Dust,, Wood Stoves/Fireplaces, Farming Operations, Consumer Products
Area	Stationary - Aggregated	Industrial Fuel Use
On-Road Motor Vehicles	On-Road Mobile	Cars and Trucks
Biogenic	Biogenic	Trees

Emissions Scenarios and the Modeled Attainment Test: Since emission changes have a significant influence on the calculation of the relative response factor (RRF), it's important that the emission inventory scenarios used in modeling are consistent with modeling guidance and that the terms used for the emission inventory scenarios are clearly defined.

- **Base Case Modeling Inventory (2007)**: Base case modeling is only intended to demonstrate confidence in the capability of the modeling system that is used for the modeled attainment test; however, it is not used as part of the modeled attainment test itself. Since 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. Thus, for use in assessing model performance, a day-specific base case modeling inventory for 2007 will be developed. This will include, for instance, actual SJVAPCD-reported point source emissions information for 2007 as well as other available day-specific activities and emission adjustments. The year 2007 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 ARB and the SJVAPCD began a comprehensive review and update of the emission inventory several years ago. At that time, the 2005 emissions inventory was the most recent inventory required to be submitted to the U.S. EPA. Therefore, 2005 was selected as the emission inventory base year for the SJVAPCD's 24-hour $PM_{2.5}$ SIP. As a result, where day-specific 2007 emissions information is not available for certain categories, the 2005 base year emission inventory will be projected to 2007.

- **Reference Year (or Baseline) Modeling Inventory (2007):** Unlike the base case modeling inventory for 2007described previously, the reference year inventory is not developed to capture day-specific emission characteristics.

Rather, per U.S. EPA guidance, the reference year inventory is intended to be a representation of emission patterns occurring through the baseline design value period (described above) 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 year reference year inventory provides an appropriate platform for comparisons between the base year and future years." The 2007 reference year inventory represents typical, average conditions and emission patterns through the 2007 design value period; and it will exclude day-specific information other than temperature, humidity, and solar insolation effects and District-reported point source emissions information for 2007.

- **Future Year Modeling Inventory (2019)**: As described previously, future year modeling inventories along with the reference year modeling inventory are used in the model-derived RRF calculation. These inventories maintain the "typical", average patterns of the 2007 Reference Year modeling inventory. The 2019 inventory will include temperature, humidity, and solar insolation effects from reference year (2007) meteorology. Future year point source emissions will be projected from the 2007 District-reported point source emissions used in the 2007 Reference Year Modeling Inventory.

In summary and based on the terminology above, the following modeling emission inventories will be developed:

- **2007 Base Case Modeling Inventory**: This day-specific inventory will be used for the model performance evaluation.
- **2007 Reference Year (Baseline) Modeling Inventory**: This 2007 reference year inventory will be used to determine site-specific RRFs in the modeled attainment test. It is not a day-specific inventory. Rather, the 2007 reference year modeling inventory represents typical, average conditions and emission patterns over the baseline design value period, excluding day-specific

information other than 2007 meteorological effects and District-reported point source emissions information for 2007.

- **Future Year Modeling Inventories for 2019**: These typical, average-day inventories will be used to determine year and site-specific RRFs in the modeled attainment test. Consistent with the 2007 Reference Year Modeling Inventory, the 2019 inventory includes 2007 meteorological effects.

4.2. Point and Area Source Emissions

4.2.1. Development of Base-Year Emission Inventory

The stationary source component of the emission inventory is comprised of nearly 20,000 individual facilities, called “point sources”, and about 160 categories of “aggregated point sources”. Aggregated point sources are groupings of many small point sources that are reported as a single source category (gas stations, dry cleaners, and print shops are some examples). These emission estimates are based mostly on area source methodologies or emission models. Thus, the aggregated point sources include emissions data for the entire category of point sources, not each specific facility. All districts report as point sources any facility with criteria pollutant emissions of 10 tons per year and greater. Most districts choose a cutoff smaller than 10 tons per year for reporting facilities as point sources. Any remaining sources not captured in the point source inventory are reported as aggregated point sources.

The area-wide source component includes several hundred source categories and is made up of sources of pollution mainly linked to the activity of people. Examples of these categories are emissions from paved and unpaved road dust; wood stoves and fireplaces; farming operations, and consumer products. The emissions for these categories are located mostly within major population centers. Some of the emissions in these categories come from agricultural centers and construction sites.

The other mobile source inventory is based on the population, activity, and emissions estimates of the varied types of off-road equipment. Major categories includes engines and vehicles used in industrial, agricultural, construction, airport ground support, and lawn and garden activities, from hedge trimmers to cranes. Other sources include ocean-going vessels, locomotives, aircraft and recreational boats and vehicles. Emissions are estimated by fuel type, such as gasoline, diesel, compressed natural gas, and liquefied petroleum gas. Emissions are estimated for about 2,000 separate categories. Carrying this level of detail allows for more accurate application of control measures as well as more specific assignments of speciation and spatial distribution. For more information, see: http://www.arb.ca.gov/msei/offroad/offroad.htm.

Local air districts estimate emissions from point sources. The districts provide point source information to ARB to update the annual average CEIDARS database. Estimating emissions from area sources is a cooperative effort between ARB and air district staffs. Updating the emission inventory is a continual process, as new information becomes available.

4.2.2. Quality Assurance of Base Year Emissions

In order to prepare the best inventory possible for use in modeling, ARB and district staff devoted considerable time and effort to conduct quality assurance (QA) of the inventory. Staffs from local air districts conducted extensive quality assurance to provide an accurate and complete inventory.

In particular, facility location, stack data, and temporal data were closely checked. This information is critical whenever air quality modeling is conducted, such as during SIP preparation or special studies such as CCAQS. However, these data are not always of sufficient quality in the inventory database since this information is not needed in the actual calculation of emissions and resources are limited. ARB ran several types of QA reports on the inventory to assist the districts in locating errors or incomplete information. This QA process began with the 1999 CEIDARS database, and continued with the 2002 CEIDARS database that was used for previous $PM_{2.5}$ and ozone inventory preparation. The QA process has continued with the 2005 and subsequent CEIDARS databases. The 2005 CEIDARS database is the basis for the modeling inventories developed for the 24-hour $PM_{2.5}$ SIPs in northern California. Staff of the

South Coast AQMD is using the 2008 CEIDARS database for their modeling effort covering southern California (approximately the Tehachapi Mountains southward).

- Stack data – The report checks for missing or incorrect stack data. The report lists missing stack data and also checks the data for reasonable stack height, diameter, temperature, and stack velocity. Additionally, the report compares the reported stack flow rate with the computed theoretical flow rate (calculated using the diameter and stack velocity).

- Location data – The report checks for missing or wrong Universal Transverse Mercator) UTM coordinates. The report lists missing UTM coordinates for both facilities and stacks. UTM coordinates are also checked to ensure that they are in the range for a given county. Another report is also run that shows the UTM coordinates for a facility grouped by the city in which the facility is located. This allows staff to look for outliers that may indicate facilities whose locations are in the county, but not in the correct location. Additionally, ARB staff reviewed location coordinates for accuracy and completeness. Comparisons were made using address or zip code mapping.

- Temporal data – The report checks for missing or invalid temporal information. Temporal codes used to describe the hours per day, days per week, and weeks per year are checked for completeness, accuracy, and validity. The relative monthly throughput, which assigns a relative amount of activity to each month of the year, is checked to ensure the sum is 100%.

- Code Assignments – Source Classification Codes (SCC) and Standard Industrial Classification Codes (SIC) were reviewed for accuracy. The SCC is used to determine the speciation profile assigned (speciation is discussed in another section of this document). The SIC and SCC combined determine which emission control rules may apply for forecasting emissions (see Section 4.3) along with the categorization of emissions for reporting purposes.

4.3. Future Year (Forecasted) Emissions

Air pollution programs have always depended on predictive models for gaining a better understanding of what the emissions will be in the future—these predictions are based on expectations of future economic conditions, population growth, and emission controls.

ARB's model to forecast or backcast emissions is known as the California Emission Projection Analysis Model (CEPAM). One module of CEPAM is the California Emission Forecasting System (CEFS) that has been used for many years to project emissions. CEPAM is designed to generate year-specific emissions estimates for each county/air basin/district combination taking into account two factors: 1) the effects of growth and 2) the effects of adopted emission control rules. It does this by linking these growth and control factors directly to emission categories for a particular base year. A key component of the model is the Rule Tracking Subsystem (RTS). The RTS was developed to link year-specific implementation of emission control rules to the emission process level. The emission process level is identified in one of two ways. For facilities, the Source Classification Code (SCC) and Standard Industrial Classification (SIC) are used. For all other sources, the Emission Inventory Code (EIC) is used. In total, the emission process level comprises more than 30,000 possible emission categories statewide.

4.3.1. Growth Factors

Growth factors are derived from county-specific economic activity profiles, population forecasts, and other socio/demographic activity. These data are obtained from a number of sources, such as:

- Districts and local regional transportation planning agencies (RTPAs) when they are available;
- Economic activity studies contracted by the ARB; and

- Demographic data, such as population survey data from the California Department of Finance (DOF) and Vehicle Miles Traveled (VMT) data from the California Department of Transportation (Caltrans).

Growth profiles are typically associated with the type of industry and secondarily to the type of emission process. For point sources, economic output profiles by industrial sector are linked to the emission sources via industrial sector classification, such as SIC or NAICS codes. For area-wide and aggregated point sources, other growth parameters such as population, dwelling units and fuel usage may be used. Growth factors are developed from the latest and best available data sources with input from stakeholders.

4.3.2. Control Factors

Control factors are derived from adopted State and Federal regulations and local district rules that impose emission reductions or a technological change on a particular emission process. These data are provided by the agencies responsible for overseeing the regulatory action for the particular emission categories affected. For example, the ARB staff develops the control factors for sectors regulated by the ARB, such as consumer products and clean fuels. The districts develop control factors for locally enforceable stationary source regulations that affect emissions from such equipment as internal combustion engines or power plant boilers. The Department of Pesticide Regulation (DPR) supplies control data for pesticides. In general, control factors account for three variables:

- Control Efficiency which estimates the technological efficiency of the abatement strategy
- Rule Effectiveness which estimates the “real-world” application of the strategy taking into account factors such as operational variations and upsets
- Rule Penetration which estimates the degree a control strategy will penetrate a certain regulated sector taking into account such things as equipment exemptions.

Control factors are closely linked to the type of emission process and secondarily to the type of industry. Control levels are assigned to emission categories, which are targeted by the rules via emission inventory codes (SCC/SIC, EIC etc.) that are used in CEIDARS.

4.4. Day-Specific Emissions

Day-specific data were used for preparing base case inventories when data were available. In previous studies, day-specific data were gathered for large point sources, unusual events (e.g. breakdowns), shipping, prescribed burns, and wildfires. Those previous studies focused on an episode lasting a few days. In this current work, inventories have been created for multiple years. The gathering of day- or hour-specific data from certain kinds of sources, such as large facilities or ship activity, becomes very resource intensive. However, ARB and district staffs were able to gather hourly/daily emission information for 1) wildfires and prescribed burns 2) paved and unpaved road dust and 3) agricultural burns in the San Joaquin Valley and Sacramento County. Additionally, a special model developed for ocean-going vessels was used.

4.4.1. 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 consists 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 consists of several steps of post-processing fire polygon emission estimates into gridded, hourly emission estimates that are formatted for use in air quality modeling.

4.4.2. Paved Road Dust

Statewide emissions from paved road dust were adjusted for each day of the year 2007. The adjustment reduced emissions by 25% from paved road dust on days when precipitation occurred.

Paved road dust emissions are calculated using the method described in AP-42, Fifth Edition, Volume I, Chapter 13: Miscellaneous Sources, Section 13.2.1 Paved Road, January 2011, (http://www.epa.gov/ttn/chief/ap42/ch13/final/c13s0201.pdf). This methodology includes equations that adjust emissions based on average precipitation in a month; these precipitation-adjusted emissions were placed in the CEIDARS databases. Since daily precipitation totals are readily available, ARB and district staff agreed that paved road dust emissions should be estimated for each day rather than by month. The emissions from CEIDARS were replaced with day-specific data for the appropriate years. A description of the steps used to calculate day-specific emissions is as follows:

1) 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.
2) To adjust for precipitation, daily precipitation data for 2005 and 2007 from ARB's meteorological database (http://www.arb.ca.gov/aqmis2/metselect.php) are used. The specific data sources for these data include: Remote Automated Weather Stations (RAWS), AIRS, and California Irrigation Management Information System (CIMIS) networks. Precipitation data are not available from ARB's meteorological database for San Francisco County and the Lake Tahoe Air Basin portion of Placer County (Placer/LT). Precipitation at the San Francisco International Airport in San Mateo County is used to determine precipitation in San Francisco County. Likewise, precipitation measured at stations in the Lake Tahoe Air Basin portion of El Dorado County is used to determine precipitation in Placer/LT.
3) The emissions from item 1 are adjusted using the precipitation data from item 2. 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.

4) Replace the annual average emissions with day-specific emissions for every day in the corresponding emission inventory dataset.

4.4.3. Unpaved Road Dust

Statewide emissions from unpaved road dust were adjusted for rainfall suppression for each day of the year. The adjustment reduced countywide emissions by 100% (total suppression) from unpaved road dust on days when precipitation greater than 0.01" occurred in a county.

Dust emissions from unpaved roads were calculated using an emission factor (EF) derived from tests conducted by the University of California, Davis, (UCD) 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 the method described in AP-42, Fifth Edition, Volume I, Chapter 13: Miscellaneous Sources, Section 13.2.2 Unpaved Road, November 2006, (http://www.epa.gov/ttn/chief/ap42/ch13/final/c13s0202.pdf). Equation (2) adjusts emissions based on annual precipitation; these precipitation-adjusted emissions were placed in the CEIDARS database. Similar to paved road dust, ARB 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.

1) Start with the daily uncontrolled emissions for each county/air basin as estimated from ARB's methodology. In other words, no precipitation adjustments have been incorporated in the emission estimates.
2) Use daily precipitation data from ARB's meteorological database (http://www.arb.ca.gov/aqmis2/metselect.php). Data sources come from outside sources, including Remote Automated Weather Stations (RAWS), AIRS, and California Irrigation Management Information System (CIMIS) networks. Convert from millimeters to inches.

3) 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.
4) Replace the annual average emissions with day-specific emissions for every day.
5) Precipitation data are not available from ARB's meteorological database for San Francisco County and the Lake Tahoe Air Basin portion of Placer County (Placer/LT). Precipitation at the San Francisco International Airport in San Mateo County is used to determine precipitation in San Francisco County. Likewise, precipitation measured at stations in the Lake Tahoe Air Basin portion of El Dorado County is used to determine precipitation in Placer/Lake Tahoe.

4.4.4. Agricultural Burn Data for San Joaquin Valley

The San Joaquin Valley Air Pollution Control District estimated emissions for each day during 2005 through 2010 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 is available at: http://www.arb.ca.gov/ei/areasrc/distmiscprocwstburndis.htm

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.

4.4.5. Ocean-Going Vessels

The emissions for ocean-going vessels were generated with version 2-3H of the ARB Marine Model. The model uses a power-based methodology to estimate emissions. Inputs to the model include vessel call data obtained from the California Lands Commission; vessel specifications and power ratings from Lloyds-Fairplay, vessel berthing statistics from port authorities, and vessel routing based upon the Ship Transportation Energy and Economic Model (STEEM) developed by the University of Delaware under contract with the Air Resources Board. Emissions were calculated by estimating ship emissions on a ship by ship and a port call by port call basis, using actual ship engine power estimates, speeds, and actual ship hoteling times where possible.

Emission control measures included in the inventory include the South Coast 20/40 nautical-mile voluntary vessel speed reduction program, the 2007 Shore Power regulation, the 2005 auxiliary engine regulation (while in effect) and the subsequent 2008 low sulfur fuel regulation, IMO tier 1 NOx engine standards, and the IMO North American Environmental Control Area which includes the IMO tier 3 NOx engine standards.

4.5. Temporally and Spatially Resolved Emissions

Emission inventories that are temporally and spatially resolved are needed for modeling purposes, for both the base year and future years. Annual average emissions for point and area sources were used as input to version 2.6 of SMOKE (Sparse Matrix Object Kernel Emission). The SMOKE processor was developed by the MCNC-North Carolina Supercomputing Center, Environmental Sciences Division, with U.S. EPA cooperation and support. Temporal information is input into SMOKE. Adjustments are made for variations in months, day of week and hour of day. Emissions are estimated for each county, air basin, and district combination for each day of the year. The SMOKE processor also distributes emissions to each grid cell. The spatial allocation of emissions is discussed in Section 4.9.

The emission inventories for $PM_{2.5}$ modeling in northern California were developed from the 2005 annual average CEIDARS database for TOG, NO_x, SO_x, CO, PM, and ammonia. Inventories for point and area sources were developed for each day for a variety of years between 2005 and 2020 as needed for input to air quality models.

4.6. 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 on mobile source and biogenic emissions in each grid cell.

Gridded temperature, humidity, and radiation fields are readily available from prognostic meteorological models such as MM5, which is used to prepare meteorological inputs for the air quality model. However, it is widely recognized that diagnostic (i.e. observation-based) models provide more accurate local-scale estimates of ground surface temperature and humidity. As a result, the CALMET diagnostic meteorological model is used to generate a gridded temperature field and an objective analysis scheme is used to generate a gridded humidity field. The solar radiation fields needed for biogenic emission inventory calculations were taken from the MM5 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 measurement) using the lapse rate of -0.0049 ^{o}C/m again.

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:

1) Calculate actual vapor pressure from observed relative humidity and temperature at all meteorological stations. The McRae (1980) method is used to calculate the saturated vapor pressure from temperature;
2) Compute the relative weights of each surface observation station to each grid in question, exactly as done by CALMET to compute the temperature field;
3) Use the weights from step 2 to compute a spatially-averaged estimate of actual vapor pressure in each grid cell;
4) For each grid cell, calculate relative humidity from values for actual vapor pressure and temperature for the same grid cell.

4.7. On-Road Mobile Source Emissions

As described in the prior sections, air quality models require gridded, hourly emission inputs. However, California's official on-road motor vehicle emission inventory model, EMFAC, is designed to produce *county-level, average-day* estimates. As a result, emission estimates from EMFAC must be disaggregated spatially and temporally from county-level, average-day estimates into gridded, hourly estimates. The general methodology that ARB has used to disaggregate EMFAC emission estimates in the past is described below and will be used again. Basically, it involves using the Direct Travel Impact Model (DTIM) (Systems Applications, Inc. 2001) to produce gridded, hourly emission estimates, and then uses these estimates as a gridded hourly spatial surrogate to distribute EMFAC emissions. The methodology has been peer reviewed by the Institute of Transportation Studies department at the University of California, Irvine, under a CCOS contract.

The most recent version of EMFAC, EMFAC2011, is comprised of two separate emission model components: EMFAC2011-LD and EMFAC2011-HD. The LD model generates emissions for light- and medium- duty gasoline vehicles, heavy-duty gasoline vehicles, and light- and medium-duty diesel vehicles. The HD model generates emissions for heavy-duty diesel vehicles. The general methodology described below will be performed three times: the first time for light duty gasoline vehicle emissions from EMFAC2011-LD; a second time for heavy duty gasoline vehicle emission estimates from EMFAC2011-LD; and a third time for heavy duty diesel vehicle emissions from EMFAC2011-HD. Methodological details are currently being updated where necessary to work with the new version of EMFAC.

4.7.1. General Methodology

Mobile source emissions are sensitive to ambient temperature and humidity. Both EMFAC and DTIM account for meteorological effects using day-specific inputs (the gridded, hourly meteorological data used are described under the prior section titled "Surface Temperature and Relative Humidity Fields"). 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.

EMFAC provides vehicle-class-specific emissions estimates for exhaust emissions, evaporative emissions, tire wear emissions and brake wear emissions. EMFAC also produces estimates of fuel consumption, vehicle miles traveled (VMT), and the number of vehicles in use. More information on EMFAC is available at the following link. http://www.arb.ca.gov/msei/modeling.htm

Temporal Adjustment (Day-of-Week adjustments to EMFAC daily totals): Day-of-Week (DOW) adjustments are made to the total daily emissions estimated by EMFAC for Friday, Saturday, Sunday, and Monday days of the week. The logic behind this is that EMFAC produces emission estimates for an *average day of the week*. It is assumed that EMFAC's average day of week emissions generally represents Tuesday, Wednesday, and Thursday. Day of week adjustment factors were developed using Automatic Vehicle Classifier (AVC) count data from the California Department of Transportation (Caltrans). These data were collected at 139 sites in the state during the summer of 2004 (specifically, data for the months of June, July and August were used, excluding data from July 2-5 to remove unusual traffic patterns around the July 4th holiday). Three Caltrans factors were developed: (1) passenger cars (LD), (2) light and medium duty trucks (LM), and (3) heavy-heavy duty trucks (HHDT). An example of the prior assignment of these factors to EMFAC2007 classifications is summarized below.

Caltrans' Factor for EMFAC2007 Class*	Description	Day-of-Week (DOW)
1	LDA	LD
2	LDT1	LD
3	LDT2	LD
4	MDV	LD
5	LHDT1	LM
6	LHDT2	LM
7	MHDT	LM
8	HHDT	HHDT
9	Other Bus	LM
10	School Bus	Unadjusted on weekdays, zeroed on

		weekend days
11	Urban Bus	LD
12	Motorhomes	LD
13	Motorcycles	LD

* Vehicle classes are being updated for use with EMFAC2011

Separate factors were developed for each Caltrans District. All counties within each Caltrans district use the same adjustment. So, the day of week adjustment process consists of applying four Caltrans day of week (DOW) factors to EMFAC daily total emission estimates (i.e. which represent Tuesday, Wednesday, and Thursday): one each for Friday, Saturday, Sunday, and Monday.

Temporal Adjustment (Hour-of-Day re-distribution of hourly travel network volumes): The travel networks provided by local government agencies and used for DTIM represent an average day hourly distribution. Like 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 day-of-week temporal variations that are known to occur on other days of the week. To rectify this, hour-of-day profiles for Friday through Monday were developed using Caltrans data. These are used to re-allocate the hourly travel network distributions used in DTIM to Friday through Monday.

Spatial Adjustment: The spatial allocation of countywide 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, so a mapping between EMFAC and DTIM vehicle categories is necessary (this is being updated to work with EMFAC2011). DTIM's 40 emission categories are presented in the table below. The categories are represented by the listed source classification codes (SCC) 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 4-2: DTIM Emission Categories

SCC for Light-duty and Medium-duty Vehicles	SCC for Heavy-Duty 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
208	308	Diesel Exhaust
209	309	Running Evaporatives
210	310	Resting Evaporatives
211	311	Multi-Day Resting
212	312	Multi-Day Diurnal
213	313	PM Tire Wear
214	314	PM Brake Wear
215	315	Catalyst Buses
216	316	Non-catalyst Buses
217	317	Diesel Bus
218	318	Catalyst Idle
219	319	Non-catalyst Idle
220	320	Diesel Idle
221	321	PM Road Dust

Summary of On-road Emissions Processing Steps: Five general steps are used to spatially and temporally allocate EMFAC emissions by hour and grid cell:

Step 1 (DTIM T & RH inputs). Gridded, hourly temperature (T) and relative humidity (RH) fields for each day are prepared as inputs to DTIM.

Step 2 (DTIM emission factor inputs). EMFAC is run in default mode (i.e. without day-specific temperature and relative humidity) to generate a look-up table of on-road mobile source emission factors by speed, temperature, and relative humidity for each county.

Step 3 (Day-specific EMFAC runs to yield daily and hourly estimates). EMFAC is run using episode-specific T and RH data to provide countywide on-road mobile source emission estimates by day and hour for EMFAC categories. The episode-specific meteorological inputs for EMFAC are generated via averaging (VMT-weighted) the gridded, hourly meteorology from Step1 by county and hour.

Step 4 (DTIM inputs – redistribute roadway network hourly volumes using Caltrans DOW factors)

- 4a. Sum the hourly volumes by vehicle type and county on the roadway network into daily totals.
- 4b. Tuesday through Thursday. No DOW adjustment. For hour of day, redistribute heavy-duty volumes by county using Caltrans hourly profiles. No change to light duty hourly volumes.
- 4c. Friday, Saturday, Sunday, and Monday. Adjust total daily volumes by county using Caltrans DOW factor. Use Caltrans hourly profiles by county to redistribute DOW-adjusted total volumes using Caltrans hourly profiles for all vehicles.

Step 5 (Run DTIM and spatially/temporally distribute EMFAC emissions)

- 5a. Run DTIM with revised roadway network activity from Step 4.
- 5b. Sum DTIM emissions by county and SCC.
- 5c. Distribute EMFAC emissions. EMFAC daily, countywide emissions (adjusted for weekend days, if needed), are disaggregated by category into grid-cells for each hour of the day using the DTIM output as a spatial and temporal surrogate. The disaggregation follows 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

ij = grid cell

hr = hourly emissions

cat = Emission Category

daily = daily emissions

cnty = county

Future Year On-road Emissions: Forecasted on-road modeling inventories are developed using the same methodology, where future year emissions are based on running EMFAC for the associated future year.

4.8. Biogenic Emissions

Development of a comprehensive emissions inventory requires estimation of both man-made and biogenic emissions. These biogenic volatile organic compounds (BVOCs) include compounds such as isoprene and monoterpenes. Due to the heterogeneity of vegetation land cover, species composition, and leaf mass distribution in California, quantifying BVOC emissions in this domain requires an emission inventory model with region-specific input databases and a high degree of spatial and temporal resolution. In response to this need, the California Air Resources Board (CARB) developed a Geographic Information System (GIS)-based model for estimating BVOC emissions, called BEIGIS (Scott and Benjamin, 2003), which uses California-specific input databases with a minimum spatial resolution of 1 km^2 and an hourly temporal resolution. To take advantage of recent scientific advances in biogenic emissions modeling, CARB has recently transitioned from the BEIGIS model to the Model of Emissions of Gases and Aerosols from Nature (MEGAN) version 2.04 (Guenther et al., 2006). MEGAN is a state-of-the-science biogenic emissions model, which represents an evolution of the Biogenic Emissions Inventory System (BEIS), and is being integrated into the Community Multi-scale Air Quality (CMAQ) modeling system by U.S. EPA scientists.

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). MEGAN requires input datasets of Emission Factors (EF; at standard conditions: temperature = 303 ˚K, LAI = 5, photosynthetically active radiation ~ 1500 μmol $m^{-2}s^{-1}$), Plant Functional Type (PFT), and hourly surface temperature and insolation. The default MEGAN input databases for EFs, 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 BEIGIS to improve emission estimates and to maintain consistency with previous California biogenic emission inventories. LAI data is derived from the MODIS 8-day LAI satellite product. Hourly surface temperatures are from observations gridded with the CALMET meteorological model and insolation (light reaching the surface) data is provided by the MM5 meteorological model. Emissions of isoprene, monoterpenes, and methylbutenol are estimated from California-specific gridded emission factor data, while emissions of sesquiterpenes, methanol, and other volatile organic compounds are estimated from California-specific PFT data and PFT derived emission rates. For urban areas, land use/vegetation land cover databases were developed from regional planning agency data and botanical surveys (Horie et al. 1990; Nowak 1991; Sidawi and Horie 1992; Benjamin et al. 1996, 1997; McPherson et al. 1998). Natural areas are represented using the GAP vegetation database (also satellite-derived and air photo interpreted) developed by the U.S.G.S. Gap Analysis Program (Davis et al. 1995). Agricultural areas are represented using crop land cover databases developed by the California Department of Water Resources (*http://www.waterplan.water.ca.gov*).

Future-year specific biogenic emissions are not estimated because future inputs to BEIGIS, such as changes in climate and land use/land cover, are highly uncertain.

Photochemical modeling for future years uses the biogenic emissions developed for the base year.

4.9. Spatial Allocation

Once the base year or future year inventories are developed, as described in the previous sections, 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 used every day. Therefore, the spatial allocation of emissions in a modeling inventory only approximates the actual location of emissions.

Before any spatial allocation can be performed, the modeling grid domain must be defined. A modeling grid domain is a rectangular area that is sufficient in size to contain all emission sources that could affect modeling results. The definition of the modeling domain for this SIP is described below.

Once a grid is defined, the spatial allocation of emissions can be performed. Each area source category is assigned a spatial surrogate that is used to allocate emissions to a grid cell. Examples of surrogates include population, land use, and other data with known geographic distributions for allocating emissions to grid cells. The sections below discuss in detail the spatial surrogates developed for the SJV $PM_{2.5}$ SIP modeling.

Point sources are allocated to grid cells using the UTM coordinates reported for each stack. If there are no stack UTM coordinates, the facility UTM coordinates are used. When location data are not reported, the county centroid is used.

Emissions are also distributed vertically into their proper layer in the air quality model. The vertical layer is determined from the calculation of buoyancy for those emissions that are released from an elevated height with a significant upward velocity and/or buoyancy. Most vertical allocation is from significant point sources with stacks. In most modeling exercises, low-level point sources are screened out at this point and placed with the area sources. However, in this modeling exercise, all point sources from the inventory were kept as possible elevated sources. The air quality model will then place the point sources in the appropriate layer of the model. Additionally in this modeling exercise, day-specific wildfire emissions were also distributed vertically.

The spatial treatment of area and point sources has been described above. The spatial allocation of on-road motor vehicles is based on DTIM as described previously. For biogenic emissions, the spatial allocation is built “from the ground up” since MEGAN estimates emissions using a Geographic Information System (GIS) at a minimum resolution of one square kilometer.

4.9.1. Grid Definition

The ARB emissions inventory domain is defined to match the MM5 model domain, which is used to generate the meteorological parameter fields used for air quality modeling. MM5 uses a Lambert projection and assumes a spherical Earth. The emission grid is defined in a similar way to match as closely as possible.

The emission 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 domain extends entirely over California and 100 nautical miles west over the Pacific Ocean. A smaller subdomain is often used when modeling is being done for the San Joaquin Valley. It has the same grid definitions and resolution as the main domain, but has a smaller area offset to cover central and northern California.

The specifications of the emissions inventory domain and CCOS subdomain are:

<u>MAP PROJECTION</u>

Lambert Conformal Conic

Datum: NONE (Clarke 1866 spheroid)

1st Standard Parallel: 30.0° N

2nd Standard Parallel: 60.0° N

Central Meridian: -120.5° W

Latitude of Projection Origin: 37.0° N

<u>COORDINATE SYSTEM</u>

Units: Meters

Semi-major Axis: 6370 km

Semi-minor Axis: 6370 km

<u>DEFINITION OF GRID</u>

321 x 291 cells (4 km x 4 km)

Lambert Origin @ (-684,000 m, -564,000 m)

Geographic Origin @ -120.5° Latitude and 37.0° Longitude

<u>DEFINITION OF SUBGRID (CCOS)</u>

192 x 192 cells (4 km x 4 km)

Lambert Origin @ (-384,000 m, -300,000 m)

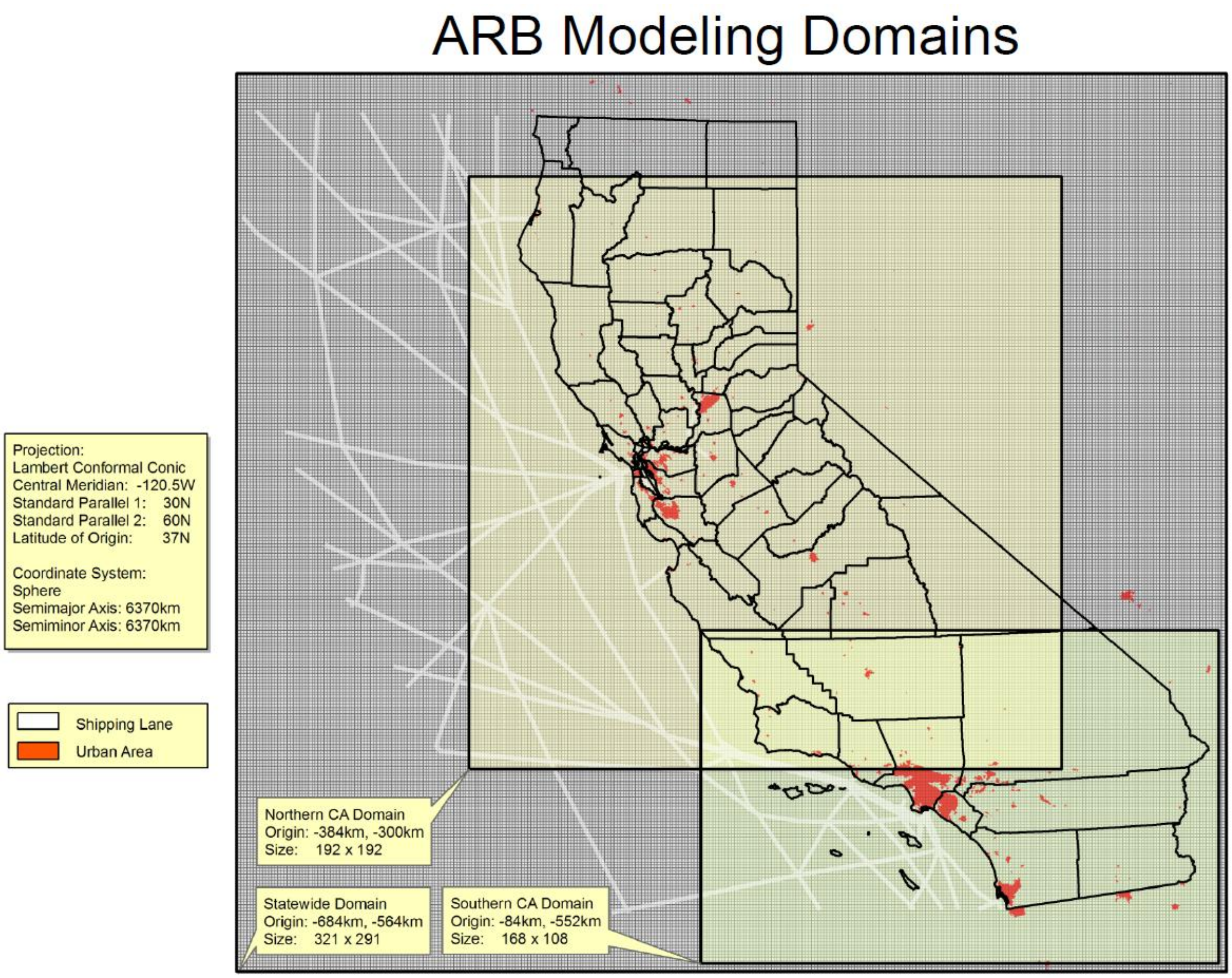
Geographic Origin @ -120.5° Latitude and 37.0° Longitude

4.9.2. Spatial Surrogates

Spatial surrogates are processed into spatial allocation factors for use in geographically distributing countywide area source emissions to individual grid cells. Spatial surrogates are developed based on economic, demographic, and land cover data which exhibit patterns that vary geographically. As has previously been discussed, point source emissions are allocated to grid cells using the location of the emission source. On-road motor vehicle emissions are spatially allocated by DTIM. Biogenic emissions are allocated by the MEGAN emissions model.

In support of CRPAQS and CCOS, Sonoma Technology, Inc. (Funk et al. 2001) developed gridded spatial allocation factors for a 2000 base-year and three future years

(2005, 2010, and 2020) for the entire state of California. STI's work was based on the statewide 4-kilometer (km) grid cell domain defined by the ARB. The definition and extent of the 4-km grid were used to create a 2-km nested grid for which spatial allocation factors were developed. In 2007, STI was contracted by CCOS again to update the spatial allocation factors. STI updated the underlying spatial data and updated the spatial surrogate cross-reference file to account for new emission source categories (Reid et al., 2006). STI then updated spatial allocation factors for ARB's statewide modeling domain for a base year of 2000 and future years of 2010, 2015, and 2020.   This task was completed in March 2008.



In preparation for modeling for the $PM_{2.5}$ SIPs, ARB staff reviewed the STI spatial surrogates associated with the highest emissions to see which surrogates were candidates for update. ARB staff searched for more recent or improved sources of data, since the underlying data used by STI were pre-recession, then updated 15 of the surrogates using more recent data. A total of 61 unique surrogates are available for use. A summary of the spatial surrogates for which spatial allocation factors were developed is listed in the table below.

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 tilling 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 rural regions, for which local data were not available, data from the Caltrans Statewide Transportation Model were used.

Table 4-3: Summary of spatial surrogates

Spatial Surrogate	Description
Airports	Spatial locations of all airports
All_PavedRds	Spatial distribution of road network (all paved roads)
AutobodyShops	Locations of autobody repair and refinishing shops
Cemeteries	Spatial locations of cemeteries
Comm_Airports	Spatial locations of commercial airports
Devplnd_HiDensity	Spatial distribution of high-density developed land
Devplnd_LoDensity	Spatial distribution of low-density developed land
Drycleaners	Locations of drycleaning facilities
DryLakeBeds	Locations of Dry lake beds
Elev5000ft	Elevation over 5000 feet developed from topological contours
Employ_Roads	Spatial distribution of total employment and road density (all paved roads)
Forestland	Spatial distribution of forest land
Fugitive_Dust	Spatial distribution of undeveloped, open land
GasStations	Locations of gasoline service stations
GasWells	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
Housing_Com_Emp	Spatial distribution of total housing and commercial employment
Housing_Restaurants	Spatial distribution of total housing and
IndusEmploy_Autobody	Spatial distribution of industrial employment and autobody/refinishing shops
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
Landfills	Locations of landfills
LiveStock	Spatial distribution of cattle ranches, feedlots, dairies, and poultry farms
Metrolink_Lines	Spatial distribution of metrolink network
MiltaryAirBases	Location of military air bases
MiltaryBases	Locations of military bases
NonIrr_Pastureland	Spatial location of non-irrigated pasture land
NonRes_Chg	Computed surrogate based on the change in spatial distribution of non-residential areas

Table 4-3. Summary of spatial surrogates (continued)

Spatial Surrogate	Description
OffShore_OilWells	Locations of off-shore oil wells
OilWells	Locations of oil wells
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 Publically Owned Treatment
PrimaryRoads	Spatial distribution of road network (primary roads)
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 the change in spatial distribution of residential and non-residential areas
ResGasHeating	Spatial distribution of gas heating population
Residential_Chg	Computed surrogate based on the change in spatial distribution of residential areas
ResNonResChg_IndEmp	Spatial distribution of industrial employment and residential/ non-residential change
Restaurants	Locations of bakeries and restaurants
ResWoodHeating	Spatial distribution of wood heating population
SandandGravelMines	Locations of sand/gravel excavation and mining
Schools	Spatial locations of schools
SecondaryPavedRds	Spatial distribution of road network (secondary roads)
Ser_ComEmp_Sch_GolfC_Cem	Spatial distribution of service and commercial employment, schools, cemeteries, and golf courses
Service_Com_Emp	Spatial distribution of service and commercial employment
Service_Emp	Spatial distribution of service employment
Shiplanes	Spatial distribution of major shipping lanes
SingleHousingUnits	Spatial distribution of single dwelling units
UnpavedRds	Spatial distribution of road network (unpaved roads)
Wineries	Locations of wineries

4.10. Speciation

The ARB's emission inventory and photochemical air quality models both quantify organic compounds as Total Organic Gases (TOG). Photochemical models simulate the physical and chemical processes in the lower atmosphere, and include all emissions of the important compounds involved in photochemistry. Organic gases are one of the most important classes of chemicals involved in photochemistry. Organic gases emitted to the atmosphere are referred to as total organic gases (TOG). ARB's chemical speciation profiles (CARB 2006) are applied to characterize the chemical composition of the TOG emitted from each source type.

TOG includes compounds of carbon, excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates, and ammonium carbonate. TOG includes all organic gas compounds emitted to the atmosphere, including the low reactivity, or exempt, VOC compounds (e.g., methane, ethane, various chlorinated fluorocarbons, acetone, perchloroethylene, volatile methyl siloxanes, etc.). TOG also includes low volatility or low vapor pressure (LVP) organic compounds (e.g., some petroleum distillate mixtures). 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.

Total Organic Gas (TOG) emissions are reported in the ARB's emission inventory and are the basis for deriving the Reactive Organic Gas (ROG) emission components, which are also reported in the inventory. ROG is defined as TOG minus ARB's "exempt" compounds (e.g., methane, ethane, CFCs, etc.). ROG is nearly identical to U.S. EPA's term "VOC", which is based on U.S. EPA's exempt list. For all practical purposes, use of the terms 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.

4.10.1. Speciation Profiles

Speciation profiles are used to estimate the amounts of various organic compounds that make up TOG. 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. Each process or product category is keyed to one of several hundred currently available speciation profiles. 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 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.

To the extent possible (i.e. given available data), ARB's organic gas speciation profiles contain all emitted organic species that can be identified (ideally, detected to very low levels). This includes reactive compounds, unreactive and exempt compounds, and to the extent the data are available, low vapor pressure compounds. Research studies are conducted regularly to improve ARB's species profiles. These profiles support ozone 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, organic gas emission profiles should be as complete and accurate as possible.

The speciation profiles used in the emission inventory are available for download from the ARB's web site at: http://www.arb.ca.gov/ei/speciate/speciate.htm.

The Organic Speciation Profiles (ORGPROF) file contains the weight fraction data (expressed as percent for ease of display) of each chemical in each profile. Each chemical fraction is multiplied by the Total Organic Gas (TOG) emissions for a source category to get the amount of each specific constituent chemical. In addition to the chemical name for each chemical constituent, the file also shows the chemical code (a 5-digit internal identifier) and the Chemical Abstracts Service (CAS) number, which is a unique identifying code (up to 9 digits) assigned to chemicals by the CAS Registry Service.

Also available for download from ARB's web site is a cross-reference file that indicates which Organic Gas profile is assigned to each source 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. This file also contains the fraction of reactive organic gas (FROG) values for organic profiles. Some of the Organic Gas Speciation Profiles related to motor vehicles and fuel evaporative sources vary by the inventory year of interest, due to changes in fuel composition and vehicle fleet composition over time.

ARB has an ongoing effort to update speciation profiles as data become available, such as through testing of emission sources or surveys of product formulations. New speciation data generally undergo technical and peer review, and updating of the profiles is coordinated with users of the data. Several recent changes to ARB's speciation profiles were for: 1) consumer products, 2) aerosol coatings, 3) architectural coatings, 4) pesticides and 5) hot soak from gasoline-powered vehicles.

The particulate matter 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 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 are used to collect PM samples for chemical analyses. Recently, the Micro-Orifice Uniform Deposit Impactor (MOUDI) has been used to collect PM samples for size resolved chemical composition analysis.

4.10.2. Chemical Mechanisms

Airshed models are essential for the development of effective control strategies for reducing photochemical air pollution because they provide the only available scientific basis for making quantitative estimates of changes in air quality resulting from changes in emissions. The chemical mechanism is the portion of the model that represents the processes by which emitted primary pollutants, such as TOG, carbon monoxide (CO), and oxides of nitrogen (NO_x), react in the gas phase to form secondary pollutants such as ozone (O_3) and other oxidants.

For State Implementation Plan (SIP) attainment demonstrations and evaluations, the U.S. EPA has approved the California Air Resources Board's photochemical air quality models. The air quality models used by the ARB for SIP attainment demonstrations use the SAPRC photochemical mechanism. This mechanism is based on extensive scientific research and is documented in the scientific literature (Carter 2000). Table 4-4 shows modeled ROG species (or species categories) for the SAPRC-99 chemical mechanism. Table 4-5 shows modeled species for NOx.

Table 4-4: ARB's SAPRC-99 Emitted Organic Model Species

Model Species Name	Description
HCHO	Formaldehyde
CCHO	Acetaldehyde
RCHO	Lumped C3+ Aldehydes
ACET	Acetone
MEK	Ketones and other non-aldehyde oxygenated products
PROD	
RNO3	Lumped Organic Nitrates
PAN	Peroxy Acetyl Nitrate

PAN2	PPN and other higher alkyl PAN analogues
BALD	Aromatic aldehydes (e.g., benzaldehyde)
PBZN	PAN analogues formed from Aromatic Aldehydes
PHEN	Phenol
CRES	Cresols
NPHE	Nitrophenols
GLY	Glyoxal
MGLY	Methyl Glyoxal
MVK	Methyl Vinyl Ketone
MEOH	Methanol
HC2H	Formic Acid
CH4	Methane
ETHE	Ethene
ISOP	Isoprene
TERP	Terpenes
MTBE	Methyl Tertiary Butyl Ether
ETOH	Ethanol
NROG	Non-reactive
LOST	Lost carbon
ALK1	Alkanes and other non-aromatic compounds that react only with OH, and have kOH < 5 x 10^2 ppm-1 min-1. (Primarily ethane)
ALK2	Alkanes and other non-aromatic compounds that react only with OH, and have kOH between 5 x 10^2 and 2.5 x 10^3 ppm-1 min-1. (Primarily propane and acetylene)
ALK3	Alkanes and other non-aromatic compounds that react only with OH, and have kOH between 2.5 x 10^3 and 5 x 10^3 ppm-1 min-1.
ALK4	Alkanes and other non-aromatic compounds that react only with OH, and have kOH between 5 x 10^3 and 1 x 10^4 ppm-1 min-1.
ALK5	Alkanes and other non-aromatic compounds that react only with

	OH, and have kOH greater than 1 x 10^4 ppm-1 min-1.
ARO1	Aromatics with kOH < $2x10^4$ ppm-1 min-1.
ARO2	Aromatics with kOH > $2x10^4$ ppm-1 min-1.
OLE1	Alkenes (other than ethene) with kOH < $7x10^4$ ppm-1 min-1.
OLE2	Alkenes with kOH > $7x10^4$ ppm-1 min-1.

Table 4-5: Model Species for NOx

Model Species Name	Description
HONO	Nitrous Acid
NO	Nitric Oxide
NO2	Nitrogen Dioxide

Both U.S. EPA's and ARB's models require estimates of total organic gases, which include the "exempt VOCs", and, to the extent data are available, any low vapor pressure compounds that become airborne. Model results for ozone non-attainment areas have demonstrated that even compounds with low photochemical reactivity or low vapor pressure can contribute to photochemical ozone formation. For example, even an "exempt VOC" like ethane has been shown to have a contribution to ozone formation. If all exempt compounds and low vapor pressure compounds were omitted from photochemical model simulations, the ozone attainment demonstration would be compromised. The model takes into account that, individually, compounds with low reactivity or that are present in small amounts have a small impact on ozone formation. However, the cumulative effect of several low reactive compounds or many low emission compounds can be a significant contributor to photochemical ozone formation.

4.11. Quality Assurance

To facilitate thorough quality assurance (QA), a variety of standardized emission summary reports for the periods simulated will be produced. Some examples of the standardized reports are contained in the sections below.

As indicated in the prior section, day-specific and external baseline adjustments were applied to baseline emission estimates. For the purpose of checking adjustment levels for accuracy, “baseline” and “adjusted” emission summary reports will be generated.

Inventory corrections will be prioritized based on emissions magnitude, schedule, and potential impact on air quality modeling results. As gridded emissions are processed and quality assured, suspect or unresolvable issues that may impact air quality model performance will be summarized and reported.

4.11.1. Examples of Standard Tabular Summaries

This section contains examples of tabular summaries that will be provided for review.

Domain Totals by Pollutant and Time Period for Baseline and Adjusted Emissions

CO	NOx	SOx	TOG	PM	NH3	ROG	PM_{10}	$PM_{2.5}$
17,939.63	4,308.18	285.01	7,334.56	4,109.78	762.98	3,620.07	2,472.03	810.70

Totals by Major Category, Pollutant, and Time Period for Baseline and Adjusted Emissions

EIC1	DESCRIPTION	CO	NOx	SOx	TOG	PM	NH3	ROG	PM_{10}	$PM_{2.5}$
0	FUEL COMBUSTION	384.18	406.63	48.20	148.62	45.55	5.49	34.17	40.08	37.24
1	WASTE DISPOSAL	2.18	3.02	0.67	1,245.77	1.62	42.56	14.86	0.83	0.73
EIC1	**DESCRIPTION**	**CO**	**NOx**	**SOx**	**TOG**	**PM**	**NH3**	**ROG**	**PM_{10}**	**$PM_{2.5}$**
2	CLEANING AND SURFACE COATINGS	0.15	0.40	0.04	381.17	0.39	2.13	279.20	0.38	0.36
3	PETROLEUM PROD AND MARKETING	10.08	13.97	58.60	536.56	4.90	1.85	219.60	3.05	2.26
4	INDUSTRIAL PROCESSES	53.52	96.16	31.57	95.55	174.20	9.22	79.44	100.22	51.50
5	SOLVENT EVAPORATION	0.00	0.00	0.00	475.95	0.03	37.45	419.42	0.03	0.03
6	MISCELLANEOUS PROCESSES	2,545.81	156.27	9.64	1,811.66	3,726.68	538.27	300.23	2,173.18	586.03
7	ON-ROAD MOTOR VEHICLES	12,726.85	2,315.33	11.27	1,343.71	74.73	75.25	1,233.16	74.09	57.91
8	OTHER MOBILE SOURCES	2,216.86	1,316.41	125.03	484.40	81.69	0.00	431.80	80.18	74.65
9	NATURAL SOURCES	0.00	0.00	0.00	811.17	0.00	50.76	608.19	0.00	0.00

Totals by Summary Category, Pollutant, and Time Period for Baseline and Adjusted Emissions

EIC3	DESCRIPTION	CO	NOX	SOX	TOG	PM	NH3	ROG	PM_{10}	$PM_{2.5}$
010	ELECTRIC UTILITIES	56.74	51.52	4.76	30.97	6.82	2.35	4.97	6.35	5.89
020	COGENERATION	49.01	30.87	1.87	17.27	4.43	0.18	4.04	4.03	3.72
030	OIL AND GAS PRODUCTION (COMBUSTION)	22.66	45.18	7.44	26.59	2.09	0.10	4.15	2.08	2.08
040	PETROLEUM REFINING (COMBUSTION)	10.22	46.03	12.75	3.52	4.26	0.61	1.79	4.06	3.98
050	MANUFACTURING AND INDUSTRIAL	52.77	86.07	14.52	20.28	5.92	1.63	3.96	5.71	5.45
052	FOOD AND AGRICULTURAL PROCESSING	111.24	22.60	2.69	7.72	3.02	0.10	6.06	2.94	2.89
060	SERVICE AND COMMERCIAL	71.00	104.86	3.66	35.62	8.31	0.40	6.90	8.24	8.19
099	OTHER (FUEL COMBUSTION)	10.55	19.50	0.50	6.65	10.70	0.11	2.31	6.68	5.05
110	SEWAGE TREATMENT	0.25	0.39	0.28	1.29	0.03	0.25	0.70	0.02	0.02
120	LANDFILLS	0.85	0.67	0.21	1,182.55	0.89	9.78	7.92	0.40	0.35
130	INCINERATORS	1.01	1.77	0.14	0.94	0.23	0.09	0.16	0.11	0.10
140	SOIL REMEDIATION	0.06	0.09	0.03	0.49	0.11	0.00	0.34	0.04	0.03
199	OTHER (WASTE DISPOSAL)	0.01	0.10	0.00	60.49	0.36	32.42	5.74	0.25	0.25
210	LAUNDERING	0.00	0.00	0.00	8.60	0.00	0.00	0.84	0.00	0.00
EIC3	DESCRIPTION	CO	NOX	SOX	TOG	PM	NH3	ROG	PM_{10}	$PM_{2.5}$
220	DEGREASING	0.00	0.00	0.00	178.79	0.00	0.00	99.87	0.00	0.00
230	COATINGS AND RELATED PROCESS SOLVENTS	0.11	0.16	0.04	122.45	0.32	0.03	114.08	0.30	0.29
240	PRINTING	0.01	0.05	0.00	25.31	0.05	0.04	25.31	0.05	0.04
250	ADHESIVES AND SEALANTS	0.00	0.00	0.00	35.84	0.01	0.00	31.80	0.01	0.01
299	OTHER (CLEANING AND SURFACE COATINGS)	0.03	0.19	0.00	10.17	0.02	2.06	7.30	0.02	0.02
310	OIL AND GAS PRODUCTION	1.91	3.32	0.53	104.11	0.10	0.00	53.90	0.08	0.08
320	PETROLEUM REFINING	6.03	9.85	58.06	49.04	3.99	1.85	38.43	2.54	2.08
330	PETROLEUM MARKETING	2.14	0.80	0.00	382.93	0.81	0.00	126.85	0.43	0.10
399	OTHER (PETROLEUM PROD AND MARKETING)	0.00	0.00	0.00	0.47	0.00	0.00	0.42	0.00	0.00
410	CHEMICAL	0.44	1.82	2.69	34.07	5.99	0.25	27.38	5.09	4.71

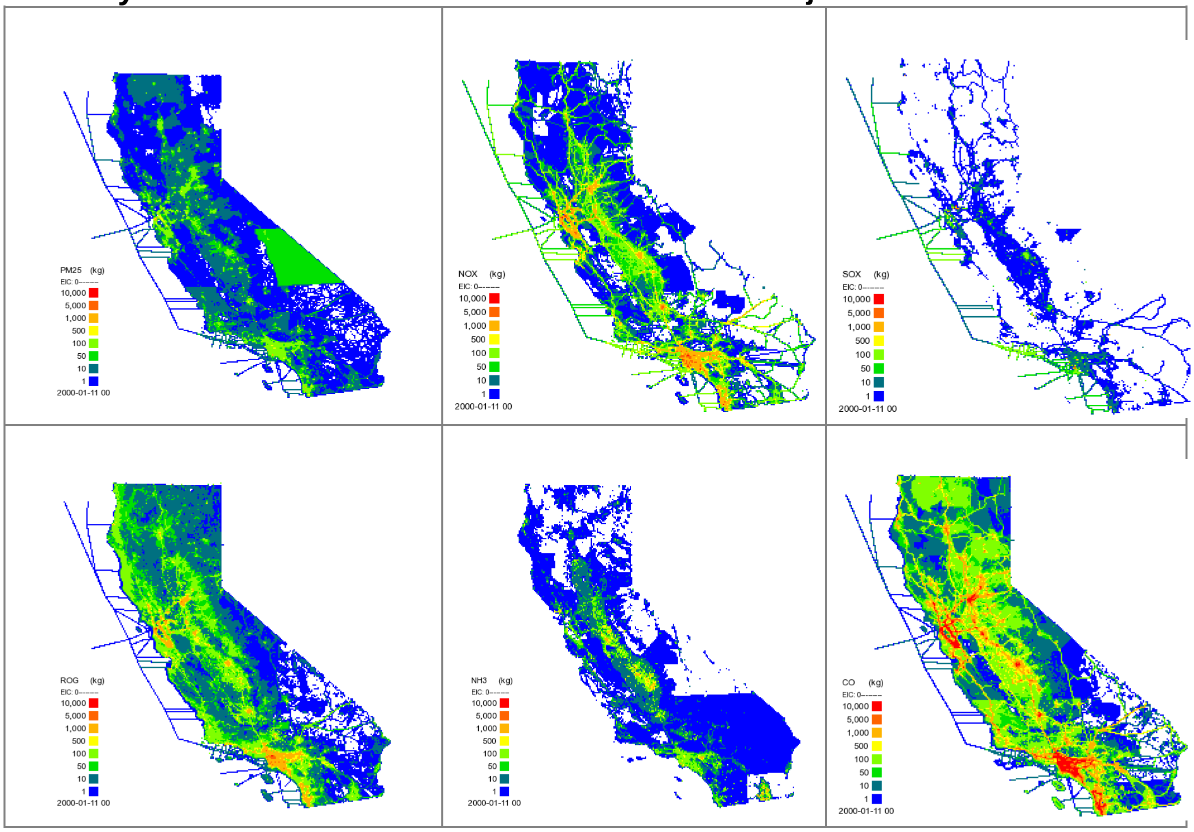
420	FOOD AND AGRICULTURE (Note: Skipping some categories from here to fit on page…)	2.71	9.60	2.52	23.33	29.67	0.07	21.15	12.05	2.79
499	OTHER (INDUSTRIAL PROCESSES)	10.37	9.31	0.85	22.72	18.20	8.82	18.42	11.70	7.86
510	CONSUMER PRODUCTS	0.00	0.00	0.00	305.34	0.00	0.00	259.30	0.00	0.00
520	ARCHITECTURAL COATINGS AND SOLVENTS	0.00	0.00	0.00	111.39	0.00	0.00	108.74	0.00	0.00
530	PESTICIDES/FERTILIZERS	0.00	0.00	0.00	39.41	0.00	37.45	32.38	0.00	0.00
540	ASPHALT PAVING / ROOFING	0.00	0.00	0.00	19.82	0.03	0.00	19.01	0.03	0.03
610	RESIDENTIAL FUEL COMBUSTION	1,741.05	129.11	8.59	274.46	270.85	12.36	120.38	253.79	244.63
620	FARMING OPERATIONS	0.00	0.00	0.00	1,419.61	147.04	467.32	113.57	72.64	17.07
630	CONSTRUCTION AND DEMOLITION	0.00	0.00	0.00	0.00	415.08	0.00	0.00	203.10	20.30
640	PAVED ROAD DUST	0.00	0.00	0.00	0.00	810.83	0.00	0.00	370.71	55.62
645	UNPAVED ROAD DUST	0.00	0.00	0.00	0.00	235.99	0.00	0.00	140.25	14.02
650	FUGITIVE WINDBLOWN DUST	0.00	0.00	0.00	0.00	1,718.35	0.00	0.00	1,016.94	135.06
660	FIRES	10.14	0.24	0.00	1.01	1.17	0.00	0.71	1.15	1.08
670	WASTE BURNING AND DISPOSAL	793.31	26.85	1.05	107.70	92.67	4.64	59.38	90.31	83.67
690	COOKING	0.16	0.00	0.00	8.77	33.40	0.00	6.13	23.38	14.03
699	OTHER (MISCELLANEOUS PROCESSES)	1.15	0.07	0.00	0.10	1.31	53.95	0.07	0.92	0.55
EIC3	**DESCRIPTION**	**CO**	**NOX**	**SOX**	**TOG**	**PM**	**NH3**	**ROG**	**PM_{10}**	**$PM_{2.5}$**
700	On-Road Motor Vehicles	12,726.85	2,315.33	11.27	1,343.71	74.73	0.00	1,233.16	74.09	57.91
710	LIGHT DUTY PASSENGER (LDA)	0.00	0.00	0.00	0.00	0.00	41.86	0.00	0.00	0.00
722	LIGHT DUTY TRUCKS - 1 (LDT1)	0.00	0.00	0.00	0.00	0.00	9.32	0.00	0.00	0.00
723	LIGHT DUTY TRUCKS - 2 (LDT2)	0.00	0.00	0.00	0.00	0.00	15.73	0.00	0.00	0.00
724	MEDIUM DUTY TRUCKS (MDV)	0.00	0.00	0.00	0.00	0.00	5.82	0.00	0.00	0.00
732	LIGHT HEAVY DUTY GAS TRUCKS - 1 (LHDV1)	0.00	0.00	0.00	0.00	0.00	1.20	0.00	0.00	0.00
733	LIGHT HEAVY DUTY GAS TRUCKS - 2 (LHDV2)	0.00	0.00	0.00	0.00	0.00	0.38	0.00	0.00	0.00
734	MEDIUM HEAVY DUTY GAS TRUCKS (MHDV)	0.00	0.00	0.00	0.00	0.00	0.26	0.00	0.00	0.00
736	HEAVY HEAVY DUTY GAS TRUCKS (HHDV)	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.00

742	LT HEAVY DUTY DIESEL TRUCKS - 1 (LHDV1)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
743	LT HEAVY DUTY DIESEL TRUCKS - 2 (LHDV2)	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
744	MED HEAVY DUTY DIESEL TRUCKS (MHDV)	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00
746	HEAVY HEAVY DUTY DIESEL TRUCKS (HHDV)	0.00	0.00	0.00	0.00	0.00	0.09	0.00	0.00	0.00
750	MOTORCYCLES (MCY)	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00
760	HEAVY DUTY DIESEL URBAN BUSES (UB)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
762	HEAVY DUTY GAS URBAN BUSES (UB)	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00
770	SCHOOL BUSES (SB)	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
776	OTHER DIESEL BUSES	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00
780	MOTOR HOMES (MH)	0.00	0.00	0.00	0.00	0.00	0.26	0.00	0.00	0.00
810	AIRCRAFT	249.71	54.02	2.81	40.28	9.03	0.00	35.91	8.81	8.72
820	TRAINS	28.90	194.16	8.05	13.29	4.40	0.00	11.12	4.40	4.05
830	SHIPS AND COMMERCIAL BOATS	38.84	276.79	109.70	17.62	20.28	0.00	14.77	19.62	18.94
840	RECREATIONAL BOATS	126.38	3.82	0.01	36.92	1.39	0.00	34.86	1.25	0.95
EIC3	**DESCRIPTION**	**CO**	**NOX**	**SOX**	**TOG**	**PM**	**NH3**	**ROG**	**PM_{10}**	**$PM_{2.5}$**
850	OFF-ROAD RECREATIONAL VEHICLES	135.10	1.08	0.25	41.00	0.80	0.00	38.28	0.72	0.54
860	OFF-ROAD EQUIPMENT	1,536.69	680.34	3.49	259.95	39.32	0.00	225.28	38.92	35.52
870	FARM EQUIPMENT	101.24	106.20	0.72	24.87	6.47	0.00	21.29	6.46	5.93
890	FUEL STORAGE AND HANDLING	0.00	0.00	0.00	50.46	0.00	0.00	50.28	0.00	0.00
910	BIOGENIC SOURCES	0.00	0.00	0.00	709.42	0.00	14.54	578.69	0.00	0.00
920	GEOGENIC SOURCES	0.00	0.00	0.00	101.75	0.00	36.22	29.50	0.00	0.00

4.11.2. Spatial Plots

Spatial plots are useful to ensure that emissions are distributed correctly into each grid cell.

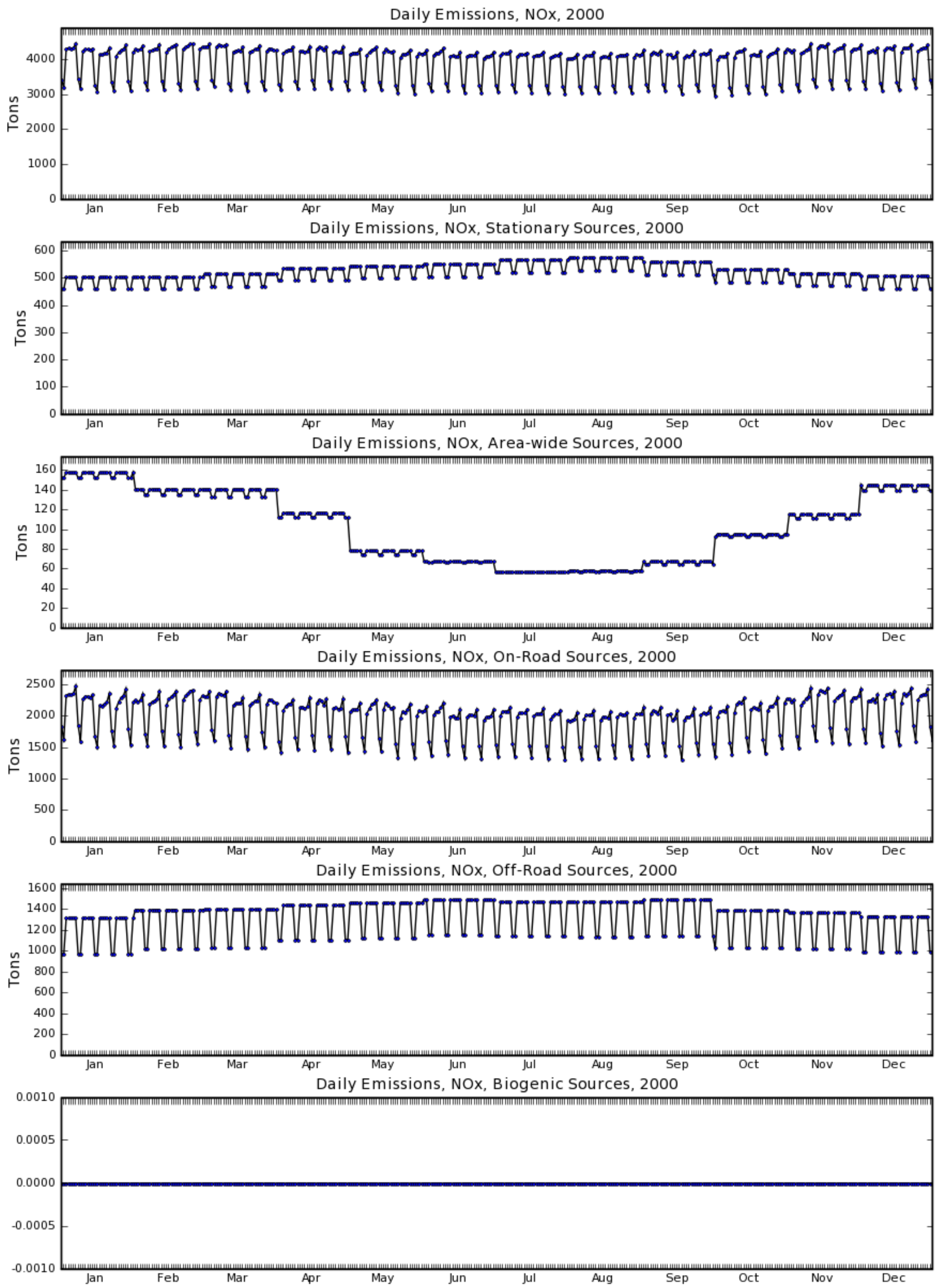
Plots by Pollutant and Time Period for Baseline and Adjusted Emissions



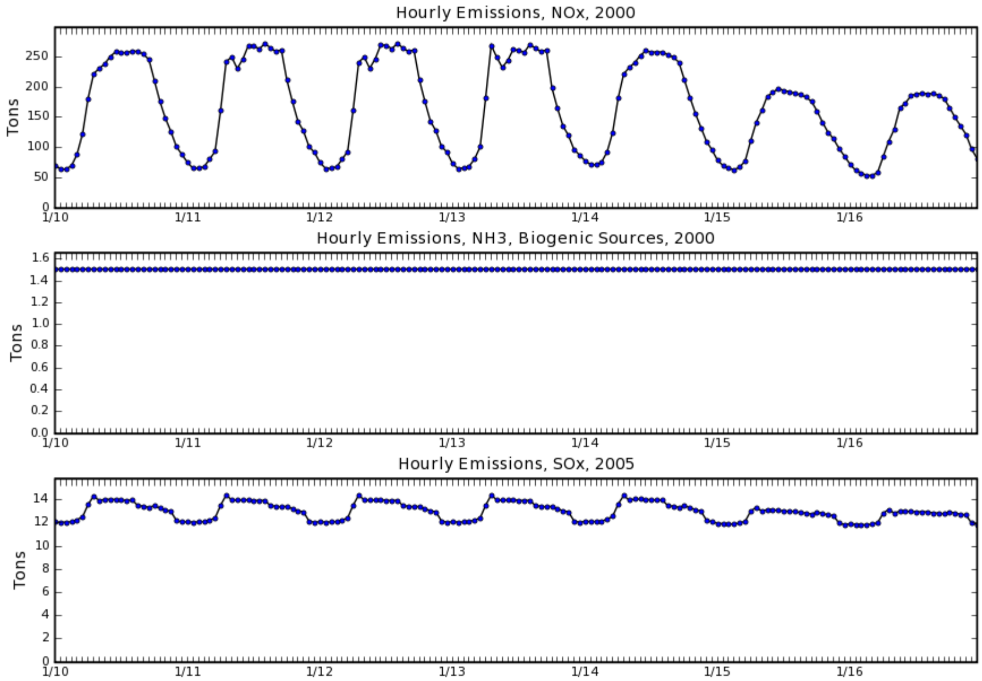
4.11.3. Time Series Plots

Time series plots are useful to ensure that emissions are distributed correctly in time across the modeling period.

Weekly Time-Series Plots of Emissions by Year



Hourly Time-Series Plots of Emissions by Week



5. Models and Inputs

5.1. Rationale for the Selection of Models

5.1.1. Meteorology Model

Meteorological model selection is based on a need to accurately simulate the synoptic and mesoscale meteorological features exhibited during the selected episodic periods. 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 features, such as wind flows, ambient temperature variation, evolution of the boundary layer, etc., to properly characterize the meteorological component of photochemical modeling.

In the past, the ARB has applied prognostic, diagnostic, and objective 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, the models under consideration for meteorological modeling are:

- Mesoscale Meteorological Model Version 5 (MM5) (Grell et al, 1994), and
- Weather and Research Forecasting Model (WRF) (Skamarock et al, 2005).

MM5 is a mesoscale, limited area, non-hydrostatic numerical model developed by Penn State and the National Center for Atmospheric Research (NCAR). It uses a terrain-following, Lambert Conformal, sigma coordinate system. MM5 allows users to study the atmospheric motions at small scales by explicitly treating the effects of convective motions on atmospheric circulations. It has been improved on an ongoing basis over the last two decades by contributions from a broad scientific community and has been maintained by NCAR along with necessary meteorological and geographical input data. Based on the complexity of terrain in northern and central California, the MM5 model represents an appropriate tool for resolving dynamics and thermodynamics using nesting capabilities. The ARB has also been using the MM5 model over the last two decades, since it has been widely used and tested for various meteorological regimes over the world and has been supported by NCAR. NCAR terminated model development for MM5 in October 2006 and the code was frozen at the minor version of V3-7-4.

Since then NCAR has devoted its resources to the development of the WRF model, which was designed to be the replacement for MM5. The WRF model is being continually updated, but ARB's experience with the model is limited compared to that with MM5. The preliminary WRF fields produced by ARB have not shown any significant improvement over those from MM5.

Based on the long history of using MM5 by ARB and stakeholder groups in California in regulatory modeling, the MM5 numerical model was chosen to generate meteorological fields for SIP modeling. A more detailed description of prognostic meteorology models and their known limitations in the complex terrain of California, see Section 6.1.

ARB will continue to evaluate the WRF model for future SIP modeling and potentially as a corroborative tool to MM5 for this SIP. More details on this effort are provided in Section 9.3.

5.1.2. **Air Quality Model**

U.S. EPA guidance requires several factors to be considered as criteria for choosing a qualifying air quality model to support the attainment demonstration. These criteria include: (1) documentation and past track record of candidate models in similar applications; (2) advanced science and technical features available in the model and/or modeling system; (3) experience of staff and available contractors; (4) required time and resources versus available time and resources; and (5) in the case of regional applications, consistency with regional models applied in adjacent regions (U.S. EPA, 2007). For the $PM_{2.5}$ 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 $PM_{2.5}$ concentrations.

The Community Multiscale Air Quality (CMAQ) Modeling System has been selected for modeling $PM_{2.5}$ in the SJV. 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 understanding of the atmospheric chemistry and physics. It 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 CMAQ model has undergone peer review every few years and was found to be state of the science (Aiyyer et al., 2007). The CMAQ model is regularly updated to incorporate new mechanisms, algorithms, and data as they become available in the scientific literature (e.g., Foley, et al., 2010). In addition, the CMAQ model is well documented in terms of its underlying scientific algorithms as well as guidance on operational uses (e.g., Binkowski and Roselle, 2003; Byun and Ching, 1999; Byun and Schere, 2006; Carlton et al., 2010; Foley et al., 2010; Kelly, et al., 2010a; UNC, 2010).

The CMAQ model was the regional air quality model used for the 2008 SJV annual $PM_{2.5}$ SIP. A number of previous studies have also used the CMAQ model to study ozone and $PM_{2.5}$ in the SJV (e.g., Jin et al., 2008, 2010; 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 are numerous applications of the CMAQ model in the U.S. and in the world (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; Sokhi et al., 2006; Smyth et al., 2006; Tong et al., 2006; Wilczak et al., 2009; Zhang et al., 2004, 2006). Staff at 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 available from the

Community Modeling and Analysis System (CMAS) Center (http://www.cmascenter.org/) established by the U.S. EPA.

The most recent version, CMAQv4.7.1 (Foley et al., 2010) will be used. While U.S. EPA released the CMAQ version 5.0 in October 2011, that release came too late for current modeling efforts.

5.2. Model Setup and Inputs

5.2.1. Meteorology Model (modeling domains, horizontal and vertical resolution, physics options, regional reanalysis data, etc.)

The MM5 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 purpose of the 12 km grid (D02) is to provide input data to the 4 km grid (D03). The D01 grid is centered at 37 N x 120.5 W while the two inner grids, D02 and D03, are placed within the coarser grid such that they are not too close to the lateral boundaries. The D01 grid consists of 70 x 70 grid cells. The D02 grid consists of 132 x 132 grid cells and the D03 grid consists of 327 x 297 grid cells having an origin at -696 km x -576 km (Lambert Conformal projection). The first two coarse grids were run simultaneously, and the D03 grid was run independently using the output of its coarser, parent D02 grid as input. The D03 grid is intended to resolve the fine details of atmospheric motion and is used to feed the air quality modeling simulations. The vertical layer structure has 30 layers, as shown in Table 5.1. The physics options are shown in Table 5.2.

The initial and boundary conditions (IC/BC) for MM5 were prepared based on 3-D analyses of the NCEP/NCAR Reanalysis Project (NNRP) that is archived at NCAR. These data are archived from global simulations and have a 209 km horizontal resolution. Initial conditions to MM5 were updated at 6-hour intervals for the 36 and 12 km grids. In addition, surface and upper air synoptic observations obtained from NCEP are also used to further refine the IC/BCs.

The MM5 model was nudged toward observed meteorological conditions by using the analysis nudging option of the Four Dimensional Data Analysis (FDDA) for the 36 and 12 km grids only. Input conditions for the 4 km grid were obtained from the output of the 12 km grid, and the observational nudging option of FDDA was used to enhance these input conditions. Only wind measurements were used for observational nudging.

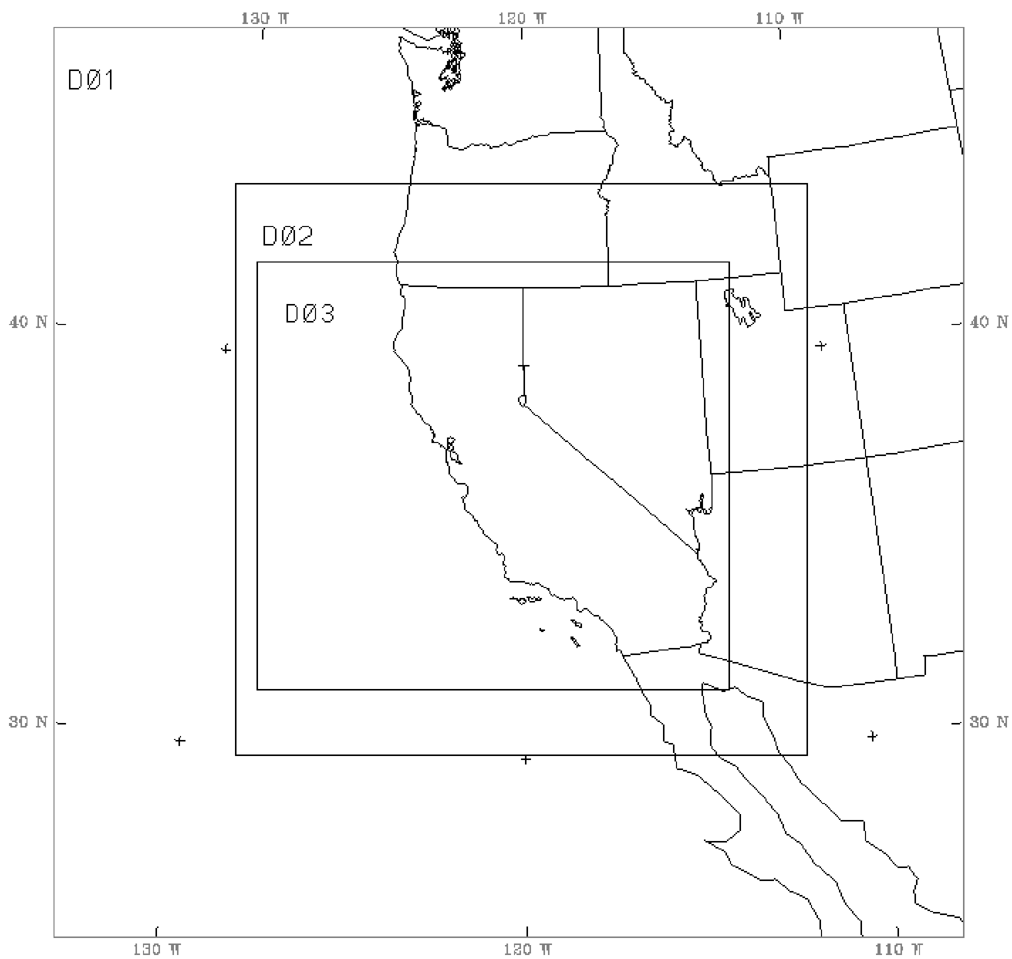


Figure 5-1: The three nested grids for the MM5 model (D01 36km; D02 12km; and D03 4km).

Table 5-1: MM5 30 Vertical Layer Configuration.

Layer No.	Height (m)	Layer Thickness (m)
30	15674	998
29	14676	982
28	13694	976
27	12718	970
26	11748	972
25	10776	973
24	9803	979
23	8824	983
22	7841	994
21	6847	1002
20	5845	972
19	4873	818
18	4055	687
17	3368	577
16	2791	484
15	2307	407
14	1900	339
13	1561	285
12	1276	238
11	1038	199
10	839	166
9	673	139
8	534	115
7	419	97
6	322	81

5	241	67
4	174	56
3	118	47
2	71	39
1	32	32
0	0	0

Table 5-2: MM5 Physics Options.

Physics Option	D01	D02	D03
Cumulus Parameterization	Grell	Grell	None
Planetary Boundary Layer Scheme	Gayno-Seaman	Gayno-Seaman	Gayno-Seaman
Explicit Moisture Scheme	Dudhia Simple Ice	Dudhia Simple Ice	Dudhia Simple Ice
Radiation Scheme	RRTM	RRTM	RRTM
Soil Temperature Model	5-layer soil slab	5-layer soil slab	5-layer soil slab

5.2.2. Air Quality Model (modeling domains, horizontal and vertical resolution, chemical mechanisms, PM routines, initial and boundary conditions, etc.)

The principle determinants of the extent of the modeling domain are the nature of the $PM_{2.5}$ problem and the scale of the emissions that impact the nonattainment area. Isolated nonattainment areas that are not impacted by regional transport and its precursors may be able to use a relatively small domain (U.S. EPA, 2007). Figure 5.2 shows modeling domains used by ARB. The two modeling domains that are proposed for this work are shown in blue (12 km coarse domain) and magenta (4 km nested domain). The coarse domain (blue) includes 107x97 lateral 12 km grid cells for each vertical layer. This domain extends from the Pacific Ocean in the west to the 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 nested domain (magenta) covers Central California with 192x192 lateral 4 km grid cells. The domain is based on the Lambert Conformal Conic projection with reference longitude at -120.5°W, reference longitude at 37°N, and two standard parallels at 30°N and 60°N, respectively.

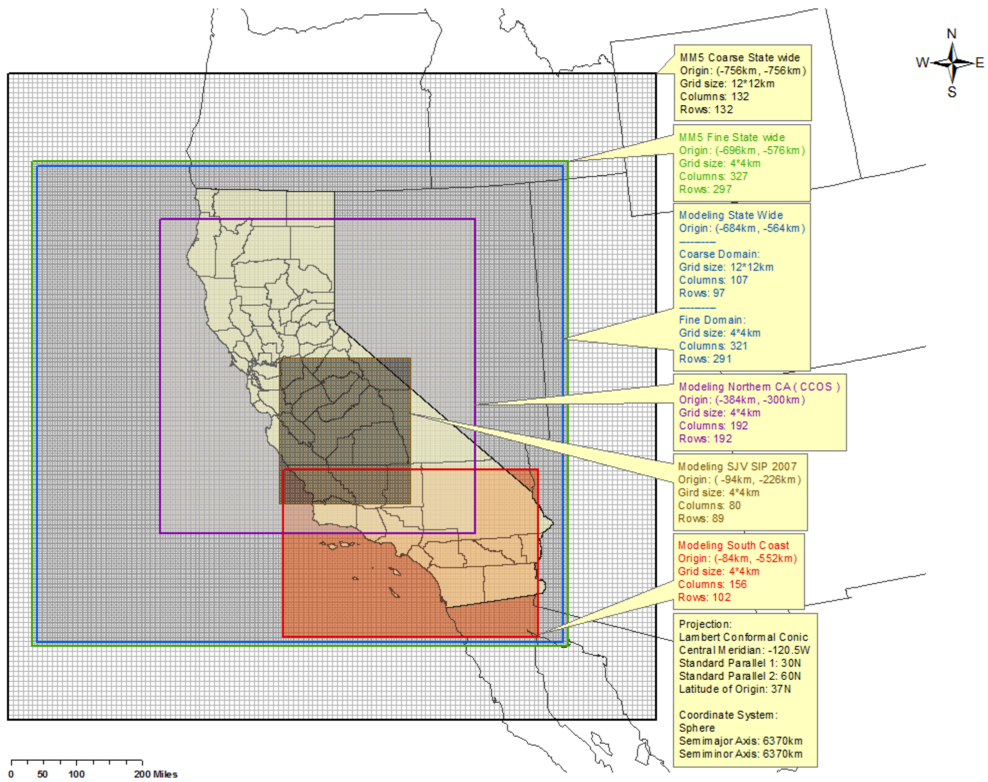


Figure 5-2: Modeling domains used by ARB

For the coarse portions of nested regional grids, U.S. EPA guidance 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 grid cells about 4 km (U.S. EPA, 2007). Our selection of modeling domains is consistent with the guidance. U.S. EPA guidance 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

100 mb) employ 12 to 21 vertical layers. For the present SIP, 15 vertical layers will be used in the CMAQ model, extending from the surface to 100 mb, consistent with the number of vertical layers used for the 2008 SJV $PM_{2.5}$ SIP. 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, 0.7733, 0.6254, 0.293, 0.0788, and 0.0. This ensures that the majority of the layers are in the planetary boundary layer.

The small black domain in the center of Figure 5-2 is the air quality modeling domain used for the previous annual $PM_{2.5}$ SIP which is now approved by the U.S. EPA (76 FR 41338; 76 FR 69896). The originally proposed 4 km domain is ~5 times larger than the previously used 4 km domain. However, preliminary modeling for the current SIP, in combination with the anticipated number of modeling runs that will be necessary to complete the SIP modeling, have demonstrated the infeasiblity of using the larger 4 km (magenta) domain with available resources. Therefore, we will use the small 4 km (black) domain which has already been approved by the U.S. EPA (76 FR 41338; 76 FR 69896).

Table 5.3 shows the CMAQv4.7.1 configuration that will be used to model $PM_{2.5}$ in the SJV. The same configuration will be used for all simulations for the base, reference, and future years. CMAQv4.7.1 will be compiled using the Portland Group FORTRAN Compiler version 10.9.

Table 5-3: CMAQv4.7.1 Schemes used for Current Simulations.

Processes	Scheme
Horizontal advection	PPM (piecewise parabolic method)
Vertical advection	PPM (piecewise parabolic method)
Horizontal diffusion	Multi-scale
Vertical diffusion	Eddy
Gas-phase chemical mechanism	SAPRC99
Chemical solver	EBI

Aerosol module	Aero5
Cloud module	ACM_AE5
Photolysis rate	Table Generated by the JPROC program

In order to simulate the complex mixture of $PM_{2.5}$ species in the SJV, the SAPRC99 mechanism coupled with the CMAQ model aerosol code version 5 and aqueous phase chemistry (AE5-AQ) has been chosen for this application. SAPRC99, 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 (NOx) (Carter, 2000). It is a well-known chemical mechanism and has been used widely in California and the U.S. (e.g., Hakami, et al., 2004a, 2004b; Liang and Kaduwela, 2005; Lin et al., 2005; Jackson, et al., 2006; Napelenok, 2006; Dennis et al., 2008; Jin et al., 2008, 2010; Lane et al., 2008; Tonse et al., 2008; Ying et al., 2008; Livingstone et al., 2009; Pun et al., 2009; Kelly, et al., 2010b; Zhang et al., 2010; Zhang and Ying, 2011).

CARB established the Reactivity Scientific Advisory Committee (RSAC) in April 1996. RSAC is a group of independent scientists who make non-binding recommendations on the science related to the reactivity of VOCs. RSAC consists of the following members: Drs. John Seinfeld (Chair, California Institute of Technology), Roger Atkinson (University of California at Riverside), Jack Calvert (National Center for Atmospheric Research), Harvey Jeffries (University of North Carolina at Chapel Hill), Jana Milford (University of Colorado at Boulder), and Armistead Russell (Georgia Institute of Technology). In 1998, RSAC recommended that the SAPRC99 mechanism undergo a scientific review. Following RSAC's recommendation, CARB contracted Dr. William R. Stockwell in 1999 to conduct a review of the SAPRC99 mechanism, its documentation, and the Maximum Incremental Reactivity scale derived from SAPRC99. Stockwell (1999) compared the chemical kinetic data used in the SAPRC99 mechanism with values from standard kinetic databases (e.g., Atkinson et al., 1994, 1997; DeMore et al., 1997) and the most recent literature available at the time. The kinetic parameters checked included the reactions, rate constants, product yields, and lumping methods. Stockwell's (1999) comments led to the revision of the mechanism and identification of outstanding issues to be resolved with further experimental studies. Stockwell (1999) concluded that SAPRC99 reflected the best available science at its completion date, and RSAC approved both the SAPRC99 peer review and the mechanism in October 1999. They also recommended that the SAPRC family of mechanisms be used for regulatory photochemical modeling activities in California.

The 2008 SJV $PM_{2.5}$ SIP also used the SAPRC99 mechanism. While a newer version, SAPRC07 (Azzi et al., 2010; Carter, 2010a,b; Derwent et al., 2010;Mollner et al., 2010; Cai et al., 2011a,b), will be incorporated into CMAQv5.0, the timeline of the official release of SAPRC07 and CMAQv5.0 is not consistent with the current modeling effort.

AE5-AQ, the newest aerosol and aqueous-phase chemistry code in CMAQv4.7.1, when coupled with a gas phase mechanism, simulates the formation and evaporation of aerosol and the evolution of the aerosol size distribution (Foley et al., 2010). AE5 includes a comprehensive yet computationally efficient inorganic thermodynamic model ISORROPIA to simulate the physical state and chemical composition of inorganic atmospheric aerosols (Nenes, et al., 1998). ISORROPIA has been proven to be the model of choice for many three-dimensional air quality models (Yu et al., 2005). AE5 also features an improved secondary organic aerosol (SOA) module with up-to-date scientific information (Carlton et al., 2010). In addition to SOA formation from more traditional aromatic compounds and biogenic monoterpene species, the SOA module in AE5 incorporates SOA formation from benzene, isoprene, and sequiterpenes, in-cloud SOA production from glyoxal and methylglyoxal, particle-phase oligomerization, acid enhancement of isoprene SOA, and NOx dependent aromatic SOA yields (Carlton et al., 2010).

CMAQv4.7.1 offers two advection schemes: the piecewise parabolic method (PPM) and the Yamartino scheme. PPM is based on the finite-volume subgrid definition of the advected scalar. It is implemented in a global mass-conserving scheme in the CMAQ model (UNC, 2010). We chose the PPM scheme because the Yamartino scheme leads to unrealistic O_3 mixing ratio predictions in the mountainous areas of Central California during winter. For example, Figure 5-3 shows an example of 1-hour O_3 mixing ratio predictions during January 2007 simulated by CMAQv4.7.1 with the Yamartino advection scheme. 1-hour O_3 mixing ratios greater than 100 ppb were predicted for some mountainous areas. This is not supported by observed O_3 mixing ratios, which only range up to 50 ppb in Yosemite and Sequoia National Parks in January 2007. The excessive O_3 prediction is due to the advection scheme that brings the upper troposphere O_3 down to the surface levels. $PM_{2.5}$ predictions from the PPM and the Yamartino schemes are comparable. For example, Figure 5-4 shows that the difference in monthly average $PM_{2.5}$ predictions for January 2007 using CMAQv4.7.1 with the PPM and Yamartino schemes is between -0.4 to 1.0 µg/m^3.

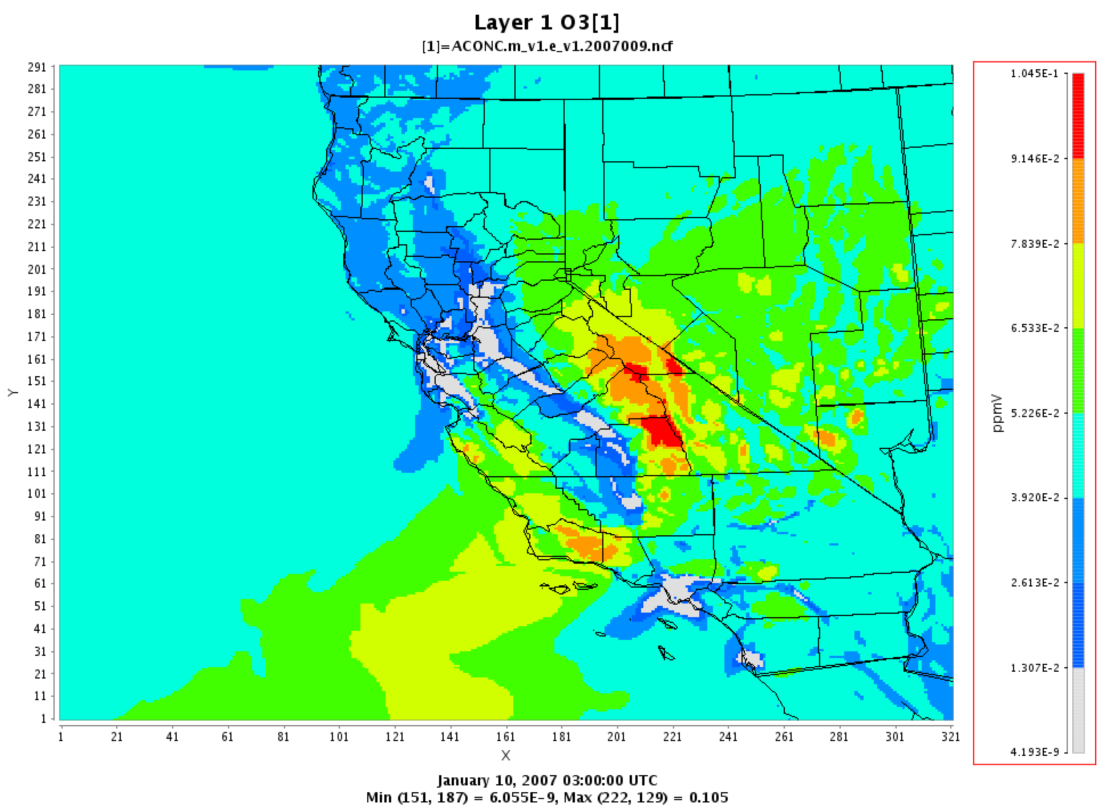


Figure 5-3: 1-hour O_3 mixing ratio at 3 am of Jan 10, 2007 (UTC) predicted by CMAQv4.7.1 with the Yamartino advection scheme.

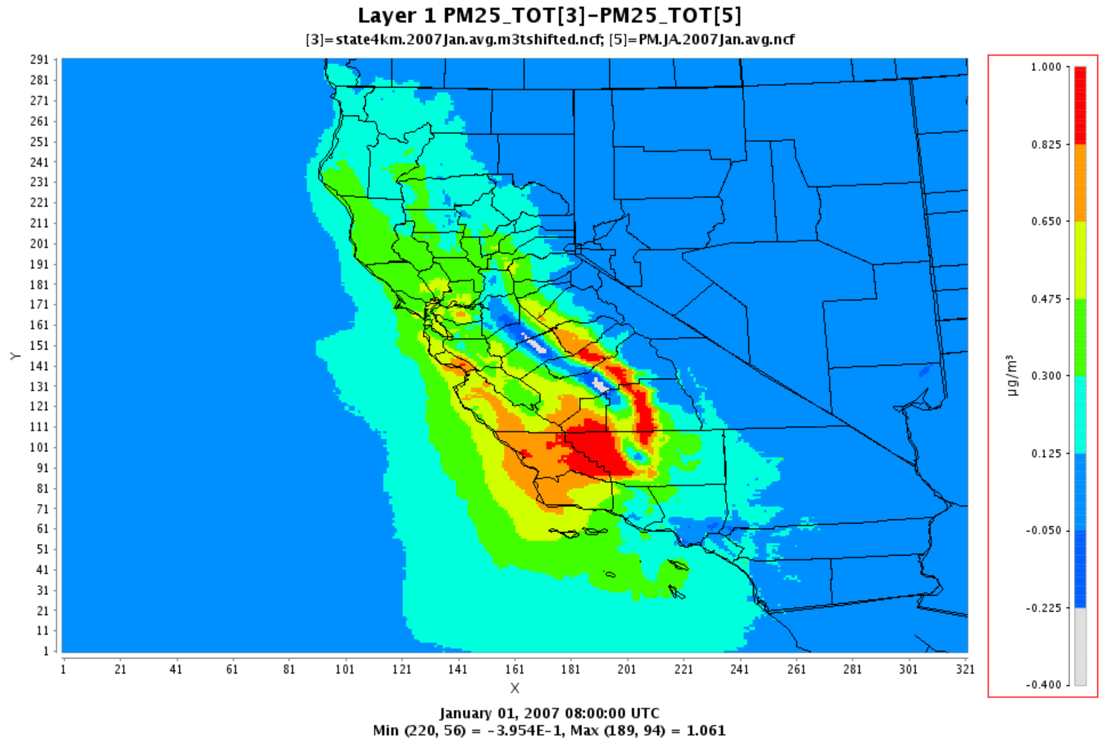


Figure 5-4: Difference in monthly average $PM_{2.5}$ predictions for January 2007 simulated using CMAQv4.7.1 with the PPM and Yamartino schemes.

U.S. EPA guidance recommends using a "ramp-up" period by beginning a simulation 5-10 days prior to the period of interest for modeling $PM_{2.5}$ (U.S. EPA, 2007). Instead of running the CMAQ model sequentially from the beginning to the end of the simulation year, we simulate each month in parallel. For each month, we run seven spin-up days prior to the beginning of each month to generate the initial conditions for the coarse domain. We then use the output from the coarse modeling domain to specify the initial conditions for the nested domain because the nested domain simulation starts after the beginning of the simulation for the outer grid, consistent with U.S. EPA guidance.

In recent years, the use of global chemical transport model (CTM) outputs as boundary conditions (BCs) in regional CTM applications has become increasingly common (Hogrefe et al., 2011; Chen et al., 2008; Lin et al., 2010; Lam and Fu, 2009; Lee et al., 2011), and has been shown to improve model performance in many cases (Tong and

Mauzerall, 2006; Tang et al., 2007; Tang et al., 2009; Borge et al., 2010; Appel et al., 2007). 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 concentrations. The Model for Ozone And Related chemical Tracers (MOZART; Emmons et al., 2010a) is a global CTM that has been widely used for such applications. MOZART has been extensively peer-reviewed and applied in a range of studies including global change impacts on air quality (e.g., Wiedinmyer et al., 2006; Brasseur et al., 2006; Huang et al., 2008; Avise et al., 2009), long-range transport of pollution (e.g., Liu et al., 2005; Liu an Mauzerall, 2007; Pfister et al., 2010), and atmospheric chemistry/air quality studies (e.g., Emmons et al., 2010b; Pfister et al., 2008; Apel et al., 2010; Fiore et al., 2005).

The MOZART model is a comprehensive global model for simulating atmospheric composition including both gases and bulk aerosols (Emmons et al., 2010a). It was developed by the National Center for Atmospheric Research, the Max-Planck-Institute for Meteorology (in Germany), and the Geophysical Fluid Dynamics Laboratory of the National Oceanic and Atmospheric Administration, and is widely used in the scientific community. In addition to inorganic gases and VOCs, boundary conditions were extracted for aerosol species including elemental carbon, organic matter, sulfate, soil and nitrate.

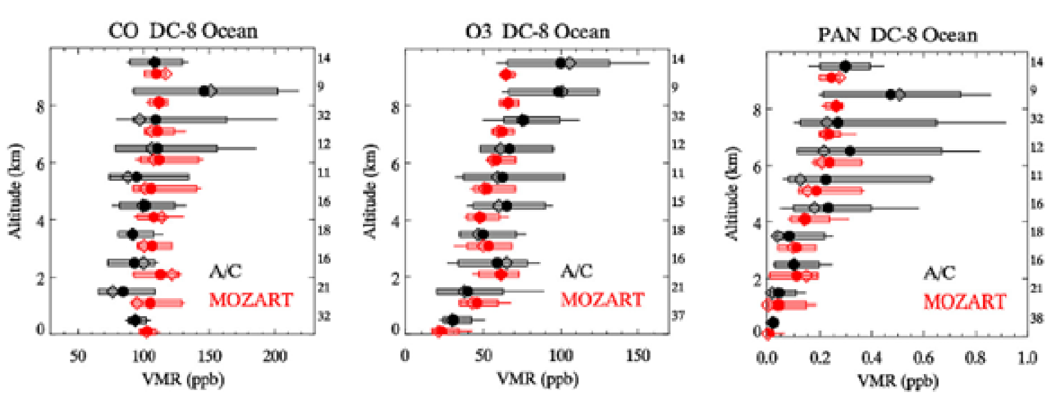


Figure 5-5: Comparison of MOZART (red) simulated CO (left), ozone (center), and PAN (right) to observations (black) along the DC-8 flight track. Shown are mean (filled

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 5-5).

Boundary conditions for the outer 12-km modeling domain were derived from MOZART4-GEOS5 simulations by Louisa Emmons (NCAR) for the year 2007; available for download at http://www.acd.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 was extracted from the MOZART-4 output and processed to CMAQ model ready format using computer code developed by ARB staff, which has been used to generate BCs for previous air quality studies (Chen et al., 2008; Avise et al., 2009; Chen et al., 2009a,b; Cai et al., 2011; Kelly et al., 2011). The final BCs represent day-specific concentrations, which vary in both space (horizontal and vertical) and time (every six hours).

The boundary conditions for the nested 4 km domain were extracted from the output for the coarse 12 km domain simulation using the BCON program in the CMAQ modeling system. The boundary conditions for the coarse domain for the reference year will be used for future years as well, consistent with U.S. EPA guidance.

Overall, using a 4 km nested domain within the 12 km coarse domain will reduce the computational burden without compromising the accuracy of the modeling results when compared to a simulation using a 4 km grid for the entire outer domain. Figure 5-6 shows the difference in average $PM_{2.5}$ prediction for January 2007 between a simulation with the nested domain and a simulation using a 4km grid for the entire outer domain. The discrepancy in monthly average $PM_{2.5}$ predictions is extremely small (± 0.1 µg/m^3) for the areas of interest.

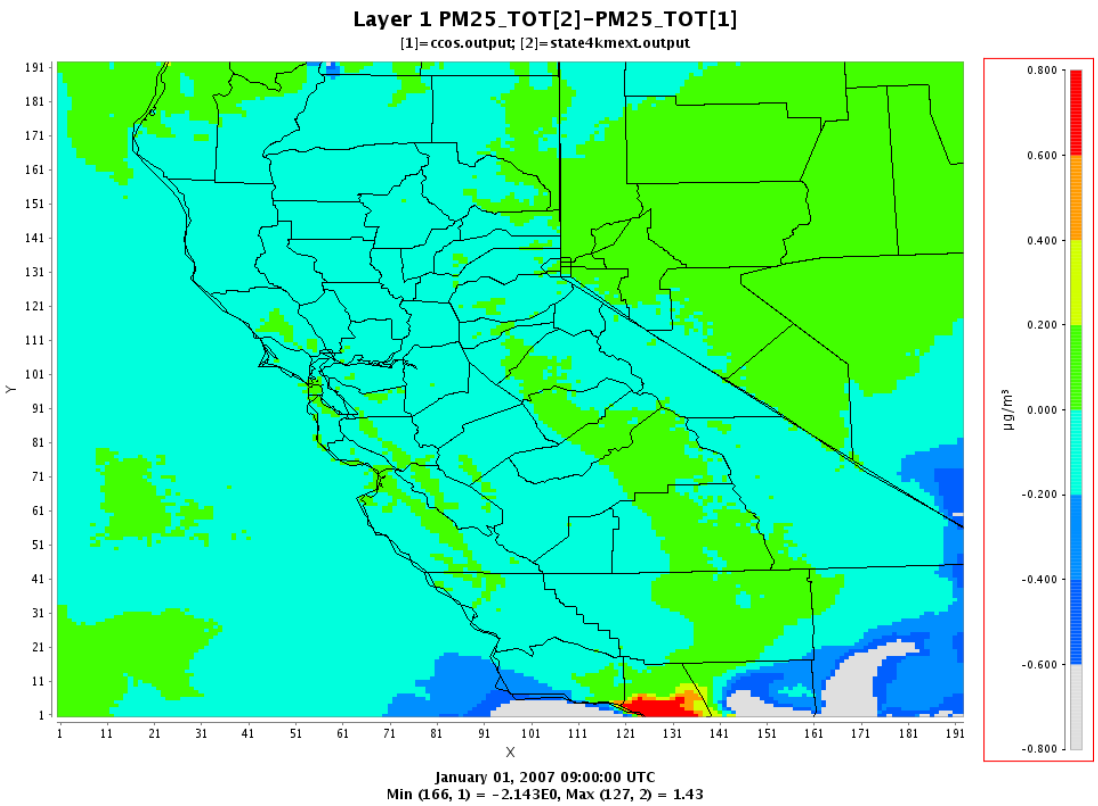


Figure 5-6: Difference in average $PM_{2.5}$ prediction for January 2007 between simulation with the nested domain and simulation using 4km grid for the entire coarse domain.

The dry and wet deposition (also known as lost processes) of pollutants (both gaseous and particulate) is explicitly included in the continuity equation solved by the CMAQ model. The time-varying species-dependent dry deposition velocities are calculated in the Meteorology-Chemistry Interface Processor (MCIP) and are passed along to the CAMQ model for the calculation of dry deposition fluxes. The wet deposition fluxes due to rainfall are calculated in the cloud module of the CMAQ model. Dry and wet deposition estimates are then saved in separate output files.

5.2.3. Construction of the Simulated $PM_{2.5}$ Mass

The CMAQ model does not output $PM_{2.5}$ total mass concentrations. Instead, it outputs concentrations for individual aerosol components in each aerosol mode (e.g., sulfate in the accumulation mode, nitrate in the coarse mode, etc.). These outputs require additional processing to generate predictions for $PM_{2.5}$ mass. For this effort, we choose to use the hourly average model species concentrations saved in the ACONC file as modeled concentrations (UNC, 2010). We will use the "combine" program in the CMAQ modeling system to generate the predictions for total $PM_{2.5}$ mass as well as $PM_{2.5}$ components that can be compared with observations.

5.2.4. Quality Assurance of Model Inputs

In developing the IC/BCs and FDDA datasets, quality control is performed on all associated meteorological data. Generally, all surface and upper air 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 not used in the modeling analyses.

6. Meteorological Model Performance Evaluation

6.1. Known Performance Issues of Meteorological Models in the Complex Terrain of California and Current Attempts to Improve Performance

The San Joaquin Valley is bordered on the west by the Coastal Mountain Range and on the east by the Sierra Nevada range. These ranges converge at the southern end of the basin at the Tehachapi Mountains. West of the Coastal Mountain Range is the Pacific Ocean. The SJV is considered to be the most fertile desert in the world. The ocean-land interface, mountain-valley topography, and the drastic temperature changes make the SJV one of the most challenging areas in the country to simulate using meteorological models.

One can generate meteorological fields using two different methods. The first is known as the diagnostic method where observed fields are interpolated. These fields represent the actual meteorological state of the atmosphere where the measurements were made. However, such measurements are sparse and often made at the surface level. Some monitors may have limited spatial representation due to their locations (e.g., in canyons). These diagnostic meteorological fields do not have dynamic consistency among variables (Seaman, 2000) and may not have all the variables required by modern air quality models. However, they have been shown to provide better air-quality model performance during the summer (Jackson et al., 2006) and winter (Hu et al., 2010) in SJV. This may be due to their ability to better represent the wind speeds and temperatures.

When a dense network of representative meteorological measurements are not available, one can use a set of non-linear partial differential equations, known as governing equations, which describe the time evolution of the atmospheric system through space and time. The governing equations are comprised of the equations of conservation of mass, motion, heat, and water (Pielke, 1984). Meteorological models that integrate the set of governing equations through space-time are known as prognostic models. There is a long history of prognostic meteorological model applications in the SJV (Seaman, Stauffer, and Lario-Gibbs, 1995; Stauffer et al., 2000; Tanrikulu et al., 2000; Jackson et al., 2006; Bao et al., 2008; Livingstone et al., 2009; Michelson et al., 2010; Jin et al., 2010; Hu at al., 2010).

The integration of the governing equations requires simplifying assumptions that lend them to numerical integrations methods. These simplifying assumptions can lead to two undesirable consequences. First, they may cause the simulated solution to stray from the ideal solution. To minimize this, four-dimensional data assimilation (FDDA) techniques were developed. While FDDA is known to steer the simulated solution towards the measured fields, the momentum redistribution within the model causes spurious features where no measurements are available. While FDDA is not considered to be a panacea, it is an operational necessity to develop meteorological fields that are accurate enough for the operation of air quality models.

The second undesirable consequence is due to the complex terrain of California itself. The centered finite difference scheme used in prognostic models works well when the terrain features are smooth and continuous. However, the SJV is bounded by three steep and rugged mountain ranges. The elevation can change by tens to hundreds of meters in one 4 km grid cell. The Coastal Range on the west is near the ocean-land interface which is also difficult to simulate. This makes the terrain in California complex compared to other parts of the country where the application of prognostic models have been more successful. To overcome this difficulty, the grid sizes were reduced from 4 km to 1.33 km as a test. The minor improvements in the fine-scale meteorological fields did not justify the nine fold increase in the computational time. Another option is to investigate the effect of using different model options, especially those related to sub-grid-scale processes. This is being done now in collaboration with Professor Robert Fovell of the University of California at Los Angeles with funding from the San Joaquin Valley Study Agency.

Figure 6-1: Terrain height changes along with counties and major rivers and lakes in California (http://geology.com/state-map/california.shtml).

6.2. Ambient Data Base and Quality of Data

The Air Quality and Meteorological Information System (AQMIS) is a web-based source for real-time and official air quality and meteorological data (www.arb.ca.gov/airqualitytoday/). This database contains 1969-2011 meteorological data (partial months for 2011). The data until the end of 2010 are quality assured and deemed official. The air quality data from 1980 to 2009 are also available on a DVD and at http://www.arb.ca.gov/aqd/aqdcd/aqdcd.htm. In addition ARB also has quality-assured upper-air meteorological data obtained using balloons, aircraft, and profilers.

6.3. Model Performance Evaluation Procedures and Metrics

While there are several U.S. EPA approved meteorological models that can be used for SIP applications, the MM5 and WRF models have been used most frequently. For the reasons provided in Section 5.1.1, the MM5 model will be used here to demonstrate model performance for the year 2007. A comparison between MM5 and WRF will be provided for the months of July and December to demonstrate the model performance differences between the two models.

6.3.1. Statistical Evaluation

Statistical analyses will be performed to evaluate how well the MM5 model captured the overall structure of the observed atmosphere during the 12-month simulation period, using wind speed, wind direction, and temperature. Since observed moisture data are very scarce, relative humidity or mixing ratio will not be used in these comparisons. It is quite common to see, especially in such a long numerical simulation period, that observed statistical characteristics of atmospheric flow may be captured well by the model during a certain time period and/or within some sub-domain while the agreement between the model and observations may not be reasonably good at other times and/or locations. As a result, the very first sign that we look for in model results is whether the model can capture the overall characteristics of the atmosphere in a statistical sense during the entire simulated period and within the entire domain. Then, the same statistical calculations will be repeated within each subregion to find out in which subregions model predictions are good or acceptable and which subregions predictions are not acceptable, so that the reason for weak model performance issues in a subregion can be investigated.

For this purpose, the performance of the MM5 model against observations will be evaluated using the METSTAT analysis tool (Emery et al, 2001). The model output and observations for all 12 months in 2007 will be read, and data points at each observational site for wind speed, wind direction, temperature, and moisture data will be extracted. Then, the following values will be calculated: Mean values of observations and model estimates, bias error (BE), gross error (GE), normalized mean bias (NMB), root mean square error (RMSE), and the index of agreement (IOA) when applicable.

The mathematical expressions for these quantities are:

$$BE = \frac{\sum_{1}^{N}(\text{Model} - \text{Obs})}{N},$$

$$GE = \frac{\sum_{1}^{N}|\text{Model} - \text{Obs}|}{N},$$

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

$$RMSE = \left(\frac{\sum_{1}^{N}(\text{Model} - \text{Obs})^2}{N}\right)^{1/2},$$

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

where, “Model” is the simulated concentrations, “Obs” is the observed value, and N is the number of observations. The model performance expectations are:

Wind Speed	RMSE Bias IOA	≤ 2 m/s < ±0.5 m/s ±0.6
Wind Direction	Gross Error: Bias	≤30 deg ≤ ±10 deg
Temperature	Gross Error Bias IOA	≤ 2 K ≤ ±0.5 K ±0.8
Humidity	Gross Error Bias IOA	≤ 2 g/kg < ±1 g/kg ±0.6

These values will be tabulated and plotted for the entire domain as well as eight subregions (the Mountain Counties; North Central Coast; South Central Coast; San Francisco Bay Area; north, central, and southern San Joaquin Valley; and the Sacramento Valley) to obtain an overall understanding of model performance within each subregion. Then, model results of the u and v-components of the wind and temperature will be plotted against observations at each station to see the degree of agreement visually, as well.

Another way to quantify the agreement between the simulated and observed quantities is to examine their frequency distributions. Model results and observations of u and v-components of the wind and temperature will be accumulated into several bins and a frequency distribution of each variable will be plotted. The observed and predicted frequency distribution indicates the dominant bins or categories of a particular variable and how the model prediction compares to the observed frequency distribution.

Time-history plots reveal information that is not readily apparent from the aforementioned analyses. Thus, a direct comparison of model results using temporal variation of wind speed, wind direction, and temperature at each station, hour-by-hour, for each week in every month will be conducted to study the model performance much more closely than can be done using statistical analyses. Due to the limited availability of continuous hourly relative humidity measurements compared to other meteorological variables, hourly comparison of relative humidity will not be performed. Based on our previous experience with meteorological simulations in California, we expect the analysis to show that wind speed is overestimated at some stations while the difference is small at others. The diurnal variations of temperature and wind direction at most stations would be captured reasonably well. However, we expect the model to underestimate the larger magnitudes of temperature during the day and smaller magnitudes at night.

6.3.2. Phenomenological Evaluation

One possible performance evaluation technique is to examine the meteorological observations in relation to ambient air quality values, to determine the relationships between air quality and key meteorological variables. As indicated above, we will examine the simulated results to see if these relationships are also evident in simulated meteorological variables and air quality. This analysis will be conducted at the station/region level.

Another possibility is to generate the geopotential height charts at 500 and 850 mb using the simulated results and to compare them to the standard charts. This will 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 NCEP Reanalysis dataset. We plan to examine the simulated meteorological fields to see if those large-scale meteorological conditions were accurately simulated. We will then examine if the relationships observed in the NCEP reanalysis were present in the simulated data sets.

Trajectory analyses can be used estimate the area of influence of a monitor using both simulated and observed wind data. In the SJV, the high $PM_{2.5}$ values are observed during winter months when the air is stagnant. Under such conditions, back trajectories constructed using observed winds would be concentrated in the area of observations. We expect to see very similar back trajectory patterns with simulated winds as well.

Spectral analysis may also be used to separate various time-scales (e.g., seasonal, synoptic, inter- and intra-day) in the $PM_{2.5}$ time-series to determine which time-scales contribute most to peak 24-hr $PM_{2.5}$ concentrations. For example, the synoptic scale $PM_{2.5}$ concentration leading up to an exceedance may contribute more to the exceedance than the intra-day contribution. This would likely mean that synoptic scale meteorological model performance is more important than performance based on hourly statistics. We will explore the possibility of using spectral analysis to separate various time scales in the SJV.

CMAQ also has process analyses capabilities. Depending on available time and resources, we may explore the possibility of using process analyses as a part of our phenomenological evaluation.

7. Air Quality Model Performance Evaluation

7.1. Ambient Data Base and Quality of 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). Quality controlled air quality observations for 2007 will be used for model evaluation. 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 NOx and other oxidized compounds), sulfur dioxide (SO_2), carbon monoxide (CO), and hydrogen peroxide (H_2O_2). The U.S. EPA recognizes that not all of these species are routinely measured (U.S. EPA, 2007) 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 other primary $PM_{2.5}$ (U.S. EPA, 2007).

Table 7-1: Observations for evaluating model performance.

Species	Sampling frequency	# of sites-2007
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	3 hours (not every day)	

measurement		
$PM_{2.5}$ measured using FRM[1]	24 hours (daily to one in six days)	
$PM_{2.5}$ 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)	
Other primary particulate matter	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.

Table 7-1 lists the species for which observations are available in the SJV for 2007. They will be used for the model performance evaluation. All observational data will be obtained from the official California ambient air quality database (http://www.arb.ca.gov/aqd/aqdcd/aqdcd.htm). The $PM_{2.5}$ speciation data was originally obtained from the U.S. EPA's Air Quality System (http://www.epa.gov/ttn/airs/airsaqs/). Quality assurance information on ambient air quality monitoring data in California can be found in http://www.arb.ca.gov/aaqm/qa/qa.htm.

These species cover the majority of pollutants of interest for model performance evaluations as recommended by the U.S. EPA. Other species such as H_2O_2, HNO_3, NH_3, and PAN are not routinely measured. Observations of these species are not available in the SJV for 2007 and are therefore not available for model evaluations. However, Zhang et al. (2010) have evaluated the CMAQ model (with the SAPRC99 mechanism) performance for NH_3 and PAN in the SJV during the winter episode of CRPAQS. In addition, the CMAQ model performance for species such as H_2O_2 and HNO_3 has been carried out in other studies and was found to be favorable (e.g., Yu et al., 2007; 2010).

7.2. Model Performance Evaluation Procedures and Metrics

As recommended by U.S. EPA, we will use a number of metrics to evaluate the model performance for $PM_{2.5}$ mass as well as $PM_{2.5}$ components. These metrics include mean fractional bias (MFB), mean fractional error (MFE), normalized mean bias (NMB), and normalized mean error (NME). The formulae for estimating these metrics are given below (U.S. EPA, 2007).

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

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

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

$$NME = \frac{\sum_{1}^{N}|Model - Obs|}{\sum_{1}^{N}Obs}\times 100\%,$$

where, “Model” is the simulated concentration, “Obs” is the observed value, and N is the number of observations.

For evaluating O_3, we will also use mean normalized bias (MNB) and mean normalized gross error (MNGE). Their definitions are given below.

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

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

In addition, we will also calculate other statistics such as mean bias, mean error, and the correlation coefficient whenever they provide meaningful information.

In terms of averaging time, both daily and seasonally averaged simulated and observed values will be compared for $PM_{2.5}$ mass and $PM_{2.5}$ components, consistent with U.S. EPA's Guidance. The FRM and STN measurements are averaged daily, so a detailed comparison of daily pairs is helpful for assessing model performance. Typically, gaseous pollutants are measured on an hourly basis, so hourly comparisons between simulated and observed values will be made.

In addition, various forms of graphics will be created to visually examine comparison of the model predictions to observations. As recommended by U.S. EPA, time series plots are useful in the examination of temporal comparisons of predictions and observations. Tile plots are useful in examining spatial comparisons. Scatter plots, on the other hand, are useful in understanding the comparisons of magnitudes. However, the frequency distributions of observed and simulated variables are not readily visible on scatter plots. Thus, we will either present scatter plots together with their frequency distribution plots or combine them so that scatter and frequency would be visible on the same plot. All these plots will be created for the pairs of observations and predictions over time scales dictated by the averaging frequencies of observations (i.e., hourly, daily, monthly, seasonally) for the species of interest. They will provide a comprehensive view of model performance during different time periods, in different sub-regions, and over different concentrations levels.

Model performance goals will be based on U.S. EPA guidance as well as performance recommendations proposed in peer-reviewed journal articles (e.g., Boylan and Russell, 2006; U.S. EPA, 2007). For example, for $PM_{2.5}$ and its components, we will create the so-called "bugle plots" that were recommended by Boyland and Russell (2006), which show the model performance criteria as goal lines together with actual model performance. An example of a "bugle plot" from Boylan and Russell (2006) is shown in Figure 7-1. We will also create the so-called "soccer plots." The soccer plot visualizes model performance by showing both the model bias and error (e.g., MFB and MFE, or

NMB and NME) on a single plot with various performance “goals” shown as dashed lines. An example of a “soccer plot” from Tesche (2006) is also given in Figure 7-2.

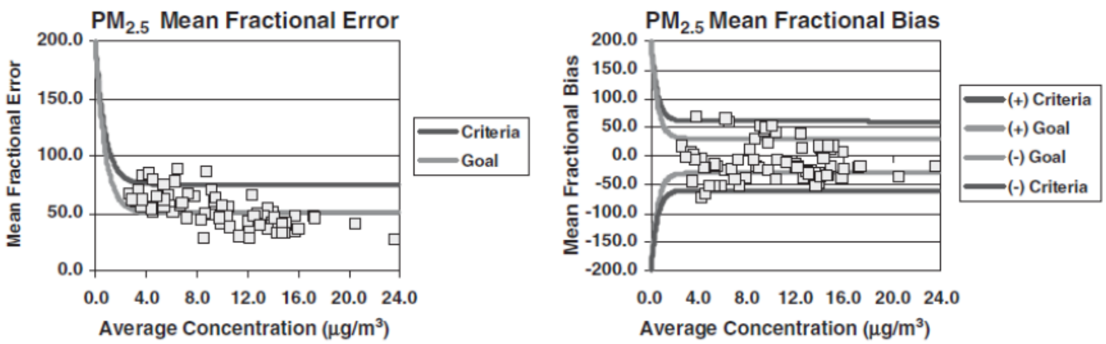


Figure 7-1: Example of “bugle plots” showing $PM_{2.5}$ actual model performance as compared to model performance criteria and goals (from Boylan and Russell, 2006).

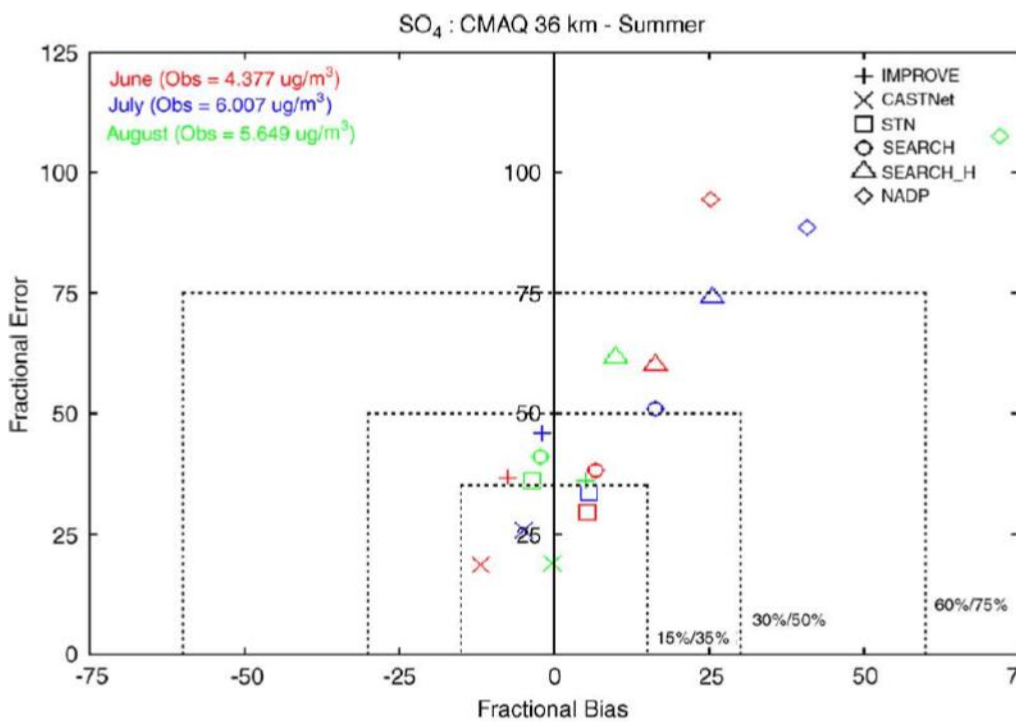


Figure 7-2: Example of a “soccer plot” showing $PM_{2.5}$ fractional bias and error (from Tesche et al., 2006).

Another convenient way to summarize the comparison between a simulated and an observed field is to use a Taylor diagram (Taylor, 2001). These diagrams can provide a concise statistical summary of how well two patterns match each other in terms of their correlation, root-mean-square difference, and ratio of their variances. These three quantities are interrelated with only two independent quantities and, thus, we are able to plot all three on a two dimensional diagram. Figure 7-3 shows an example of a Taylor diagram. Here, the radial distances from the origin to the points are proportional to the standard deviations for the test patterns (e.g., simulations) with that for the reference field (e.g., observations) indicated as REF on the x-axis. The azimuthal positions give the correlation coefficient between the reference and test fields. The dotted lines, representing circular arches centered on the standard deviation of the reference field (REF on the x-axis) indicate the root-mean-square error.

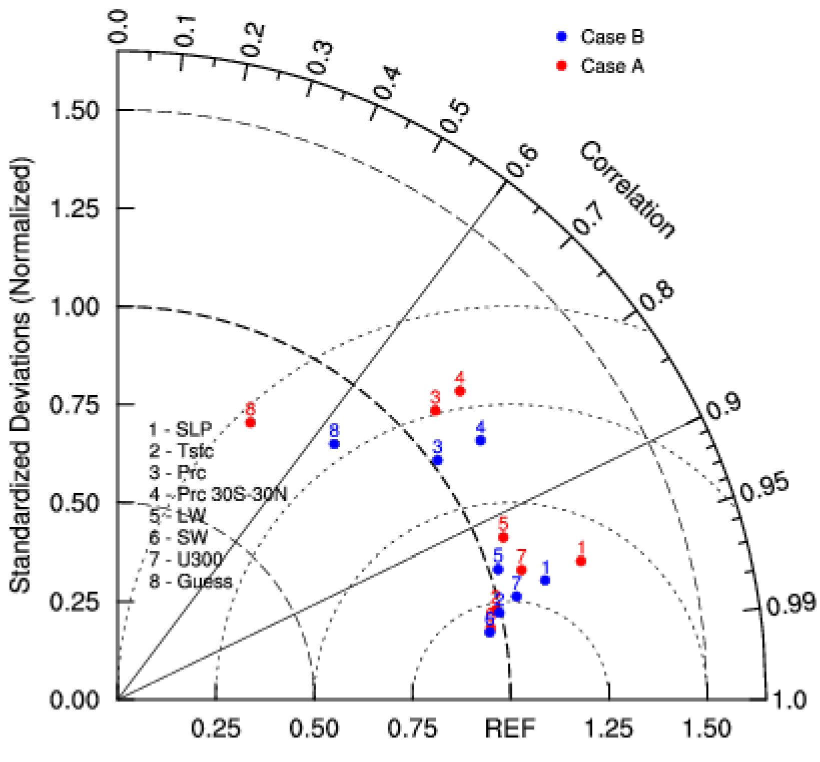


Figure 7-3: An example of a Taylor diagram.

When the metrics are normalized to the variance of the observed field (as shown in Figure 7-3), the comparison of several simulated and observed fields can be plotted on the same diagram. For example, these diagrams may be useful in displaying the model's skill at simulating $PM_{2.5}$ and its components on one diagram. We will explore the applicability and the feasibility of using Taylor diagrams in the model performance evaluation.

7.3. Diagnostic Testing

Possible Diagnostic Testing that could be used to Improve Model Performance is discussed in this section. Throughout the modeling process, many sensitivity analysis runs will be performed to improve the model performance and to find out the best set of model combinations and configurations. Examples of these analyses include different meteorological models (i.e., WRF or MM5), different meteorological model inputs and physics options, different algorithms/schemes in the CMAQ model, different setup of modeling domain and resolutions, etc. The best combinations of configurations/schemes will be used along with the consideration of computational burden.

Receptor models such as Positive Matrix Factorization can also be performed to complement the grid-based photochemical models. These models do not use emissions and meteorological data. Instead, they only rely on the chemical compositions to identify and quantify the contributions to the ambient $PM_{2.5}$ from various source types.

Furthermore, other techniques such as decoupled direct method (DDM), dynamic, or probabilistic model evaluations (Dennis et al., 2010) could also be explored as part of a broader ongoing model performance evaluation and improvement project.

8. Attainment Plan

8.1. Calculation of Relative Response Factors

According to new U.S. EPA guidance (U.S. EPA, 2011b), for the 24-hour $PM_{2.5}$ attainment test, for each quarter, the relative response factor (RRF) is calculated as the ratio of future year to reference year modeled predictions for sulfate, nitrate, elemental carbon, organic carbon, salt, and other primary $PM_{2.5}$ for the top 10% of modeled $PM_{2.5}$ days based on predicted concentrations of 24-hour average $PM_{2.5}$ for each quarter. Since we are modeling each day of the year, the top 10% of simulated $PM_{2.5}$ days would be equal to nine days per quarter. The RRF for component j at a site i is given by:

$$RRF_{ij} = \left(\frac{C_{j,future}}{C_{j,reference}} \right)_i ,$$

where $C_{j,reference}$ is the reference year mean species concentrations (for the nine high modeled $PM_{2.5}$ days for each quarter) predicted at the grid cell containing the monitoring site i; and $C_{j,future}$ is the future year mean species concentrations (for the high nine modeled $PM_{2.5}$ days for each quarter) predicted at the grid cell containing the monitoring site i.

8.2. <u>S</u>ulfate, <u>A</u>djusted <u>N</u>itrate, <u>D</u>erived<u>W</u>ater, <u>I</u>nferred <u>C</u>arbonaceous Material Balance Approac<u>h</u> (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 is based. The 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 ^{o}C. 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.

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,

(2) Calculate quarterly averages for retained nitrate, sulfate, elemental carbon, sea salt, and ammonium[1],

(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[2],

(4) Add 0.5 $\mu g/m^3$ 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.

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%:

$$\ln(K_i) = 118.87 - (24084/T_i) - 6.025 \times \ln(T_i),$$

[1] Ammonium mass will be calculated assuming complete neutralization of retained nitrate and sulfate. As we described in the supporting documentation for the 2008 Annual $PM_{2.5}$ SIP approval, the abundance of ammonia in the San Joaquin Valley makes both nitrate and sulfate fully neutralized. This will also make the calculation of ammonium mass consistent for both reference and future years.

[2] We will use the polynomial regression equation used during the preparation of the 2008 Annual $PM_{2.5}$ SIP.

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).

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. 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. Here, we will use the polynomial regression equation used during the preparation of the 2008 Annual $PM_{2.5}$ SIP.

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 $\mu g/m^3$) for each quarter of the years represented by the speciated data. Note that blank mass is kept constant at 0.5 $\mu g/m^3$ between the base and future years, and future year particle bound water needs to be calculated for the future year values of nitrate, ammonium, and sulfate.

8.3. Estimation of Species Concentrations at Federal Reference Method (FRM) Monitors that Lack Speciation Data

Speciation data for four STN (speciation) sites was used to speciate the FRM mass for all FRM sites. For those sites not collocated with STN monitors, surrogate speciation sites were determined based on analysis of CRPAQS data to determine which sites had similar speciation profiles. The composition was assumed to be the same at both Bakersfield sites (BAC and BEP). Similarly, the percent composition at the three Fresno sites (CLO, FSF and FSH) was assumed to be the same. Stockton (SOH), Corcoran (COP), and Modesto (MRM) were assumed to have the same speciation as one of the four speciation sites based on CRPAQS data analysis. For a list of all FRM sites and their associated speciation site, see Table 8.1.

Table 8-1: The FRM sites in SJV and their companion speciation sites.

Site Name	Code	Speciation
Bakersfield-410 E Planz Road	BEP	BAC
Bakersfield-5558 California Avenue	BAC	BAC
Clovis-N Villa Avenue	CLO	FSF
Corcoran-Patterson Avenue	COP	VCS
Fresno-1st Street	FSF	FSF
Fresno-Hamilton and Winery	FSH	FSF
Merced-2334 M Street	MRM	M14
Modesto-14th Street	M14	M14
Stockton-Hazelton Street	SOH	M14
Visalia-N Church Street	VCS	VCS

8.4. Speciated Modeled Attainment Test (SMAT)

Following U.S. EPA's latest guidance (U.S. EPA, 2011b), the modeled attainment test will be performed with the following steps.

Step 1: Determine the eight highest observed 24-hour $PM_{2.5}$ concentrations days in each quarter for each year at each FRM site (32 days per year), and determine the day rank of the observed 98th percentile value for each year based on the number of collected ambient samples.

Step 2: Calculate quarterly ambient species fractions on "high" $PM_{2.5}$ days for each of the major component species of $PM_{2.5}$ (i.e., sulfate, nitrate, ammonium, elemental carbon, organic carbon, particle bound water, salt, and blank mass). The "high" days are the top 10% of days in each quarter. Depending on the sampling frequency, the top 10% of days 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 8.1, to observed daily species concentrations from step 2 to obtain future year concentrations for 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 an empirical formula derived from the AIM model.

Step 5: Add the concentrations of species components to produce total $PM_{2.5}$ concentrations for each of the 32 days per year at each site. Then the 32 days for each site for each year are sorted by total $PM_{2.5}$ concentrations. For each site and year, the monitored 98^{th} percentile rank is used to determine the 98^{th} percentile rank for each year.

Step 6: Average the future-year 98^{th} percentile values to obtain the future-year design value. Compare the future-year 24-hour design values to the NAAQS. The 24-hour $PM_{2.5}$ design values are truncated after the first decimal place. Any value that is less than 35.5 $\mu g/m^3$ is compliant with the NAAQS.

8.5. Sensitivity Analyses

The effectiveness of reducing $PM_{2.5}$ precursors, such as NO_x, SO_x, VOCs, and NH_3, as compared to reducing direct $PM_{2.5}$ emissions is quantified using inter-pollutant equivalency ratios. Sensitivity analysis will be performed for five cases involving 10% reductions of primary $PM_{2.5}$, NO_x, SO_x, VOCs, and NH_3 emissions separately. The changes in simulated $PM_{2.5}$ concentrations compared to the base case without the 10% emission reductions will be quantified at a given FRM monitor. The effectiveness of reducing emissions, or the change in concentrations per unit emissions change, will then be determined by dividing the change in the 24-hour $PM_{2.5}$ design value by the amount of emission reductions corresponding to the 10% reduction. The 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 (i.e., the effectiveness of NO_x, SO_x, VOCs, and NH_3).

This analysis will be conducted for the FRM sites in the Bakersfield and Fresno areas in the future year using only anthropogenic emissions changes. The emissions changes will be implemented only in and around these two urban areas. We will determine the area of influence for these monitors depending on the season in which the 98^{th} percentile value occurs. Past experience dictates that, in the San Joaquin Valley, the 98^{th} percentile value will occur in the winter and it has been shown previously that, during the winter, monitors in these areas are impacted predominantly by local emissions (Ying et al., 2009b).

In addition, carrying capacity diagrams for pairs of precursors will also be developed. These pairs will include NO_x vs. primary $PM_{2.5}$, NO_x vs. VOC, NO_x vs. NH_3, and NO_x vs. SO_x. These diagrams will be used to assess significant precursors.

8.6. Unmonitored Area Analysis

The unmonitored area analysis ensures that a control strategy leads to reductions in $PM_{2.5}$ at other locations which could have baseline or future design values exceeding the NAAQS if a monitor was located there (U.S. EPA, 2007). U.S. EPA recommends combining interpolated spatial fields and modeled gradients to generate the gradient adjusted spatial fields for $PM_{2.5}$. Future year estimates for unmonitored grids are created by applying the grid specific RRFs to the gradient adjusted spatial fields. The general procedures are as given below:

Step 1: Interpolate base year ambient $PM_{2.5}$ to create a set of spatial fields. For 24-hour $PM_{2.5}$, U.S. EPA recommends interpolating the $PM_{2.5}$ concentrations in each quarter which is equal to or less than the 98th percentile value of the year. For the $PM_{2.5}$ component species, U.S. EPA recommends interpolating the high $PM_{2.5}$ days in each quarter.

Step 2: Adjust the spatial fields using gridded model output gradients for the base year. For 24-hour $PM_{2.5}$, the gradient adjusted fields can be created from the high end of the distribution of daily averages in each quarter.

Step 3: Apply the gridded model RRFs to the gradient adjusted spatial fields created in step 2 to obtain the future year concentrations. For $PM_{2.5}$, the RRFs for each of the species in each quarter are multiplied by the gradient adjusted spatial fields for each species and each quarter.

We do not know at this time if we will use the U.S. EPA software (MAPS), since complete source code is not available, or will develop in-house software for this task.

9. Supplemental Analyses

9.1. Additional Analyses to be completed to corroborate the Modeling

The Weight of Evidence (WOE) analysis provides a corroborative set of analyses supplementing the SIP required modeling that provides confidence that the correct pollutants are being controlled and the attainment demonstration is appropriate. These analyses can include consideration of measured air quality, emissions, and meteorological data, evaluation of other air quality indicators, and additional air quality modeling. Each analysis is weighted based on its ability to quantitatively assess the ability of the proposed control measures to yield attainment.

For the San Joaquin Valley, the $PM_{2.5}$ WOE analysis will include an evaluation of air quality trends, emission trends, observational models, indicator species, meteorological trends, and air quality modeling results to demonstrate attainment of the 35 $\mu g/m^3$ $PM_{2.5}$ standard. The air quality trends will include data from the official Federal Reference Monitor and chemical composition networks and other types of $PM_{2.5}$ monitoring data. ARB will analyze the data to examine the yearly, seasonal, and spatial trends. In addition, ARB will discuss the yearly meteorological conditions and the impact of these conditions on the measured $PM_{2.5}$ air quality. The met-adjusted trends can also be used in conjunction with emissions trends to review the impacts of emission reductions. Two complementary observational models, chemical mass balance (CMB) and positive matrix factorization (PMF) will be used to identify the sources contributing to the San Joaquin Valley $PM_{2.5}$ problem. ARB will use the latest version of CMB and PMF and appropriate input data for California. In addition, ARB will compare these PMF and CMB results with other published results on the sources of $PM_{2.5}$ in the San Joaquin Valley.

The speciated rollback technique (NRC, 1993) can also be applied to study the changes in ambient concentrations due to changes in emissions. A fundamental assumption here is that the changes in ambient concentration of a pollutant is linear with changes in its precursors. While this assumption may be sound for directly-emitted pollutants (such as primary $PM_{2.5}$), the response of secondary pollutants to changes in their precursors is known to be non-linear. Fully allowing for such non-linearity is not possible within the speciated rollback technique.

ARB will explore the possibility of using an indicator species approach to investigate the effectiveness of precursor controls on secondary species such as ammonium nitrate. This approach would incorporate air quality data, a review of San Joaquin Valley specific published papers, and air quality modeling sensitivity runs to identify the limiting precursors for ammonium nitrate formation in the context of the 24-hour $PM_{2.5}$ standard. Finally, ARB will evaluate the grid-based modeling results in the context of the corroborative analyses to provide confidence that $PM_{2.5}$ attainment is reached as expeditiously as practicable in the San Joaquin Valley.

9.2. Base Case Air-Quality Modeling with Meteorological Fields Generated with the Weather and Research Forecast (WRF) Model

The prognostic meteorological model that will be used to generate meteorology will be MM5 for the reasons outlined in Section 5.1.1.

A base year CMAQ model simulation will also be performed using meteorological fields generated with the WRF model (Skamarock et al., 2008). The primary objective is to study how $PM_{2.5}$ predictions in the San Joaquin Valley differ when the meteorological fields from WRF instead of MM5 are used to drive the CMAQ model. Traditionally, MM5 has been used to provide meteorological data for air quality simulations (Appel et al., 2009). With the emergence of WRF, many air quality model simulations started to use WRF to provide the meteorological fields for air quality models (e.g., Appel et al., 2009; de Meji, 2009; Eder et al., 2009; Hu, et al., 2010; Lin et al., 2010; Shimadera, 2011).

The WRF model version 3.3 will be used. Detailed configuration of the WRF model can be found in the meteorological modeling sections. The WRF model output will be processed by the Meteorology-Chemistry Interface Processor (MCIP, Otte and Pleim, 2010) of the CMAQ modeling system. The MCIP version 3.6 in the CMAQv4.7 modeling system will be used. Compared to the base year simulation using MM5 meteorological fields (MM5-CMAQ), all modeling inputs and configurations for the CMAQ model will be the same except that the meteorological fields are generated by the WRF model (WRF-CMAQ). This will ensure that the difference in the CMAQ model output is only attributed to the different meteorological fields.

WRF-CMAQ model output in terms of $PM_{2.5}$ total mass and individual $PM_{2.5}$ components (i.e., nitrate, sulfate, ammonium, elemental and organic carbon, other primary $PM_{2.5}$ components) will be compared to the MM5-CMAQ model outputs. WRF-CMAQ model outputs will also be evaluated against the ambient air quality data using the same modeling performance procedures and metrics used for the MM5-CMAQ model outputs. Model performance metrics such as mean fractional bias (MFB), mean fractional error (MFE), normalized mean bias (NMB), and normalized mean error (NME) will be calculated and will be compared to the performance metrics of the MM5-CMAQ model outputs.

10. Procedural Requirements

10.1. How Modeling and other Analyses will be Archived, Documented, and Disseminated

The air quality modeling system covers the central portion of California with 4x4 km^2 grids. In total there are approximately half a million grid cells in each simulation (192 x 192 cells in the lateral direction and 15 levels in the vertical). 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 take ~200 DVDs to hold one TB). Please note that this estimate is for simulated surface-level pollutant concentrations only. If three-dimensional pollutant concentrations are needed, it would add a few more TB. 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
Planning and Technical Support 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.

10.2. 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 24-hour $PM_{2.5}$ Design Value Calculations using SANDWICH, RRF, and SMAT
- Unmonitored area analysis
- Access to input data and simulated results

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Appendix G

PM2.5 Weight of Evidence Analysis

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SAN JOAQUIN VALLEY PM2.5 WEIGHT OF EVIDENCE ANALYSIS

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EXECUTIVE SUMMARY

The San Joaquin Valley 2012 PM2.5 Plan demonstrates that the San Joaquin Valley will attain the PM2.5 24-hour standard of 35 ug/m^3 as expeditiously as practicable due to adopted and proposed control measures. As part of the attainment demonstration, the 2012 PM2.5 Plan specifically identifies the: 1) most expeditious date of when the San Joaquin Valley (Valley) will attain the standard, 2) attainment plan precursors, 3) amount of emissions needed to attain, and 4) sources to control. The weight of evidence analysis provides a set of complementary analyses that supplement the required modeling. Because all methods have strengths and weaknesses, examining an air quality problem in a variety of ways offsets the limitations and uncertainty that are inherent in air quality modeling. This approach also provides a better understanding of the overall problem and the level and mix of emissions controls needed for attainment.

Analyses conducted by Air Resources Board (ARB) and San Joaquin Valley Air Pollution Control District (SJVAPCD or District) staff, along with findings from the California Regional Particulate Air Quality Study (CRPAQS) provide the supplemental information supporting the attainment demonstration. CRPAQS was a public/private partnership designed to advance our understanding of the nature of PM2.5 in the Valley and guide development of effective control strategies. The study included monitoring at over 100 sites as well as data analysis and modeling, results of which have been published in over 60 papers and presented at national and international conferences.

Studies such as CRPAQS provide valuable information that supports the State Implementation Plan (SIP) process in a number of ways. First, these studies provide additional observational data that help to provide a more detailed understanding of the nature of the PM2.5 problem in the San Joaquin Valley. This data also is used to update the fundamental algorithms contained within air quality models, thereby enhancing their ability to simulate observed air quality conditions. Finally, they provide an improved basis for model applications used in the preparation of SIPs and a more robust platform for evaluating the response to emission controls and predicting future air quality.

What is the nature of the 24-hour PM2.5 problem in the Valley?

The geography of the San Joaquin Valley, along with weather patterns influence the accumulation, formation, and dispersion of PM2.5. As a result, PM2.5 concentrations are generally higher in the central and southern portions of the Valley, with highest values in the urban areas of Fresno and Bakersfield. Concentrations are highest during the winter months of November through February. During these months, high-pressure weather systems over Northern California can cause the atmosphere to become stagnant for extended periods, resulting in PM2.5 episodes that can persist from several days up to several weeks.

Ammonium nitrate and carbonaceous material (organic and elemental carbon) are the largest constituents of PM2.5 on exceedance days, comprising 85 to 90 percent of the mass. Geological material (dust), and ammonium sulfate are small contributors. Ammonium nitrate is formed in the atmosphere from reactions of gaseous precursors. Emissions of nitrogen oxides (NOx) from mobile sources and stationary sources react with ammonia which is primarily emitted from livestock operations, fertilizer application, and mobile sources. The stagnant, cold, and damp conditions that occur during the winter promote the formation and accumulation of ammonium nitrate. Elevated concentrations can be found at both urban and rural sites. In contrast, organic carbon is highest in urban areas due to emissions from residential wood combustion, commercial cooking operations, and mobile source tailpipe emissions which are largest in urban areas. Due to the localized urban increment from these activities, which adds to the more regional ammonium nitrate concentrations, the highest PM2.5 concentrations in the Valley occur at urban sites.

What progress has been made in reducing PM2.5 concentrations?

The Valley has experienced progress in reducing both annual average and 24-hour PM2.5 concentrations over the last ten years. Between 2001 and 2011, annual average design values in the Valley declined between 30 and 40 percent at individual monitoring locations. Overall, annual PM2.5 trends adjusted for the effects of meteorology indicate that between 1999 and 2010, annual PM2.5 concentrations decreased about 40 to 50 percent at Bakersfield and Fresno due to emission reductions. With on-going implementation of the 2008 PM2.5 Plan, annual average PM2.5 concentrations in the Valley are expected to continue to improve and reach attainment in 2014.

During this same time period, 24-hour PM2.5 design values in the Valley have also decreased between approximately 30 and 50 percent. In addition, the number of days exceeding the 24-hour standard decreased by about 45 to 50 percent. After adjusting for the influence of meteorology, the number of exceedance days has decreased between 60 and 65 percent in Bakersfield and Fresno.

Additional evaluations provide further insight into the annual and 24-hour PM2.5 progress that has been observed. For example, as the fraction of days recording PM2.5 levels above the 24-hour standard has decreased, there has been a corresponding increase in the fraction of days below the level of the annual standard of 15 ug/m^3. Average concentrations during the winter months have decreased, and under similar meteorological conditions, peak 24-hour concentrations during episodes are now 40 percent lower than they were ten years ago.

What are the attainment plan precursors?

Ambient PM2.5 is comprised of many different constituents and as a result there are multiple precursor pollutants that lead to PM2.5 formation (directly emitted PM2.5, NOx, sulfur oxides (SOx), volatile organic compounds (VOCs), and ammonia). The U.S. Environmental Protection Agency's (U.S. EPA) PM2.5 implementation rule specifies that a precursor is considered "significant" for control strategy development purposes when a significant reduction in the emissions of that precursor pollutant leads to a significant decrease in PM2.5 concentrations. Such pollutants are known as

"PM2.5 attainment plan precursors" (72 FR 20586). The PM2.5 implementation rule also establishes a presumption that PM2.5, NOx, and SOx are attainment plan precursors, while VOCs and ammonia are not. For the annual PM2.5 plan, PM2.5, NOx, and SOx were identified and approved as the only attainment plan precursors by U.S. EPA.

Given the large contribution of ammonium nitrate on 24-hour PM2.5 exceedance days, a number of different studies and analyses were evaluated to understand the role of VOCs and ammonia in ammonium nitrate formation in the San Joaquin Valley and to determine whether they should be considered attainment plan precursors for the 2012 24-hour PM2.5 Plan. The amount of ammonium nitrate produced depends upon the relative atmospheric abundance of its precursors. It is therefore important to understand which precursor controls are most effective in reducing ammonium nitrate concentrations. In simple terms, the precursor in shortest supply will limit how much ammonium nitrate is produced. This is known as the limiting precursor and controls of this precursor will have the most significant benefits in reducing PM2.5 concentrations.

The precursor assessment for the 24-hour PM2.5 plan included evaluation of emissions inventories, monitoring studies, and photochemical modeling analyses of ammonium nitrate sensitivity to precursor emission reductions. While emissions inventory and monitoring data can indicate the relative abundance of the different precursors, photochemical models provide a quantitative approach to simulate the effects that emission reductions in each of gaseous precursors would have on the predicted ammonium nitrate concentrations.

Evaluation of both emissions inventory and monitoring data concluded that the ammonia-rich conditions throughout the Valley demonstrate that NOx rather than ammonia is the limiting precursor during wintertime PM2.5 episodes. In addition, photochemical modeling studies found that while large reductions in NOx led to commensurate reductions in ammonium nitrate, comparable reductions in ammonia were much less effective. Precursor sensitivity modeling conducted for the 2012 PM2.5 Plan showed that on a per ton basis, reductions in NOx are approximately nine times more effective than reductions in ammonia. Finally, evaluation of ambient air quality trends show that reductions in NOx emissions, gaseous NOx concentrations, and particulate nitrate all track each other well.

Evaluation of monitoring studies also provided some evidence that VOCs could be important at times, however these studies were not conclusive. Therefore photochemical modeling studies are more appropriate to assess the overall impact of VOC controls. These modeling studies found that at current NOx levels, further VOC emission reductions produce essentially no benefit, and in some instances may actually lead to an increase in ammonium nitrate concentrations. Findings from these prior studies were supported by precursor sensitivity modeling conducted for the 2012 PM2.5 SIP, which indicated a very small disbenefit from reductions in VOCs.

As noted previously, U.S. EPA's PM2.5 implementation rule directs SIP planning efforts and regulation to those pollutants generally known to significantly contribute to PM2.5 concentrations. Based on the weight of evidence presented from historical studies, coupled with the modeled precursor sensitivity analyses conducted as part of the 2012 PM2.5 Plan, VOCs and ammonia are not considered significant precursors for 24-hour PM2.5. Therefore the 2012 24-hour PM2.5 plan attainment precursors are directly emitted PM2.5, NOx, and SOx.

When will the Valley attain the 24-hour PM2.5 standard?

Consistent with U.S. EPA guidelines, air quality modeling was done to predict future PM2.5 concentrations at each monitoring site in the San Joaquin Valley. This modeling shows attainment of the 24-hour PM2.5 standard by 2019 in all counties except Kings and Kern, based on implementation of the ongoing control program. In these counties, additional focused emission reductions are needed to provide for attainment. The modeling analysis includes new emission reductions each year between now and 2019 from implementation of a combination of adopted ARB and District programs. As a result, most sites in the northern and central Valley are expected to attain prior to 2019.

ARB staff then modeled a scenario with an enhanced wood burning curtailment program Valley wide, which would be designed to prevent wood burning on days that may lead up to a PM2.5 exceedance. The predicted design values for each site from this modeling scenario are shown in Table E-1.

Table E-1.

2019 Modeled 24-hour PM2.5 Design Values with Enhanced Residential Wood Burning Curtailment Program.

Monitoring Site	Design Value (μg/m^3)
Bakersfield - California	35.7
Bakersfield - Planz	32.9
Corcoran - Patterson	32.1
Visalia - N. Church	29.4
Fresno - Hamilton	28.6
Fresno - First	30.5
Clovis	28.6
Merced	22.6
Modesto	24.7
Stockton	21.4

While adoption of a more stringent wood burning curtailment program brings the Bakersfield-California site very near attainment, further reductions are still needed and will be provided through a measure to achieve additional emission reductions from commercial cooking operations. Design values at all other sites are well below attainment levels.

What is the attainment control strategy?

In order to determine the emission reductions needed to bring Bakersfield into attainment, ARB staff conducted additional modeling sensitivity runs to assess the relative efficacy of further reductions of different PM2.5 precursors. The current 24-hour PM2.5 standard modeling demonstrates that on a relative basis the greatest benefits are achieved from reductions in sources of directly emitted PM2.5, followed by NOx, based on U.S. EPA's relative response factor procedures. Kern County specific model sensitivity runs were also conducted to evaluate the benefits of emission reductions focused on the Bakersfield area. These runs show that directly emitted PM2.5 emission reductions are approximately 8 times more effective than NOx reductions.

The implementation of new reductions from California's on-going emission control programs will provide the majority of the emission reductions needed to attain the 24-hour PM2.5 standard throughout the San Joaquin Valley in 2019. The PM2.5 design value at the Bakersfield-California site must decrease by approximately 45 percent to demonstrate attainment. Between 2007, the base year used in the photochemical modeling attainment demonstration and 2019, implementation of these control programs will reduce NOx emissions by 55 percent. The weight of evidence analysis has demonstrated that prior reductions in NOx have resulted in commensurate reductions in ambient concentrations of nitrate. This is consistent with modeled predictions that demonstrate a nearly 50 percent reduction in ammonium nitrate concentrations.

In addition, while directly emitted PM2.5 emissions in aggregate are decreasing by nearly 30 percent, a major focus of the attainment control strategy is further curtailment of residential wood burning, along with implementation of a measure to reduce emissions from commercial cooking. District analysis has demonstrated the significant benefits of past implementation of wood burning curtailment. Further, examination of emission sources surrounding the Bakersfield-California monitor, and a modeling sensitivity run support the benefits of reducing emissions from cooking operations. The final attainment demonstration for the Bakersfield-California design site is provided in Table E-2.

Table E-2.

Attainment Demonstration for the Bakersfield-California Design Value Site.

2007 Design Value (ug/m3)	2019 Design Value with Wood Burning Program Enhancement (ug/m3)	2019 Final Design Value (ug/m3)
65.6	35.7	≤35.4

Note: The benchmark for attainment is a design value that is equal to or less than 35.4 μg/m³.

Consideration of the entirety of information presented in the weight of evidence provides a consistent assessment that supports the modeled attainment date of 2019. The substantial continuing reductions that will result from implementation of the ongoing control program, coupled with new measures addressing residential wood burning and cooking, are consistent with the results predicted in the modeled attainment demonstration.

1. INTRODUCTION

The 2012 PM2.5 Plan demonstrates that the San Joaquin Valley will attain the PM2.5 24-hour standard as expeditiously as practicable due to adopted and proposed control measures. As part of the attainment demonstration, the 2012 PM2.5 Plan specifically identifies the: 1) most expeditious date for when the San Joaquin Valley (SJV or Valley) will attain the standard, 2) attainment plan precursors, 3) amount of emissions needed to attain, and 4) sources to control.

Following U.S. Environmental Protection Agency (U.S. EPA) guidance and procedures, the attainment demonstration was conducted through a modeled attainment test. Photochemical modeling was used to identify the most expeditious attainment date, the relative benefits of controlling different PM2.5 precursor pollutants, and the magnitude of emission reductions needed from each pollutant. The Weight of Evidence (WOE) analysis provides a set of complementary analyses that supplement the required modeling.

A WOE approach looks at the entirety of the information at hand to provide a more informed basis for the attainment strategy. Because all methods have strengths and weaknesses, examining an air quality problem in a variety of ways offsets the limitations and uncertainty that are inherent in air quality modeling. This approach also provides a better understanding of the overall problem and the level and mix of emissions controls needed for attainment.

The U.S. EPA recognizes the importance of a comprehensive assessment of air quality data and modeling and encourages this type of broad assessment for all attainment demonstrations. In their modeling guidance, they further note that the results of supplementary analyses may be used in a WOE determination to show that attainment is likely despite modeled results which may be inconclusive (U.S. EPA 2007). Following the U.S. EPA guidance, future year modeled 24-hour design values that fall between 32 and 37 ug/m^3 need to be accompanied by a WOE demonstration to determine whether attainment will occur. This range in modeled design values reflects the uncertainty in predicting absolute PM2.5 concentrations that is inherent in air quality modeling, and therefore recognizes that an improved assessment of attainment can be derived from examining a broader set of analyses.

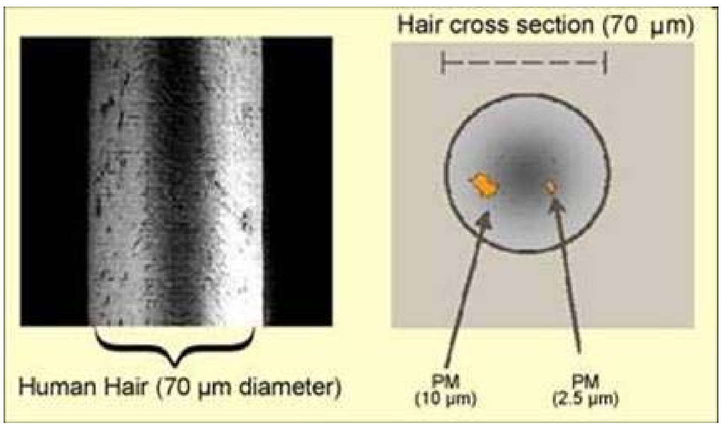
U.S. EPA recommends that three basic types of analyses be included to supplement the primary modeling analysis in the WOE approach: 1) analyses of trends in ambient air quality and emissions, 2) observational models and diagnostic analyses, and 3) additional modeling evaluations. The scope of the WOE analysis is different for each nonattainment area. The level of detail appropriate for each area depends upon the complexity of the air quality problem, how far into the future the attainment deadline is, and the amount of data and modeling available. For example, less analysis is needed for an area that is projecting attainment near-term and by a wide margin, and for which recent air quality trends have demonstrated significant progress, than for areas with more severe air quality challenges

The following sections present the WOE assessment that supports the attainment demonstration the 24-hour PM2.5 standard in the San Joaquin Valley.

2. PM2.5 STANDARDS AND HEALTH EFFECTS

PM2.5 is a complex mixture of particles and liquid droplets that vary in size and chemical composition. As a subset of PM10, particles with diameters up to 10 micrometers, PM2.5 comprises particles with diameters up to 2.5 micrometers (Figure 1). PM2.5 contains a diverse set of substances including elements such as carbon and metals, compounds such as nitrates, sulfates, and organic materials, and complex mixtures such as diesel exhaust and soil or dust. Some of the particles are directly emitted into the atmosphere. Others, referred to as secondary particles, result when gases are transformed into particles through physical and chemical processes in the atmosphere.

Figure 1. PM2.5 particle diameter compared to the thickness of a single strand of hair.



Numerous health effects studies have linked exposure to PM2.5 to increased severity of asthma attacks, development of chronic bronchitis, decreased lung function in children, increased respiratory and cardiovascular hospitalizations, and even premature death in people with existing cardiac or respiratory disease. In addition, California has identified particulate exhaust from diesel engines as a toxic air contaminant – suspected to cause cancer, other serious illnesses, and premature death. Those most sensitive to PM2.5 pollution include people with existing respiratory and cardiac problems, children, and older adults.

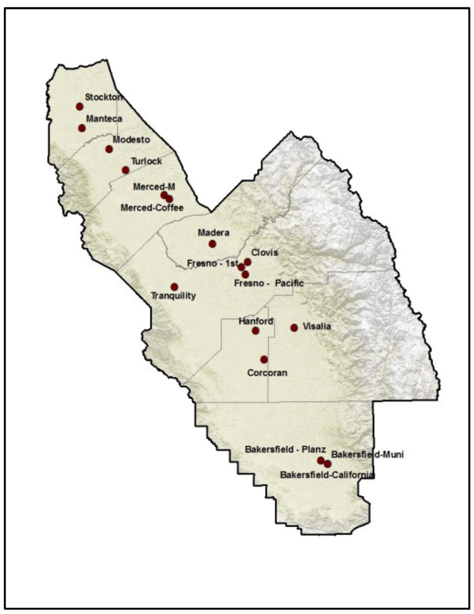
Ambient air quality standards establish the levels above which PM2.5 may cause adverse health effects. In 1997, U.S. EPA adopted the first set of PM2.5 air quality standards, an annual standard of 15 µg/m^3 and a 24-hour standard of 65 µg/m^3. To address the 1997 PM2.5 standards, the San Joaquin Valley Air Pollution Control District (SJVAPCD or District) adopted the 2008 PM2.5 Plan. At the time of plan development, the San Joaquin Valley already attained the 24-hour standard, thus the 2008 PM2.5 Plan focused on the annual PM2.5 standard. U.S. EPA approved this Plan in 2011 (76 FR 41338; 76 FR 69896). In 2006, U.S. EPA tightened the 24-hour standard to 35 µg/m^3. Attainment of this standard is the focus of the SJV 2012 PM2.5 Plan.

3. MONITORING IN THE SAN JOAQUIN VALLEY

a. Established monitoring network

An extensive network of PM2.5 monitors throughout the SJV provides data to assess compliance with ambient air quality standards and to study the nature of ambient PM2.5. Currently, the network comprises 21 monitoring sites. Many sites include multiple monitoring instruments running in parallel. Seven sites operate Federal Reference Monitors (FRMs), which provide regulatory data that are used to assess compliance with the federal PM2.5 standards. An additional 20 monitors provide hourly PM2.5 measurements. Eleven of these continuous monitors are Federal Equivalent Monitors (FEM), which can also be used to assess compliance with the standards. The FRM and FEM monitoring sites are shown in Figure 2. The locations of these monitors are designed to capture population exposure. In addition, data collected at these monitors serve to report air quality conditions to the public, and support forecasting for the District's agricultural and residential burning curtailment programs. Finally, four sites have chemical speciation monitors. The speciation monitors collect samples that are further analyzed in the laboratory to determine the chemical make-up of PM2.5.

Figure 2. San Joaquin Valley PM2.5 monitoring network (FRMs and FEMs, October 2012).



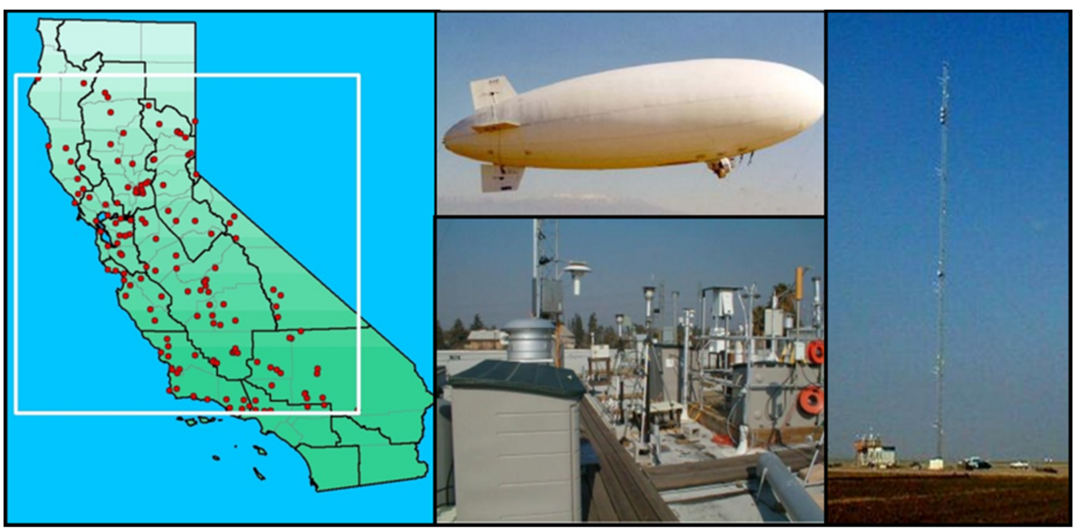
b. Extensive field studies

The San Joaquin Valley is one of the most studied areas in the world with an extensive number of publications in peer-reviewed international scientific/technical journals and other major reports. Since 1970, close to 20 major field studies have been conducted in the Valley and surrounding areas that have elucidated various aspects of the nature and causes of ozone and particulate matter. A comprehensive listing of publications (reports and peer-reviewed journal articles) is provided in Appendix 1.

The first major study specifically focused on particulate matter was the Integrated Monitoring Study in 1995 (IMS-95), which was the pilot study for the subsequent California Regional Particulates Air Quality Study (CRPAQS) in 2000 (Solomon and Magliano, 1998). IMS-95 formed the technical basis for the SJV 2003 PM10 Plan that was approved by the U.S. EPA in 2004 (71 FR 63642), and the Valley was subsequently re-designated as attainment in 2008 (73 FR 66759). CRPAQS was a key component of the technical foundation for the SJV 2008 PM2.5 Plan that U.S. EPA approved in 2011 (76 FR 41338; 76 FR 69896). Although conducted more than ten years ago, CRPAQS findings remain relevant to the development of the current 24-hour PM2.5 Plan.

CRPAQS was a public/private partnership designed to advance the understanding of the nature of PM2.5 in the Valley and guide development of effective control strategies. The study included monitoring at over 100 sites (Figure 3) as well as data analysis and modeling, results of which have been published in over 60 papers and presented at national and international conferences. The field campaign was carried out between December 1999 and February 2001. CRPAQS improved our understanding of the spatial and temporal distribution of PM2.5 in the Valley, its chemical composition, transport and transformation processes, and contributing sources. More details on CRPAQS can be found at the following link: http://www.arb.ca.gov/airways/ccaqs.htm.

Figure 3. CRPAQS monitoring program.



Findings from CRPAQS and other studies have been integrated into the conceptual model of PM2.5 in the San Joaquin Valley. The conceptual model provides the scientific foundation for the WOE analysis supporting the 24-hour PM2.5 standard attainment demonstration. Specific findings are integrated into the various WOE analysis sections of this document.

Further field studies relevant to PM2.5 include the California portion of the Arctic Research of the Composition of the Troposphere (ARCTAS-CARB) which took place in 2008 (Jacob, et al., 2010) and Research at the Nexus of Air Quality and Climate (CalNex2010) conducted in 2010 (www.esrl.noaa.gov/csd/calnex/). The monitoring operations for both studies occurred during the early to mid-summer and extended over Southern California and the Central Valley. Some study findings have been published (e.g., Kaduwela and Cai, 2009, Cai and Kaduwela, 2011, Kelly et al., 2011), but data analysis is still in progress.

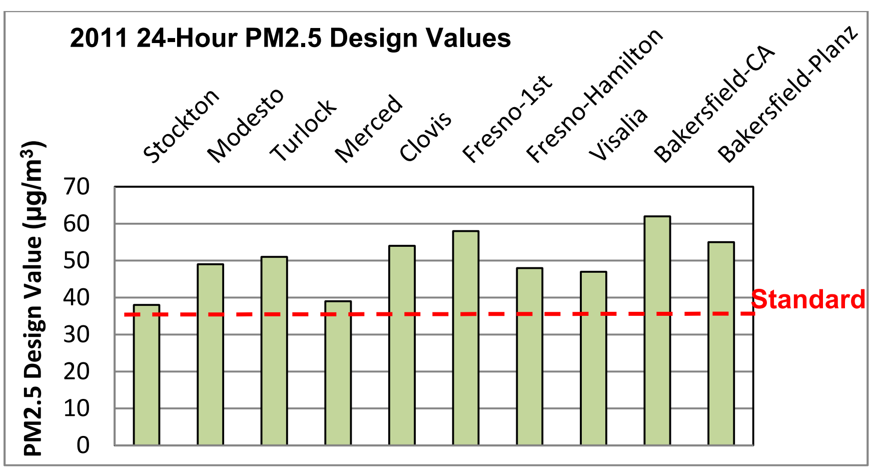
4. NATURE AND EXTENT OF THE PM2.5 PROBLEM

a. Current air quality

The geography of the San Joaquin Valley, along with large-scale regional and local weather patterns, influence the accumulation, formation and, dispersion of air pollutants. Covering nearly 25,000 square miles, the Valley is a lowland area bordered by the Sierra Nevada Mountains to the east, the Pacific Coast range to the west, and the Tehachapi Mountains to the south. The mountains act as air flow barriers, with the resulting stagnant conditions favoring the accumulation of pollutants. To the north, the Valley borders the Sacramento Valley and Delta lowland, which allows for some level of pollutant dispersion. As a result of geography and meteorology, PM2.5 concentrations are generally higher in the southern and central portions of the Valley.

To determine attainment for the 24-hour standard, the design value at each monitoring site must be calculated following strict U.S.EPA protocols. The design value represents a three-year average of the 98th percentile of the measured PM2.5 concentrations. Depending on a site's 24-hour PM2.5 data collection schedule, the 98th percentile usually corresponds to a value between the 2nd and the 8th highest value. If the design value is equal to or below 35.4 µg/m^3, the site attains the standard. Figure 4 shows the 2011 24-hour PM2.5 design values throughout the San Joaquin Valley. All sites currently record design values above the standard, although design values are generally lower in the northern and central Valley. Urban sites in the Fresno and Bakersfield areas register the higher design values.

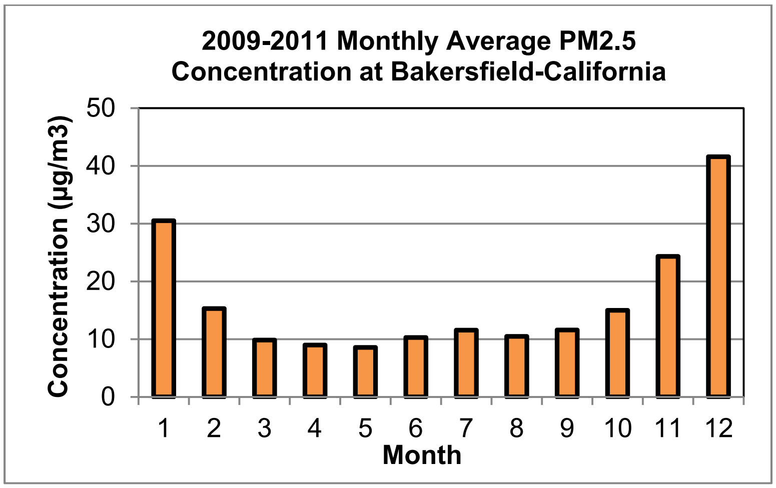
Figure 4. 2011 24-hour design values



b. Seasonal variability

PM2.5 concentrations in the San Joaquin Valley exhibit a strong seasonal pattern, with highest concentrations occurring from November through February (Figure 5). During the winter, PM2.5 builds up over several days or weeks. These PM2.5 episodes are caused by increased activity in some emission sources and by meteorological conditions that are conducive to the build-up and formation of PM2.5. During the winter, high-pressure weather systems over California can cause the atmosphere to become stagnant for extended periods leading to temperature inversions. Under normal conditions, temperature decreases with altitude, allowing free upward air flow and dispersing emissions and pollutants. In contrast, a temperature inversion positions a layer of warmer air above cooler air, impeding upward flow of emissions and air pollutants. Often the inversion layer is lower than the mountains surrounding the Valley, trapping emissions and pollutants.

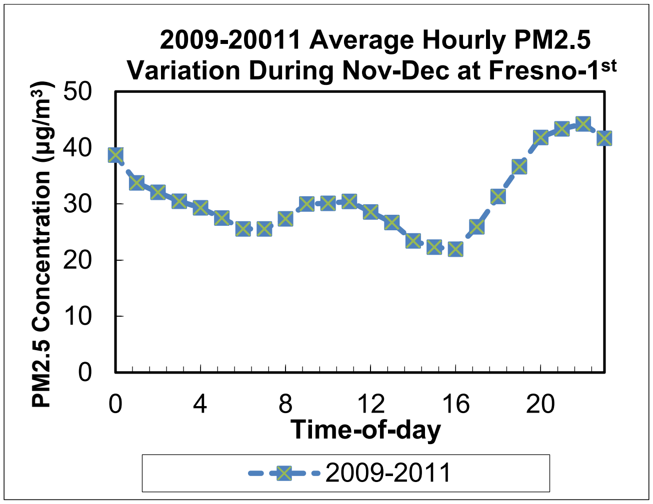
Figure 5. Seasonal variation in PM2.5 concentrations at Bakersfield-California.



c. Diurnal variability

During the winter, PM2.5 levels in the San Joaquin Valley also vary significantly across the 24-hour period. For example, in urban Fresno, the highest PM2.5 concentrations occur during the night (Figure 6). Peak evening concentrations generally reflect the influence of lowering inversion heights which trap pollutants close to the surface, as well as increased activity from evening commute traffic and residential wood combustion. The smaller peak of PM2.5 concentrations observed during mid-day is due in part to traffic activity, but mostly reflects secondary pollutant formation and PM2.5 formed above the inversion layer from previous day's emissions that mix back to the surface during the day.

Figure 6. Variation in hourly PM2.5 concentrations during the winter at Fresno-1st.



d. Chemical composition

Examination of the chemical make-up of PM2.5 on days exceeding the daily standard provides another important element in understanding the nature of PM2.5 in the Valley and contributing sources. The pie charts in Figure 7 show the current chemical components that contribute to PM2.5 on days that exceed the standard at urban sites in the southern (Bakersfield), central (Fresno), and northern (Modesto) regions of the Valley. These sites currently record the highest PM2.5 concentrations in their corresponding regions. While the relative percentages vary, in all cases the major components are ammonium nitrate and organic material (organic carbon).

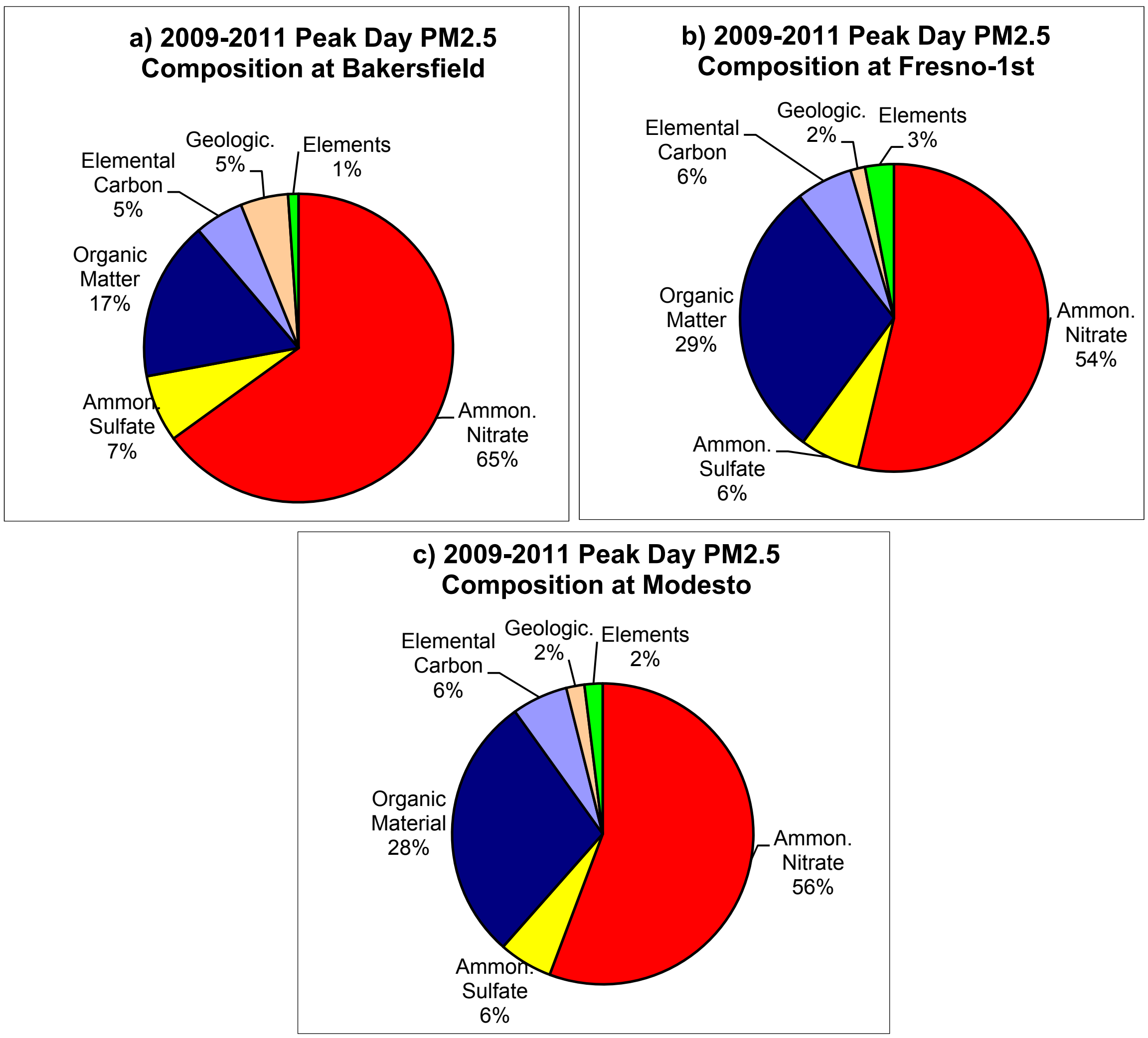
Ammonium nitrate is the largest contributor to PM2.5, especially in the southern region. At Bakersfield, ammonium nitrate constitutes about 65 percent of PM2.5, while at Fresno and Modesto it constitutes about 55 percent. Ammonium nitrate is formed in the atmosphere from chemical reactions of NOx and ammonia. Sources emitting NOx include motor vehicles and stationary combustion sources. The largest sources of ammonia are livestock operations, fertilizer application, and mobile. The stagnant, cold, and damp conditions that occur during the winter promote the formation and accumulation of ammonium nitrate. Additional information on ammonium nitrate formation can be found in section 5.

The organic matter component of PM2.5 is largest in the central and northern portions of the Valley. Organic matter constitutes about 30 percent of PM2.5 at Modesto and Fresno compared to less than 20 percent at Bakersfield. Activities such as residential wood combustion, cooking, biomass burning, and direct tailpipe emissions from mobile sources contribute to the PM2.5 organic matter component.

Ammonium sulfate and elemental carbon each contribute about five percent at the three sites. Ammonium sulfate is also formed in the atmosphere from SOx emitted from combustion sources. Elemental carbon results from mobile and stationary combustion sources, with significant contributions from diesel sources.

Geological material contributes to a lesser extent, about five percent at Bakersfield and about two percent at Modesto and Fresno. Geological material comes from dust suspended into the air by vehicle travel on roads, soil from agricultural activities, and other dust producing activities such as construction.

Figure 7. 2009-2011 average peak day PM2.5 chemical composition at a) Bakersfield, b) Fresno, and c) Modesto.



e. Spatial distribution of the major PM2.5 components; local versus regional

As noted previously, high PM2.5 concentrations in the Valley occur almost exclusively during multiday pollution episodes under stagnant winter weather conditions. The duration and strength of an episode depends on atmospheric stability, but episodes can last several weeks. Once the weather conditions conducive to an episode set in, PM2.5 concentrations increase due to the accumulation of primary pollutants and formation of secondary pollutants.

Each episode has a regional as well as local component (Turkiewicz et al., 2006). High concentrations of nitrate can occur over large regions, including both urban and rural areas (Figure 8). As shown in Figure 9, ammonia is mostly concentrated in rural areas, particularly between Fresno and Bakersfield. On the other hand, high concentrations of organic carbon are more localized around urban sites, especially Fresno, with lower concentrations at rural sites (Figure 10).

The differences between the regional and local component can be traced back to the emission sources and subsequent formation and transport processes for each chemical component. Gaseous precursors of ammonium nitrate (NOx and ammonia) are transported much more efficiently than directly emitted organic matter particles (Ying and Kleeman, 2009). Although, some of the emitted NOx forms ammonium nitrate in urban areas, it is also transported to downwind regions where it reacts with ammonia to form particulate ammonium nitrate in the rural areas. While transport does occur, the distances are still relatively limited, with transport distances of 50 to 60 kilometers in the central and southern Valley. Ying et.al. (2009) found for example that most of the PM2.5 nitrate in Bakersfield is produced from sources within the southern Valley.

In contrast, carbonaceous aerosols are emitted into the atmosphere as particles and have a shorter lifetime due to higher deposition rates. Under stagnant conditions they can only be transported a short distance and therefore, have the greatest impact locally. Transport distances for carbonaceous aerosols during CRPAQS were only 20 to 40 kilometers. Due to this localized organic carbon increment, which adds to the more regional ammonium nitrate concentrations, the highest PM2.5 concentrations occur at urban sites.

Figure 8. Spatial distribution of winter ammonium nitrate concentrations measured during CRPAQS (Chow et al., 2005).

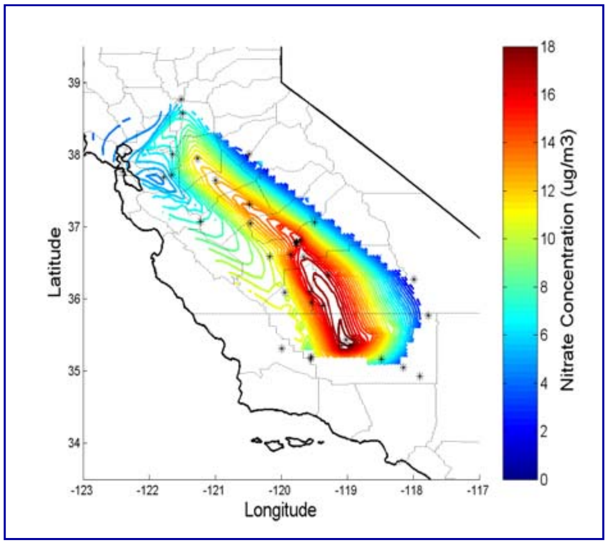


Figure 9. Spatial distribution of annual ammonia (NH_3) concentrations (2/1/2000-1/31/2001) during CRPAQS (Chow et al., 2005).

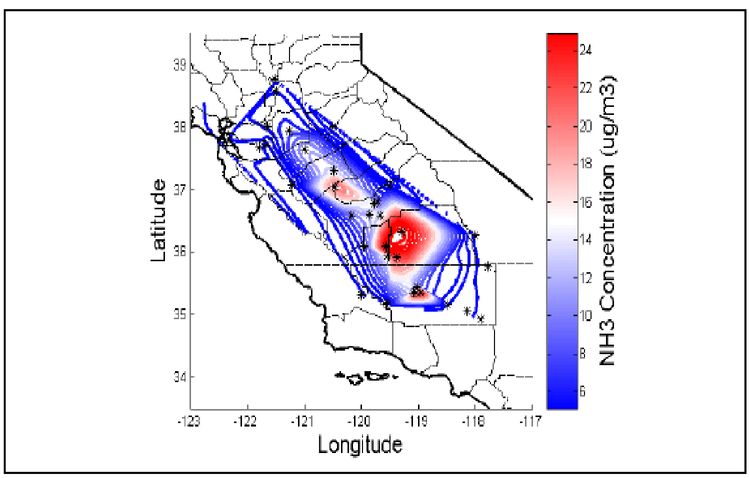
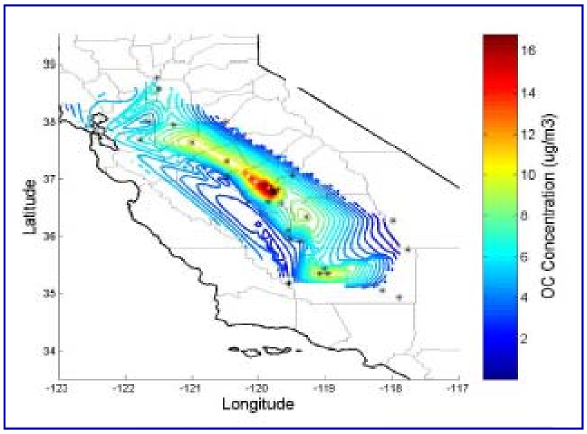


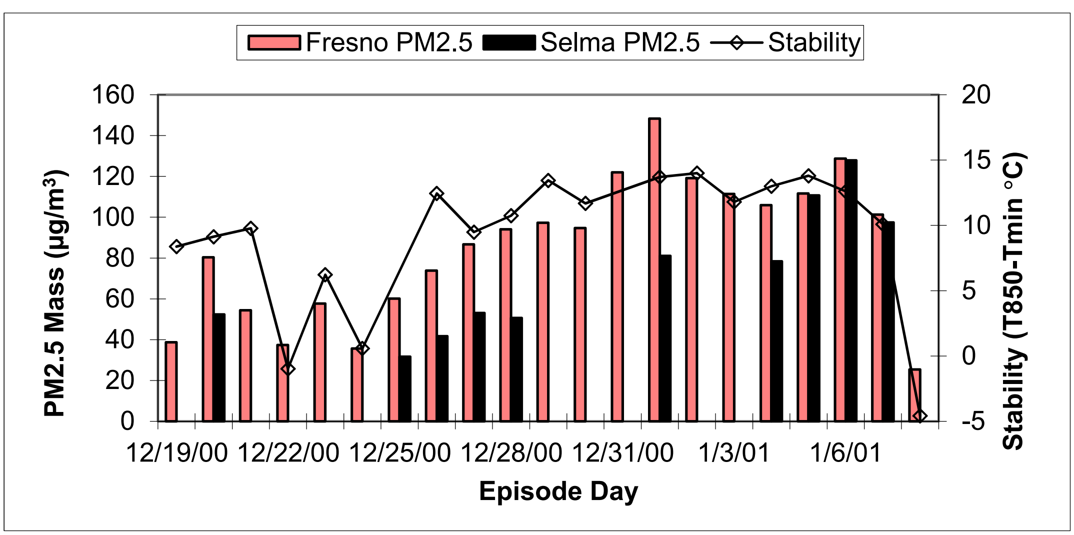
Figure 10. Spatial distribution of winter organic carbon concentration measured during CRPAQS (Chow et al., 2005).



f. Episode development

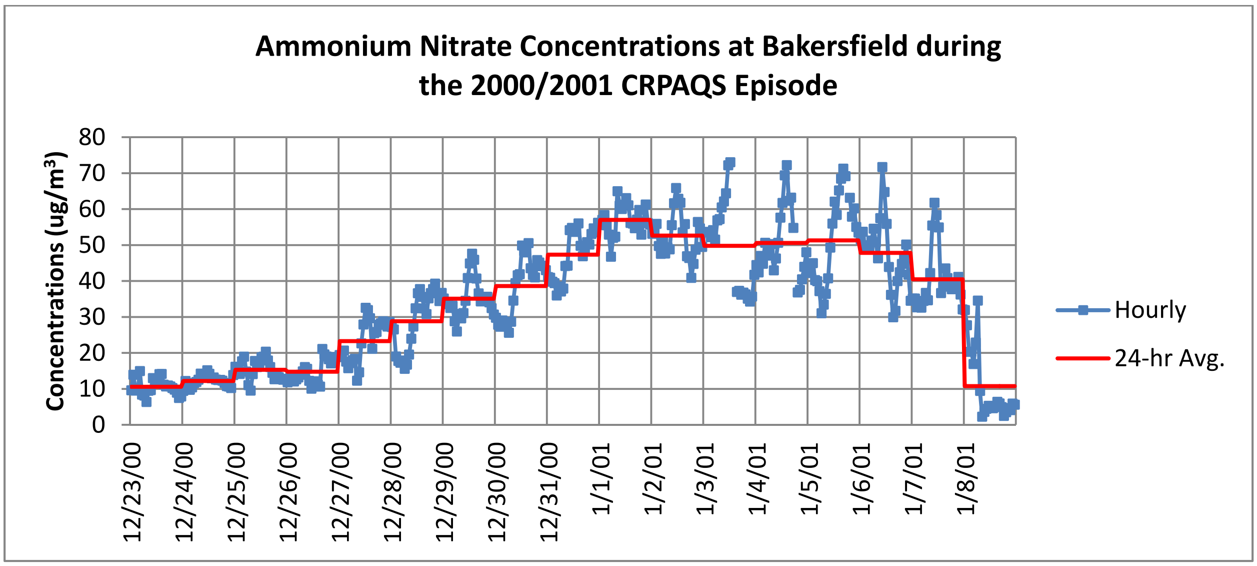
The development of PM2.5 episodes in the Valley is strongly controlled by meteorological conditions. The rate of concentration buildup depends on the intensity of atmospheric stability, with concentrations building up faster at urban sites than at rural sites (Turkiewicz et al., 2006). Figure 11 illustrates the differences in the PM2.5 buildup rate between an urban (Fresno) and a rural (Selma) site in the Fresno area during CRPAQS. Although urban sites reach the highest overall concentrations, at the end of an episode rural sites may reach equivalent levels. However, because of the lag in the overall buildup rate, rural sites have fewer days above the standard and lower episode-average concentrations.

Figure 11. Atmospheric stability and buildup of PM2.5 concentrations at an urban site (Fresno) and a rural site (Selma) in the Fresno area during the December 2000 CRPAQS episode.



The rate of buildup and the differences between urban and rural sites can be explained by the differential contributions of ammonium nitrate and organic carbon. Throughout the duration of an episode, ammonium nitrate concentrations tend to build to a plateau that is maintained until a weather front breaks the stagnation, causing the levels to decrease. Figure 12 illustrates the buildup of ammonium nitrate concentrations measured during the 2000/2001 PM2.5 episode in Bakersfield. This ammonium nitrate buildup generally begins in urban areas, followed by a buildup in rural areas as urban NOx is mixed downwind and reacts with rural ammonia. In contrast, organic carbon is largest in urban areas, and tends to be more stable across an episode, although individual peaks can occur during periods of enhanced wood burning such as weekends and holidays. The combination of early ammonium nitrate buildup along with the urban organic carbon increment results in the highest concentrations being observed in urban areas. The abrupt decrease in concentrations on January 8th was due to the passage of a cold front effectively ending the PM2.5 episode.

Figure 12. Ammonium nitrate concentrations at Bakersfield during the 2000/2001 CRPAQS episode.



5. SECONDARY AMMONIUM NITRATE FORMATION

a. Chemistry

As discussed previously, the cooler temperatures and higher humidity of the winter months are conducive to ammonium nitrate formation through a complex process involving NOx, ammonia, and VOCs. This occurs both at the surface and aloft, via both daytime and nighttime chemistry. Understanding the interactions amongst these precursors is needed to design an appropriate and effective approach to reduce ammonium nitrate.

During the day, NO_2 is oxidized to nitric acid (HNO_3). This daytime pathway also involves sunlight, VOCs, and background ozone:

$$NO \xrightarrow{O_3} NO_2 \xrightarrow{OH} HNO_3$$

Main oxidant is OH
Requires high sunlight, VOC rich environment

During the night, nitric acid is formed through oxidation of NO_2 (via N_2O_5) by background ozone:

$$NO \xrightarrow{O_3} NO_2 \xrightarrow{O_3} NO_3 \xrightarrow{+NO_2} N_2O_5 \xrightarrow{H_2O} 2\,HNO_3$$

Main Oxidant is Ozone (O_3)
Favors low sunlight intensity, wet conditions

The nitric acid formed from these reactions then combines with ammonia (NH_3) to form ammonium nitrate (NH_4NO_3):

$$HNO_3 + NH_3 \longleftrightarrow NH_4NO_3$$

Since the chemistry of NOx to nitric acid formation involves multiple steps and also depends on the availability of oxidants, only a portion of the NOx emitted ultimately forms ammonium nitrate. An early photochemical modeling study applying a box model to a typical winter episode in the San Joaquin Valley found that approximately 33 percent of the molecules of emitted NOx were converted to ammonium nitrate (Stockwell et. al. 2000). A subsequent study that modeled the January 4-6, 1996 episode in the San Joaquin Valley with the University California Davis/California Institute of Technology (UCD-CIT) photochemical transport model found that on average, only 13 to 18 percent of the emitted NOx (expressed as NO_2) was converted to ammonium nitrate (Kleeman et. al. 2005). The fraction of NOx converted varied by location, with urban regions converting little NOx to ammonium nitrate, while in remote areas up to 70 percent NOx was converted.

As previously described, NOx emissions mostly originate from urban traffic and transportation corridors, while ammonia is primarily generated from livestock operations, fertilizer application, and mobile sources. Analysis of CRPAQS measurements suggest that, on average, daytime production of nitric acid in the San Joaquin Valley is relatively slow, and that nighttime production is the more dominant pathway (Lurmann et al. 2006). Although daytime mixing is limited, NOx and ammonia emitted during the day can be mixed upward where nighttime interactions can occur more regionally to form ammonium nitrate. Based on analyses conducted to characterize the atmospheric transport and dispersion processes during the winter CRPAQS episodes, MacDonald et al. (2006) found that the ammonium nitrate that is formed aloft during the night is subsequently entrained into the daytime boundary layer. This was observed through a rapid rise in hourly ammonium nitrate concentrations which coincided with the growth of the surface mixed layer (Watson and Chow 2002). These mechanisms help explain the more regional distribution of ammonium nitrate that is observed throughout the Valley.

b. Limiting precursor concept

The amount of ammonium nitrate produced will depend on the relative atmospheric abundance of its precursors – VOCs, NOx, and ammonia (NH_3). It is therefore important to understand which precursor controls are most effective in reducing ammonium nitrate concentrations. In simple terms, the precursor in shortest supply will limit how much ammonium nitrate is produced. This is known as the "limiting" precursor. The following figures provide an illustration of this concept. As shown in Figure 13, each molecule of ammonia pairs with one NOx molecule to produce one molecule of ammonium nitrate. In this example, there are more ammonia molecules than NOx, and therefore not all of the ammonia participates in forming ammonium nitrate, i.e. there is "excess" ammonia. Figure 14 illustrates the impact of reducing NOx. Here, a reduction in NOx, the less abundant precursor, leads to a commensurate reduction in ammonium nitrate. In contrast, Figure 15 illustrates that a larger reduction in the more abundant precursor, ammonia, results in no reduction in ammonium nitrate, as the ammonia reduced did not participate in ammonium nitrate production.

Figure 13. Ammonium nitrate formation.

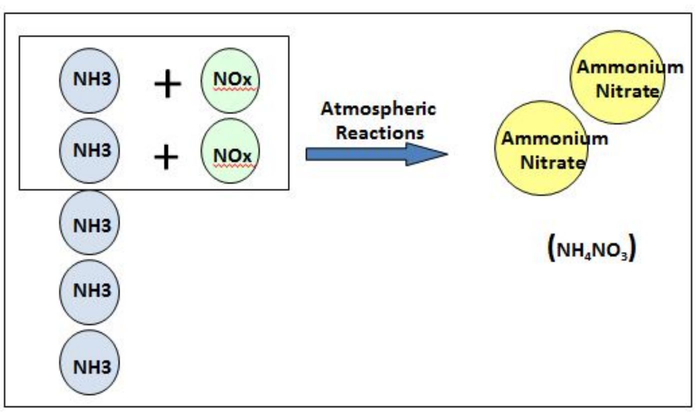


Figure 14. Reducing the less abundant precursor is more effective in reducing ammonium nitrate.

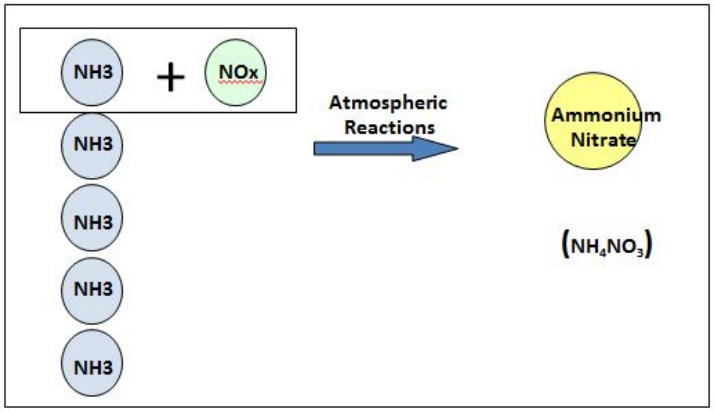
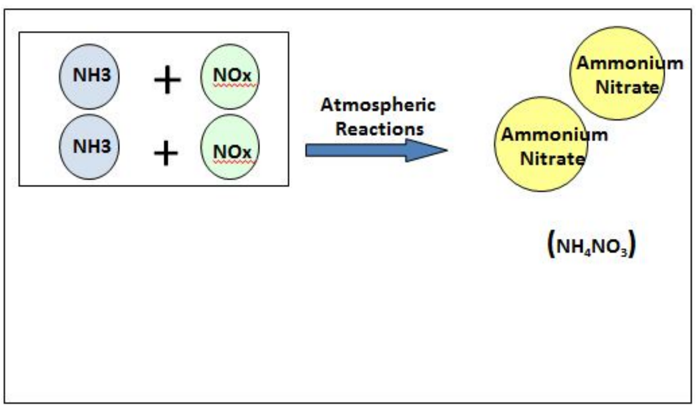


Figure 15. Reducing the more abundant precursor is less effective in reducing ammonium nitrate.



The following sections describe the current state of the science regarding the role of ammonia, VOCs, and NOx in ammonium nitrate formation and identify the most effective precursors for control.

c. Role of ammonia in ammonium nitrate formation

A number of different studies and analyses were evaluated to understand the role of ammonia in ammonium nitrate formation in the San Joaquin Valley. These included: a) comparison of the magnitude of the NOx and ammonia emissions inventories, b) ambient measurements of ammonia, nitric acid, and particulate ammonium; and c) photochemical modeling analyses of ammonium nitrate sensitivity to precursor emission reductions. While evaluation of emissions inventory and ambient data can provide indications of the relative abundance of different precursors, photochemical models provide a tool to quantitatively evaluate the impact of reducing precursor emissions on resulting ammonium nitrate concentrations.

Emission inventory

As discussed in the limiting precursor section, the precursor in shortest supply limits the amount of ammonium nitrate formation. An evaluation of the magnitude of NOx and ammonia emissions provides a first level assessment of the relative abundance of these two precursors. Table 1 lists NOx and ammonia winter emissions in the current inventory for three years (2000, 2011, and 2019). As Figure 13 in the limiting precursor section illustrated, in simple terms it takes one molecule of NOx and one molecule of ammonia to form one molecule of ammonium nitrate. However, due to differing molecular weights, one ton of NOx contains fewer molecules than one ton of ammonia. Therefore it is most appropriate to make an emissions inventory comparison after normalizing for molecular weight.

Due to emission source test procedures, most NOx emissions are expressed in terms of nitrogen dioxide (NO_2). Since one NO_2 molecule weighs 46 universal atomic units (u) and one NH_3 molecule weighs 17 u, one ton of NH_3 has 2.7 times (46 u/17 u) the number of molecules as one ton of NO_2. Dividing the NOx emissions by 2.7 therefore provides a common basis for comparison to the ammonia emissions. On this normalized comparison basis, ammonia is significantly more abundant than NOx, particularly in future years (Table 1). In addition, as noted in the chemistry section, only a portion on the NOx is ultimately converted to ammonium nitrate.

Table 1. Comparison of NOx and ammonia emissions in selected years.

Year	Winter NH_3 emissions (tpd)	Winter NOx emissions (tpd)	Normalized NOx emissions (tpd)
2000	330	550	204
2011	386	330	122
2019	360	209	77

Monitoring studies

Ambient measurements of precursor concentrations provide another method to investigate the relative abundance of each precursor and therefore which is most effective for control of ammonium nitrate. Blanchard, et al. (2000) examined two metrics using ambient data collected during the IMS-95 field program in the San Joaquin Valley. The first parameter was the excess of particulate ammonium plus gas-phase ammonia over the sum of nitric acid, particulate nitrate, and particulate sulfate. The second was the ratio of particulate to total nitrate concentrations. Both metrics indicated an excess of ammonia in most IMS-95 samples and concluded that greater reductions in aerosol nitrate would occur when nitric acid was reduced rather than ammonia.

Lurmann, et al. (2006) also compared ammonia and nitric acid ambient concentrations measured in the San Joaquin Valley during the winter of 2000/2001 as part of CRPAQS. Figures 16 and 17 show the concentrations of nitric acid and ammonia measured at the rural Angiola site and at the urban Fresno site. At both sites ammonia concentrations are generally at least an order of magnitude higher than the nitric acid concentrations. These ammonia-rich conditions throughout the Valley indicate that, during the winter, nitric acid rather than ammonia is the limiting precursor.

Figure 16. Comparison of ammonia and nitric acid concentrations measured at Angiola during the winter of 2000/2001 as part of CRPAQS.

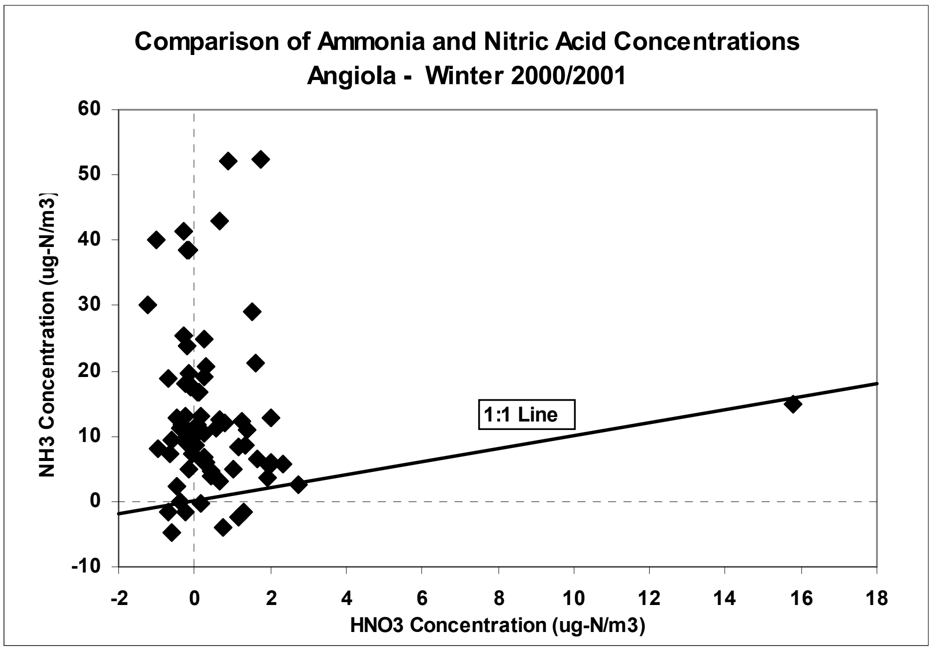
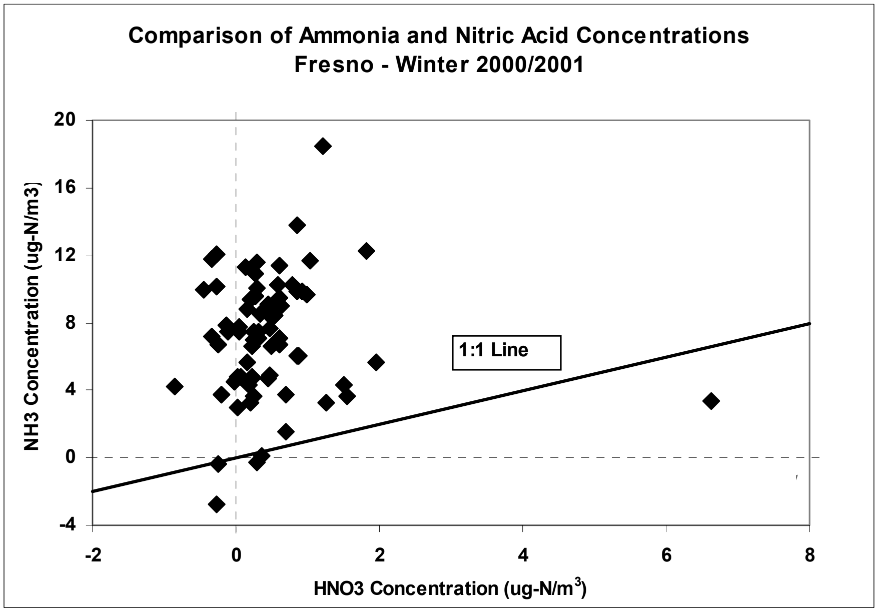
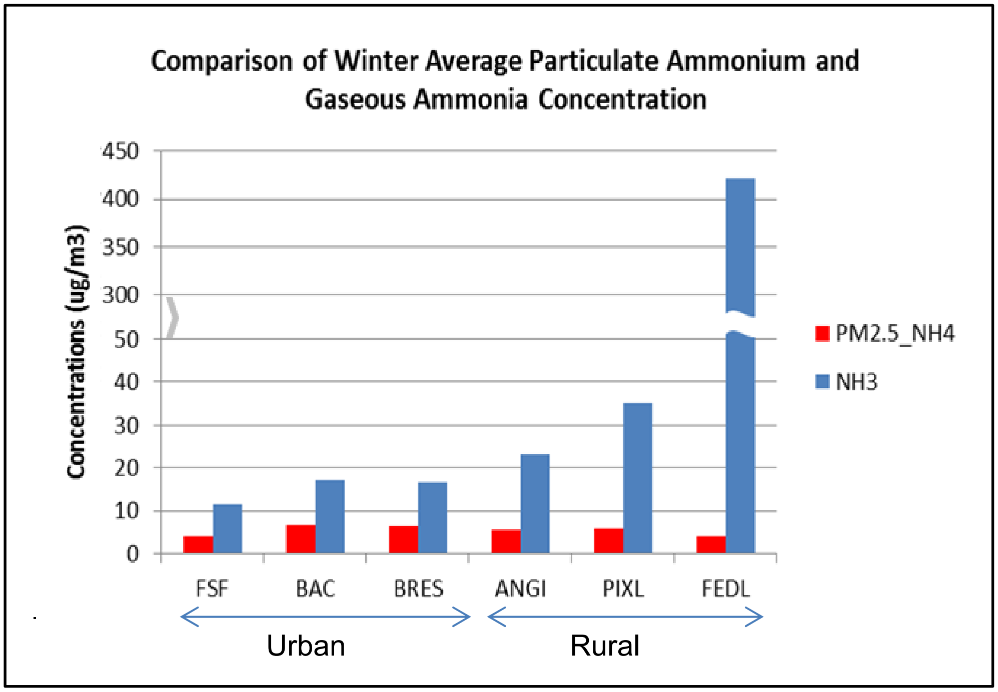


Figure 17. Comparison of ammonia and nitric acid concentrations measured at Fresno during the winter of 2000/2001 as part of CRPAQS.



The amount of gaseous ammonia (NH3) compared to particulate ammonium (NH4) provides another indicator of how much of the ammonia is converted to ammonium nitrate and therefore whether there is excess ammonia available. These measurements were collected at a larger number of sites during CRPAQS. Figure 18 shows the concentrations of particulate ammonium and gaseous ammonia at three urban sites (Fresno-1st, Bakersfield-California, and Bakersfield-residential), and three rural sites (Angiola, Pixley, and Feedlot) measured during the 2000/2001 winter CRPAQS episode. Overall, the levels of particulate ammonium at all sites are comparable, consistent with a regional formation mechanism of ammonium nitrate. Although ammonia concentrations are higher at the rural sites, especially at the Feedlot site, there is still a large amount of ammonia at each site beyond the amount that reacted with nitric acid to form ammonium nitrate. Again, these ammonia rich conditions indicate that nitric acid, rather than ammonia is the limiting precursor.

Figure 18. Comparison of particulate ammonium and gaseous ammonia concentrations measured throughout the SJV during the winter of 2000/2001 as part of CRPAQS.

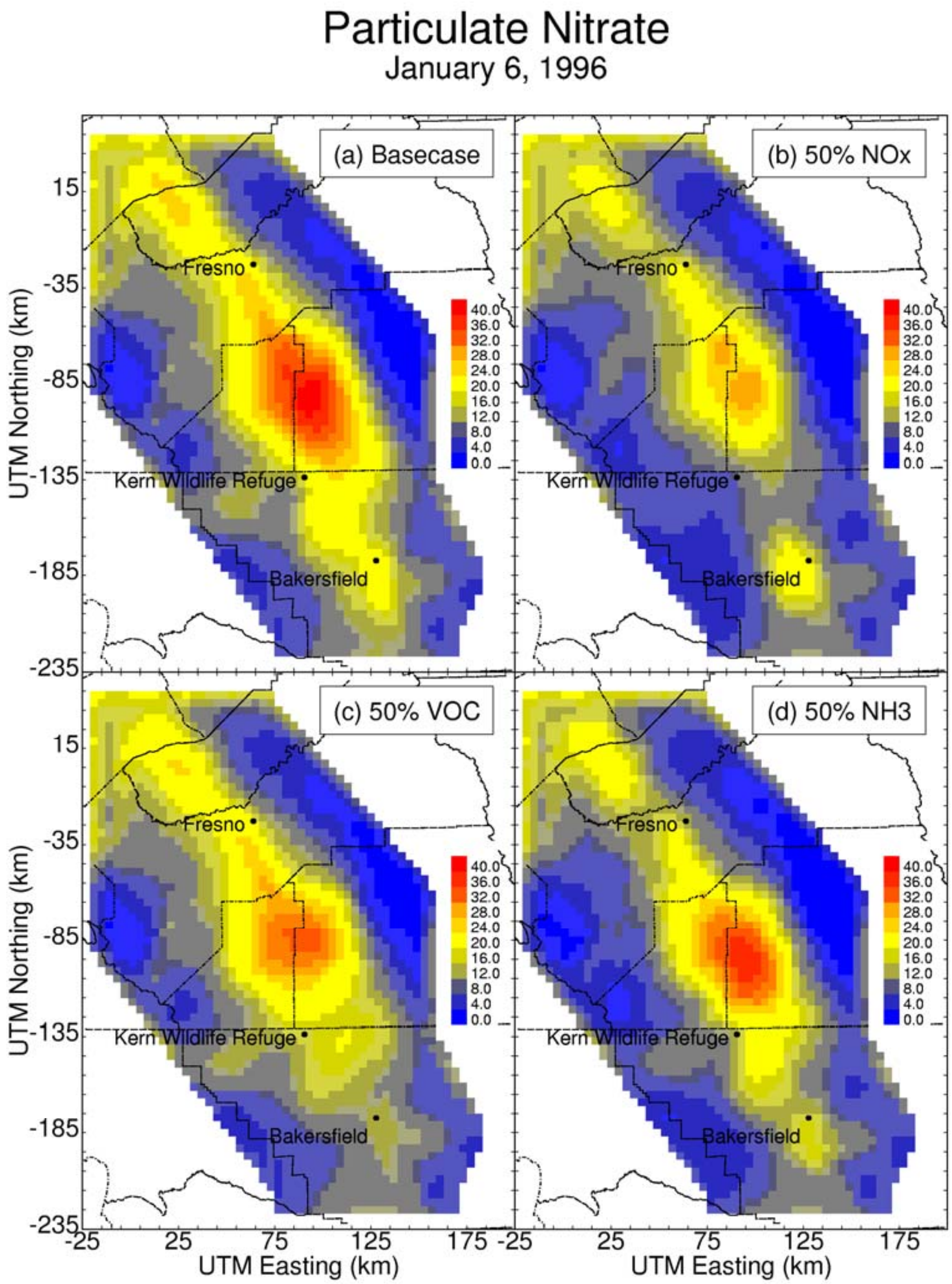


Photochemical Modeling

In contrast to the previous analyses, photochemical models provide a quantitative approach to simulate the effects that emission reductions in each of the gaseous precursors would have on the predicted ammonium nitrate concentrations. A number of modeling studies have been conducted by ARB staff and academic researchers to evaluate precursor sensitivity.

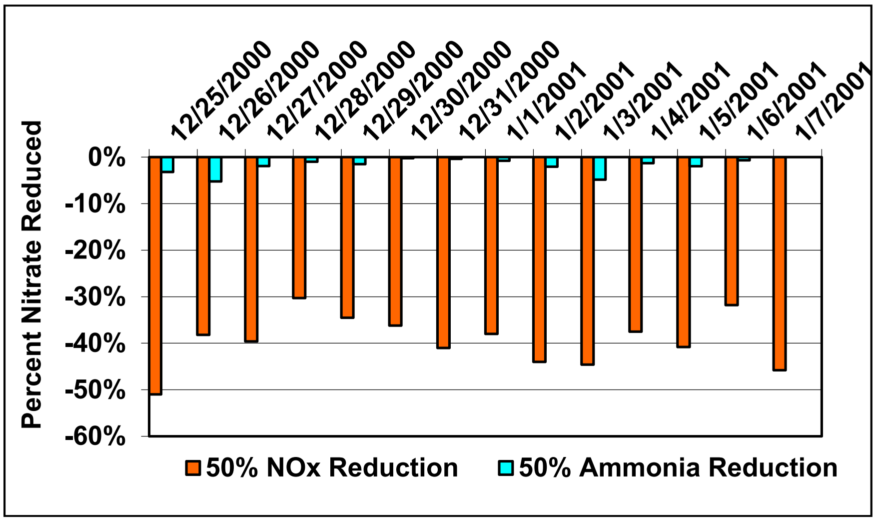
An investigation of precursor limitations for the January 4-6, 1996 PM2.5 episode measured in San Joaquin Valley as part of the IMS-95 field study used the UCD-CIT model. This sensitivity analysis revealed that NOx controls were the most effective control strategy to reduce PM2.5 ammonium nitrate concentrations (Kleeman, et al. 2005). In this study, a 50 percent reduction in NOx emissions resulted in a 25 percent reduction in total nitrate, while a 50 percent reduction in ammonia emissions resulted in a 10 percent reduction in total nitrate. The results of this analysis are shown graphically across the entire San Joaquin Valley in Figure 19.

Figure 19. Particulate nitrate reductions in response to 50 percent reductions in precursor emissions on January 6, 1996.



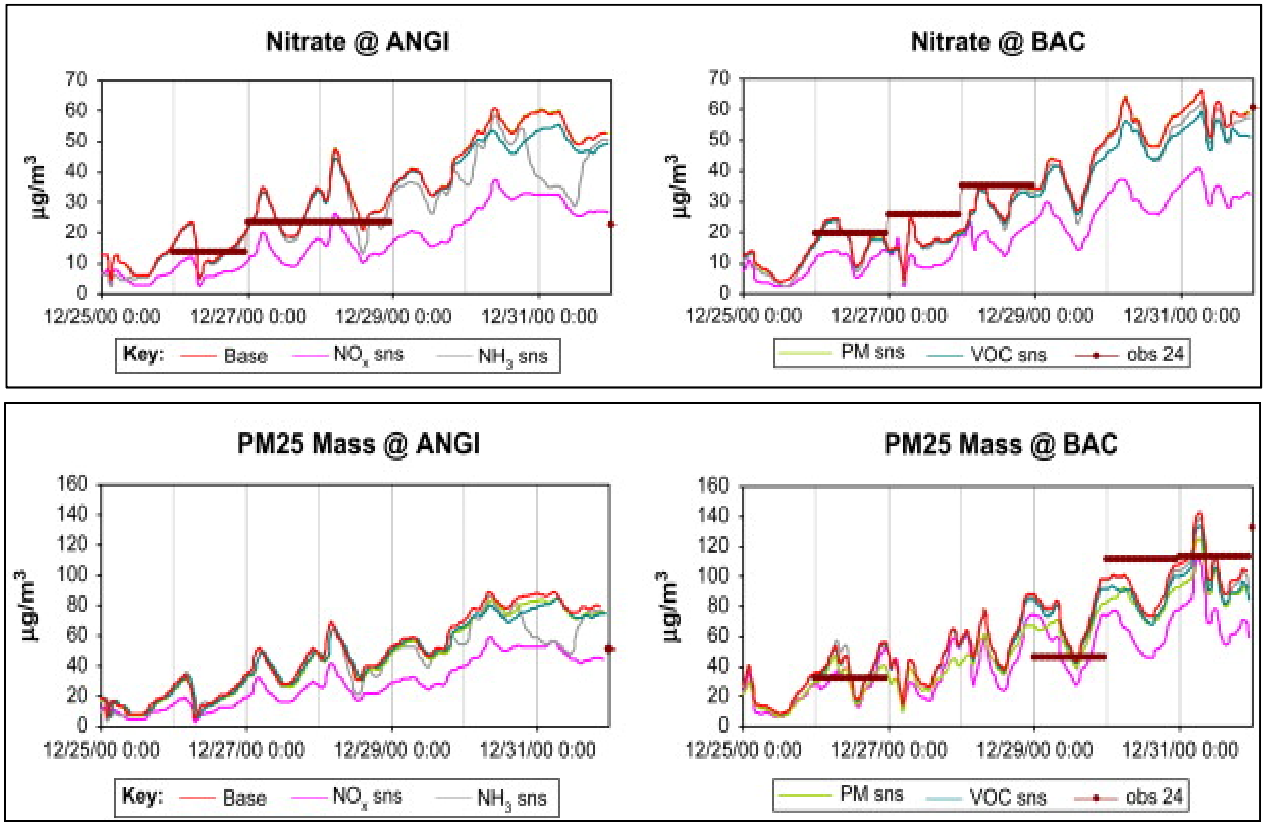
In 2006, ARB staff modeled air quality during the three week winter CRPAQS episode using U.S. EPA's Community Multiscale Air Quality (CMAQ) model with California-specific modifications and corrections (Liang et al. 2006). Figure 20 illustrates the effects that reducing the emissions of ammonia and NOx have on ammonium nitrate levels. This modeling indicated that reducing ammonia emissions by 50 percent reduced ammonium nitrate by less than 5 percent. On the other hand, reducing NOx emission by 50 percent reduced ammonium nitrate concentrations by approximately 35 percent. This analysis, therefore, indicated that reducing NOx emissions was the most beneficial control strategy to reduce ammonium nitrate.

Figure 20. Percent ammonium nitrate reduction in response to 50 percent reduction in NOx or ammonia emission reductions at Fresno during the winter of 2000/2001.



In another study based on sensitivity analyses using CMAQ-Madrid simulations of the December 2000 CRPAQS episode, Pun et al. (2009) found that a 50 percent reduction in NOx emissions reduced ammonium nitrate by approximately 50 percent at rural sites and between 30-45 percent at Bakersfield. As shown in Figure 19, a 50 percent reduction in ammonia emissions did not have a significant effect on ammonium nitrate concentrations at urban sites. At the rural site of Angiola, ammonium nitrate concentrations decreased between 10 and 25 percent. However, such reductions in ammonium nitrate occurred only at the end of the episode, when PM2.5 concentrations at the rural site reached approximately 80 µg/m^3 and urban concentrations peaked at over 110 µg/m^3 (Figure 21). Such high PM2.5 levels are no longer reached in the Valley. The authors noted that under wintertime conditions, nitric acid concentrations in the SJV were small and therefore ammonium nitrate formation was generally limited by the availability of nitric acid rather than ammonia.

Figure 21. Time series with daily observations, base case simulation results and results from the sensitivity cases of (a) nitrate and (b) PM2.5 at Angiola (left) and Bakersfield (right). (Source: Pun et al., 2009, excerpt from Figure 2, pg. 406).



Taken together, the emission inventory, monitoring data, and precursor sensitivity analyses all indicate that in the San Joaquin Valley, NOx, rather than ammonia is the limiting precursor for ammonium nitrate formation.

d. Role of VOC in ammonium nitrate formation

A number of studies have also been examined regarding the role of VOCs in ammonium nitrate formation. These include both monitoring studies conducted as part of CRPAQS, as well as studies that used differing types of air quality modeling to quantitatively assess the expected change in ammonium nitrate to hypothetical VOC reductions.

Monitoring studies

As previously mentioned, there are two primary pathways through which ammonium nitrate can form. During the day, NO_2 is oxidized to nitric acid. Nitric acid then reacts with ammonia to form ammonium nitrate. This daytime nitric acid formation pathway involves sunlight, VOCs, and background ozone. During the night, nitric acid is formed through oxidation of NO_2 (via N_2O_5) by background ozone, which then also reacts with ammonia to form ammonium nitrate. Studies by Pun et al. (1998, 2004) suggested that the daytime pathway may be important and therefore the formation of ammonium nitrate would be sensitive to changes in VOC emissions. However, other studies (Lurmann et al., 2006), suggest that on average, daytime production of nitric acid in the San Joaquin Valley is relatively slow and that nighttime production of ammonium nitrate aloft, which then mixes to the surface after sunrise could explain the observed homogeneous patterns of ammonium nitrate in the Valley. Ying et al. (2009) also theorized that the ozone concentration aloft in the San Joaquin Valley is predominantly due to the regional background and does not vary significantly with surface-level VOC emissions. Therefore, nighttime ammonium nitrate formation in the San Joaquin Valley would not be sensitive to VOC reductions.

While the monitoring studies cited above provide evidence that the VOC pathway may be important at times, these studies do not provide quantitative information about the overall role of and cannot be used to evaluate the benefits of, VOC controls. Rather, modeling studies are more appropriate to assess the overall impact of precursor controls.

Photochemical Modeling

Staff reviewed the results of six modeling studies containing information on the significance of VOC controls in reducing ammonium nitrate in the San Joaquin Valley. While the results of the earliest studies were mixed, later studies provide generally consistent results regarding the role of VOCs. In assessing the potential benefits of VOC controls it is important that significance be interpreted in the context of California's overall control program with its strong focus on NOx control to achieve benefits for both PM2.5 and ozone.

Two early studies used simplified box modeling to explore the sensitivity of ammonium nitrate to VOC and NOx reductions. One of the two studies simulated a typical winter episode (Stockwell et al., 2000) and found that decreases in VOC emissions had little effect. The second study (Pun and Seigneur, 2001) simulated winter conditions during the 1996 IMS-95 pilot study around the Fresno area. The study found that ammonium nitrate formation decreased with VOC emission reductions, but increased with NOx reductions. Pun and Seigneur (2001) theorized that reducing NOx could lead to higher concentrations of the hydroxyl radical (OH) and increase the overall rate of nitrate production, despite the reductions in NOx. However, the box modeling approach used had a number of limitations, including lack of transport into/out of the box, robust vertical transport, and use of an older chemical mechanism. In addition, the VOC emissions were increased by a factor of two to improve model performance. As such, the box modeling did not fully represent the complete scope of atmospheric variations and has limited usefulness in assessing the responsiveness to VOC controls.

Subsequent modeling sensitivity studies for the same winter episode were conducted with the UCD-CIT model, an advanced research grade modeling system (Kleeman et al., 2005). The authors concluded that NOx emission controls are more effective in reducing PM2.5 nitrate concentrations in the San Joaquin Valley. Summary study results indicate that on average, large reductions in VOC emissions (on the order of 50 percent) reduced PM2.5 nitrate concentrations by approximately 17 percent. However, to evaluate the significance and effectiveness of VOC controls in the context of control strategy design, the study's isopleths of PM2.5 nitrate response to combined NOx/VOC emission reductions provide more in-depth information.

Figures 22 (a) and 23 (a) show that, based on the shapes of the graphs, NOx controls are the most effective approach to reduce PM2.5 nitrate concentrations at Fresno and at the location with the highest modeled PM2.5 nitrate concentration (grid location - 85 km Northing, 90 km Easting) respectively. Once NOx controls are taken into consideration, VOC emission reductions produce essentially no benefit, and in some instances may actually lead to an increase in PM2.5 nitrate concentrations. For example, as illustrated in Figure 22 (a) for Fresno, after considering an approximately 70 percent reduction in NOx emissions resulting from existing and proposed controls, reductions in VOC emissions to any level would not decrease PM2.5 nitrate concentrations. Furthermore, at grid location -85 km Northing, 90 km Easting (Figure 23 (a)), any level of VOC emission reductions would actually cause an increase in nitrate concentrations. Nitrogen-containing molecules such as PAN can act as temporary sinks for nitrogen dioxide (NO_2). When VOCs are controlled, the reduced availability of certain radicals, which are generated from VOCs, reduces the amount of NO_2 that is sequestered, thereby increasing the availability of NO_2 and enhancing ammonium nitrate formation (Meng et al., 1997).

Figure 22. 24-hour average NOx/VOC particulate nitrate isopleths at Fresno for (a) all sources, (b) diesel engines, (c) catalyst equipped gasoline engines, and (d) upwind sources of nitrate. Units are μg/m³. (Source: Kleeman et al., 2005, Figure 3 pg. 5333).

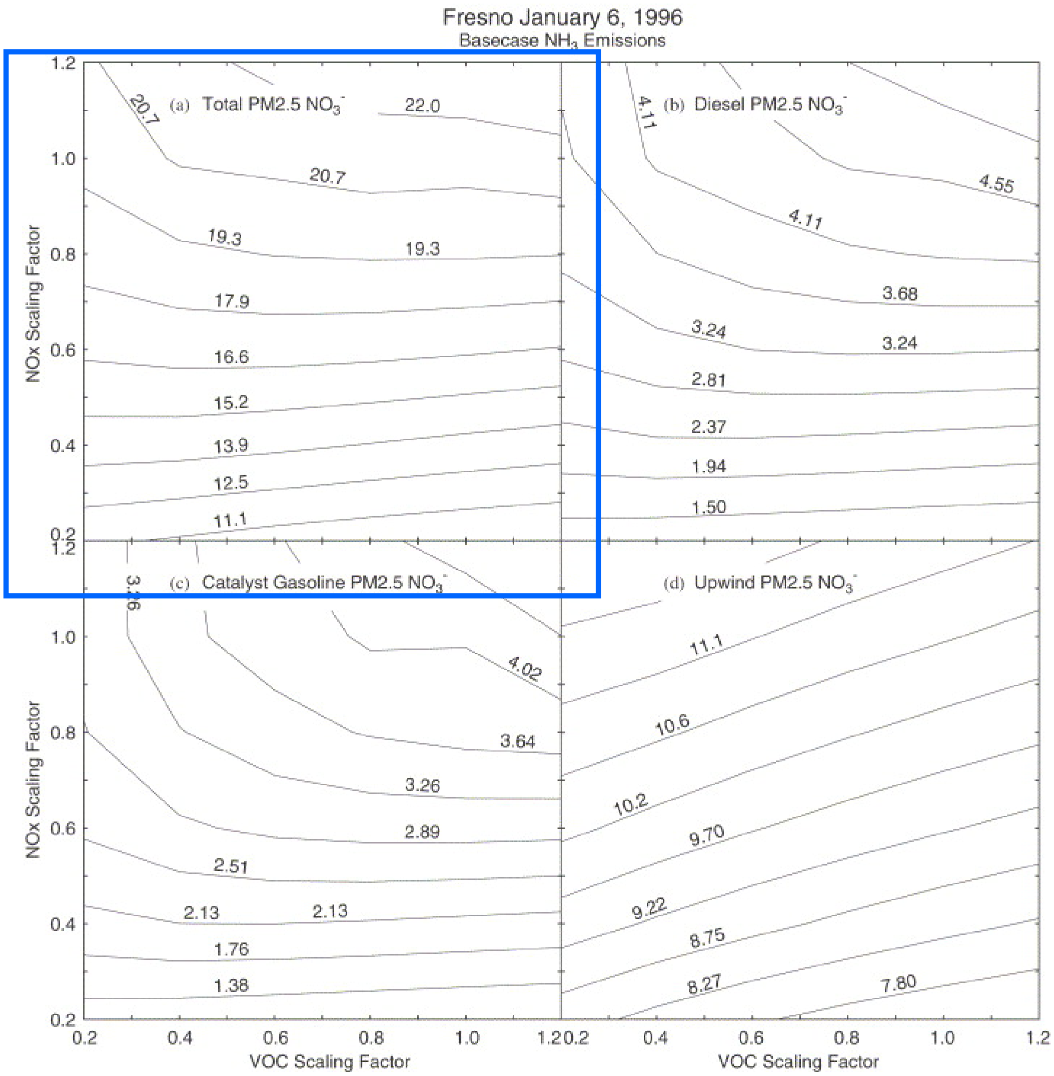
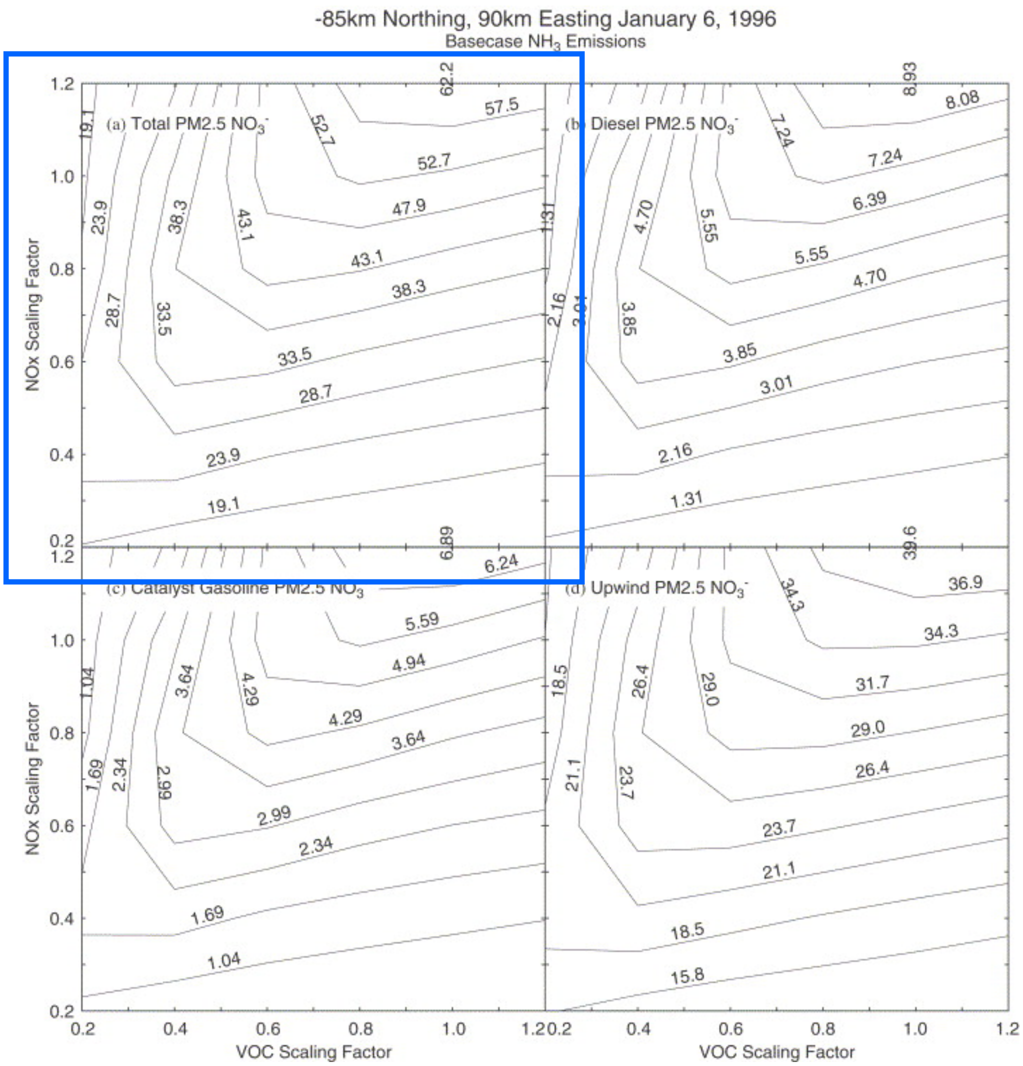


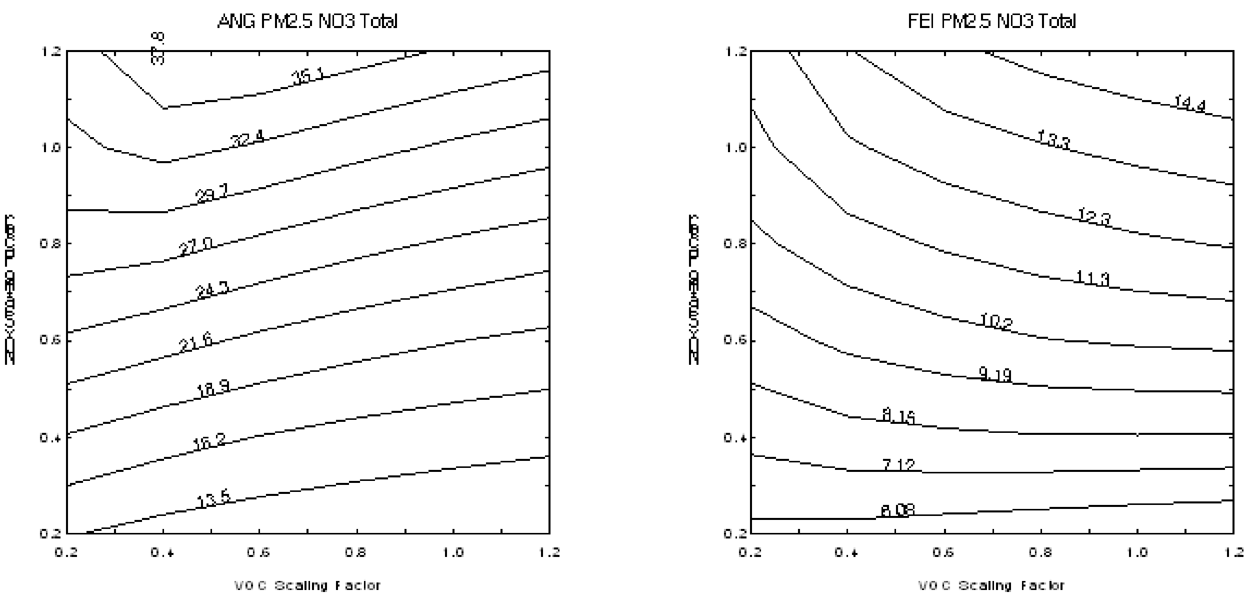
Figure 23. 24-hour average NOx/VOC particulate nitrate isopleths at grid location -85 km Northing, 90 km Easting for (a) all sources, (b) diesel engines, (c) catalyst equipped gasoline engines, and (d) upwind sources of nitrate. Units are μg/m^3. (Source: Kleeman et al., 2005, Figure 5 pg. 5335).



Three additional modeling studies investigated the more recent two-week winter episode of 2000-2001 that occurred during the CRPAQS field study.

In the first study, preliminary data from modeling of this CRPAQS winter episode conducted using the Lagrangian form of the UCD-CIT model qualitatively confirm that NOx control is the most efficient method to reduce nitrate concentrations (Kleeman, M.J., personal communication, May 2008). Figure 24 illustrates the response of PM2.5 nitrate concentrations to NOx and VOC emission reductions at a rural (Angiola) and an urban (Fresno) site on December 31, 2000. Again, based on their shapes, these graphs show that NOx controls are the most effective approach to reduce PM2.5 nitrate concentrations. Once NOx controls are taken into consideration (approximately 70 percent reduction in NOx emissions), reductions in VOCs of up to 30 percent produce basically no benefit (Fresno). Furthermore, at some locations (Angiola) any VOC emission reductions may actually lead to an increase in PM2.5 nitrate concentrations.

Figure 24. The isopleths plot of PM2.5 nitrate with emission control of NOx and VOC at Angiola (ANG) and Fresno (FEI) after a five-day back trajectory simulation for December 31, 2000. Units are in µg/m^3. (Source: Kleeman, M.J., personal communication, May 2008).



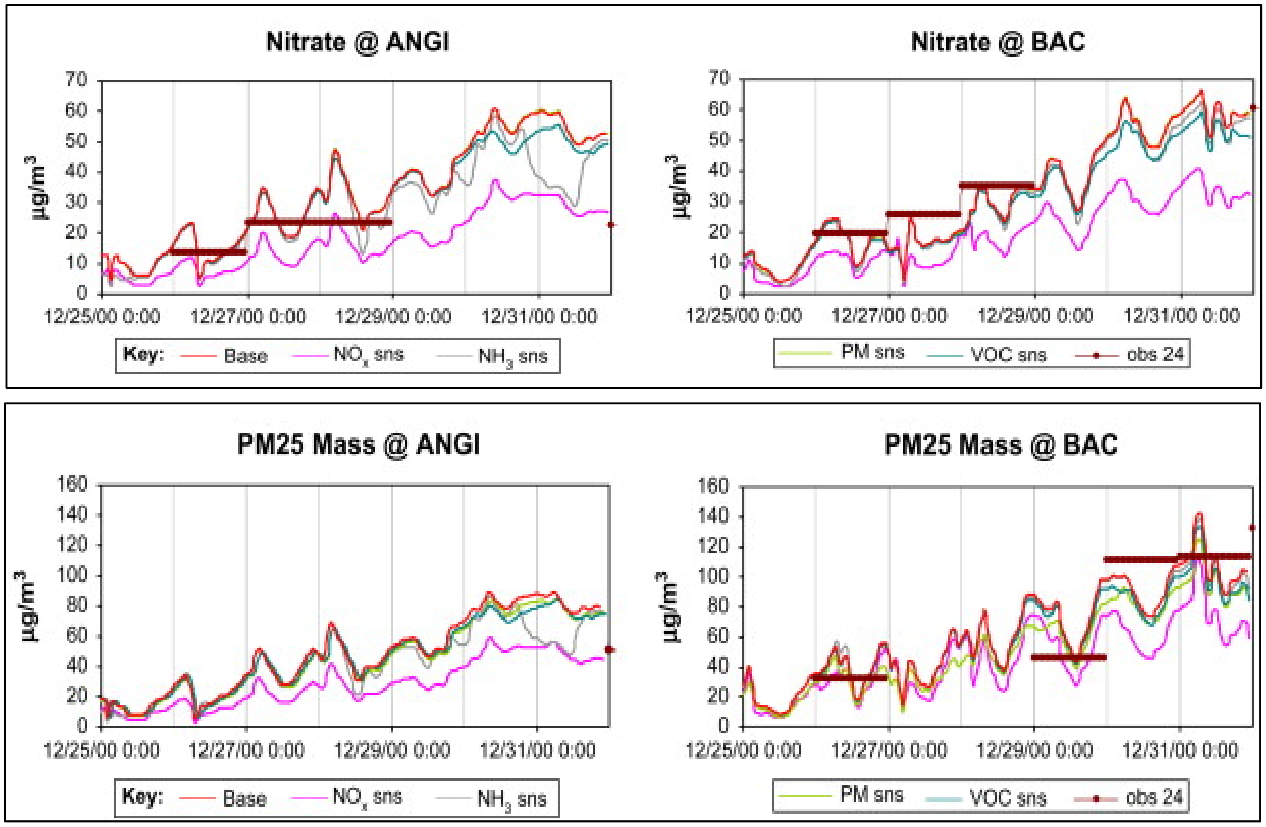
A second study conducted simulations of the two-week CRPAQS episode with the CMAQ photochemical model (Livingston, et al., 2009). The study consisted of two simulations. The first was a baseline scenario using a preliminary emissions inventory. This simulation showed that 50 percent reductions in anthropogenic VOC and NOx emissions had similar effects in reducing ammonium nitrate (about 20 percent each). A second simulation was conducted using an updated emission inventory representing a more accurate spatial distribution of total ammonia emissions (referred to as "Vehicle NH_3" scenario, per Livingston, P., personal communication, January 19, 2011). This second 50 percent VOC reduction simulation showed a much lower response to VOC controls. The response was lowered to a 12 percent reduction in ammonium nitrate, with a corresponding increase in responsiveness to NOx control of 38 percent reduction in ammonium nitrate. These results are consistent with those found by Kleeman et al., 2005.

A third study modeled one week of the CRPAQS episode using a version of CMAQ with a more advanced chemical mechanism (CMAQ-Madrid) (Pun et al, 2009). In contrast to the earlier Pun study using a simplified box modeling approach, this later work found that on average, nitrate was most sensitive to reductions in NOx emissions. While isopleths were not provided, the time evolution of nitrate and PM2.5 mass to VOC response illustrated in Figure 25 provides further details regarding the efficacy of VOC control. The response of nitrate to a 50 percent reduction in VOC emissions increased as PM2.5 levels rose during the episode. In urban areas, a 50 percent reduction in anthropogenic VOC emissions caused small reductions in nitrate, on the order of 10 percent, on the modeled days when 24-hour PM2.5 concentrations measured over 100 µg/m^3 at urban sites and above 65 µg/m^3 in rural areas.

The difference in the VOC response on the days with the higher PM2.5 concentrations as compared to those days with lower concentrations may be due to a difference in the chemical formation regime for nitrate. In general, there is sufficient background ozone to generate enough free radicals to initiate and propagate the chemistry of nitrate formation (Ying et. al, 2009). However, on days with high PM2.5 concentrations, the daytime photochemistry may have contributed to a rapid increase in nitrate, resulting in higher VOC and NOx sensitivity. It does not appear that VOCs contributed significantly to the free radical budget on the simulated days mainly because rapid increases in ozone were not observed. The effect of VOC levels on nitrate formation may also have a diurnal pattern since the hydroxyl and hydroperoxyl radical levels are high during the daytime and negligible at night. In addition, more reactive VOCs react quickly during the day and there is a minimal carry over to the next day. Therefore, it is reasonable to assume that the higher response to VOC and NOx at higher PM2.5 concentrations may be due to the nitrate formation mechanism rather than to PM2.5 accumulation due to the length of the episode.

Overall, nitrate was only responsive to a 50 percent reduction in VOCs at PM2.5 concentration levels that are no longer reached in the San Joaquin Valley. Currently, the 24-hour PM2.5 design value in the Valley is 62 µg/m^3 recorded at Bakersfield and the rest of the Valley records 24-hour design values between 38 µg/m^3 and 58 µg/m^3. Given the current levels of PM2.5, we believe the Valley is now in a nitrate chemical formation regime that is less responsive to VOC controls.

Figure 25. Time series with daily observations, base case simulation results and results from the sensitivity cases of (a) nitrate and (b) PM2.5 at Angiola (left) and Bakersfield (right). (Source: Pun et al., 2009, excerpt from Figure 2, pg. 406).



Taken together, these air quality modeling studies indicate that in the San Joaquin Valley, NOx, rather than VOCs, is the limiting precursor for nitric acid, and subsequent ammonium nitrate formation.

6. SECONDARY ORGANIC AEROSOL FORMATION

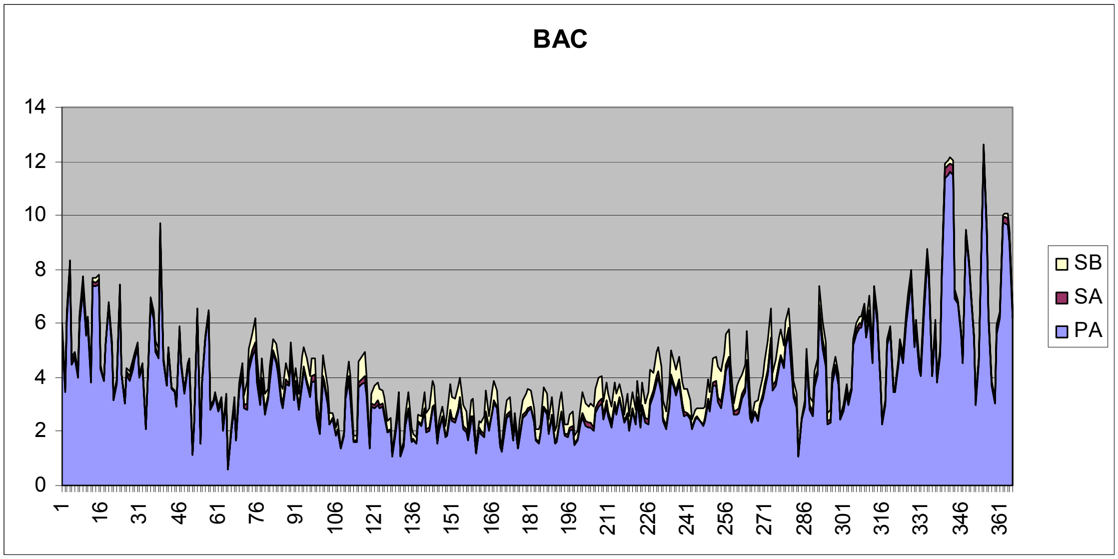
VOC emissions also have the potential to contribute to secondary organic aerosols (SOA). While these components contribute to observed PM2.5 concentrations in the San Joaquin Valley to a small degree, the weight of evidence indicates that anthropogenic VOC is not a significant contributor to PM2.5.

SOA form when intermediate molecular weight VOCs, emitted by anthropogenic and biogenic sources, react and condense in the atmosphere to become aerosols. In addition, lighter VOCs participate in the formation of atmospheric oxidants which then participate in the formation of SOA. The processes of SOA formation are complex and have not been fully characterized. The apportionment of PM2.5 organic carbon to primary and secondary components is a very active area of current research.

Using the UCD-CIT model, Chen et al. (2010) investigated the apportionment of PM2.5 organic carbon for the 2000/2001 CRPAQS episode. From the total predicted PM2.5 organic carbon in the urban Fresno and Bakersfield areas, six percent and four percent were SOA, respectively, while in the rural Angiola area, 37 percent was SOA. The major SOA precursors of secondary organic aerosol were long-chain alkanes followed by aromatic compounds. The sources of these precursors were solvent use, catalyst gasoline engines, wood smoke, non-catalyst gasoline engines, and other anthropogenic sources, in that order.

In contrast, on an annual average basis, secondary organic aerosols derived from anthropogenic VOC emissions account for only one to two percent of the annual total PM2.5 concentrations throughout the Valley. ARB air quality modeling exercises conducted as part of the SJV 2008 PM2.5 Plan attainment demonstration analysis using the CMAQ model showed that primary PM2.5 emissions are the main contributor to organic aerosols and SOA contribute to only a small extent. Furthermore, as illustrated in Figure 26, SOA are mostly formed during the summertime, when total PM2.5 concentrations are low, and are mainly derived from biogenic emission sources. On an annual average basis, SOA derived from anthropogenic VOC emissions are a small part of the organic aerosol concentrations (three to five percent).

Figure 26. Daily contributions to organic aerosol concentrations in Bakersfield in 2000 modeled with CMAQ: Primary organic aerosols (PA), secondary aerosols formed from biogenic VOC emissions (SB) and secondary aerosols formed from anthropogenic source VOC emissions (SA). Units are µg/m³.



As part of the CRPAQS study, simulations of a wintertime episode conducted using CMAQ-Madrid, a model with an enhanced secondary organic aerosol formation mechanism, also found that organic aerosol concentrations were dominated by directly emitted (primary) emissions. The study found that, because of the dominance of primary PM2.5 organic matter, a 50 percent reduction in anthropogenic VOC emissions has limited effects on the modeled PM2.5 organic matter (Pun, et al., 2009).

These study results show that for secondary organic aerosols, further VOC reductions would have very limited effectiveness in reducing PM2.5 concentrations.

7. EMISSION SOURCES OF WINTERTIME PM2.5

a. Emission inventory

Emission inventories provide emission estimates for sources of directly emitted (primary) PM2.5 and of each of the gaseous precursors of secondary PM2.5 (NOx, SOx, and ammonia). Table 2 lists the main PM2.5 components and links them to their largest emission sources based on the 2011 San Joaquin Valley emission inventory data. Emission sources are listed in descending order of magnitude.

As described in section 4d, ammonium nitrate is the main PM2.5 component, contributing about 55 to 65 percent of PM2.5. It is formed in the atmosphere from reactions of NOx and ammonia. Heavy-duty diesel vehicles (trucks) emit most of the NOx, followed by off-road equipment, light-duty vehicles, and trains. Ammonia is primarily emitted from livestock husbandry, fertilizer application, and mobile sources. Ammonium sulfate, formed in the air from reactions of SOx and ammonia, contributes about five percent to PM2.5. SOx is mostly emitted from fuel combustion sources in oil and industrial manufacturing processes. Organic carbon, which contributes about 20 to 30 percent to PM2.5, and elemental carbon, which contributes about five percent of PM2.5, are directly emitted, with key sources being residential fuel combustion, managed burning, diesel trucks, and commercial cooking operations. Geological, a minor component contributing about two to five percent of the PM2.5 mass, is directly emitted from activities generating dust, such as farming operations and on-road and off-road vehicle travel, as well as wind-blown dust. It should be noted that while wind-blown dust may contribute on some winter days, PM2.5 exceedances primarily occur on very stagnant days when windblown dust emissions are minimal.

While emission inventories provide a broad overview of Valley wide and county level sources, additional methods using ambient data and source apportionment modeling provide supplemental information on the sources directly impacting individual monitoring sites. The following sections describe these analyses.

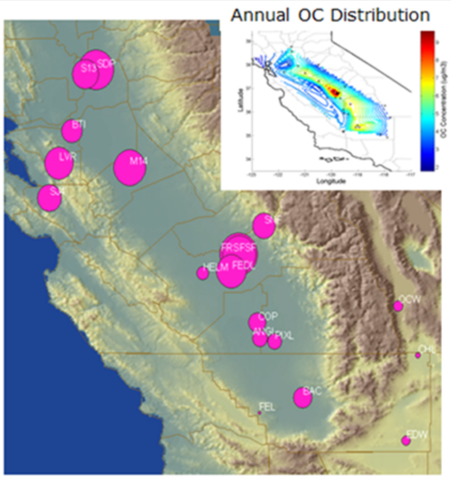
Table 2. Main emission sources of PM2.5 components.

PM2.5 Component (percent of PM2.5)	**Process**	**Emission Sources**
Ammonium nitrate (about 55-65 percent)	Formed in the atmosphere from the reactions of NOx and ammonia emissions	**NOx:** Heavy duty diesel vehicles account for 40 percent of the 2011 winter NOx emissions. Farm equipment, off-road equipment, light and medium duty trucks, trains, light duty passenger cars, and residential fuel combustion account for an additional 40 percent.
		Ammonia: Livestock husbandry, fertilizer application, and mobile sources account for over 90 percent of the 2011 winter ammonia emissions.
Ammonium sulfate (about 5 percent)	Formed in the atmosphere from the reactions of SOx and ammonia emissions	**SOx:** Fuel combustion in oil production, at electric utilities, and in manufacturing and industrial boilers, heaters, and engines, manufacturing of chemicals and glass related products, residential wood combustion, and aircraft account for about 75 percent of the 2011 winter SOx emissions.
Organic Carbon (about 20-30 percent)	Directly emitted from motor vehicles and combustion processes	**Combustion PM2.5**: Residential fuel combustion, managed burning and disposal, diesel trucks, cooking, oil and gas production, and farm equipment account for 80 percent of the combustion PM2.5 emissions.
Elemental Carbon (about 5 percent)	Directly emitted from motor vehicles and combustion processes	
Geological (about 2-5 percent)	Directly emitted from dust generating sources	**Dust PM2.5:** Farming operations, fugitive windblown dust, paved and unpaved road dust, mineral processes, and construction and demolition account for 100 percent of the 2011 dust PM2.5 emissions.

b. Chemical markers of source types

Selected compounds measured in the atmosphere can serve as chemical markers for specific sources. Based on this approach, as part of the extensive monitoring effort during CRPAQS, residential wood combustion was identified as the main source of PM2.5 organic carbon in the San Joaquin Valley. Measurements of levoglucosan, a chemical marker for wood smoke were conducted throughout the San Joaquin Valley. Figure 27 illustrates the geographical distribution of the annual averages of these levoglucosan measurements (pink circles on the map). Each circle size is proportional to the levoglucosan concentration. The largest levoglucosan levels occurred in urban areas, most notably the Fresno area (FSF and FSR), as did the largest PM2.5 organic carbon levels depicted on the small map to the upper left. The second largest levoglucosan levels the San Joaquin Valley were measured in Modesto (M14), sequentially followed by Bakersfield (BAC) and then Corcoran (COP).

Figure 27. Spatial distribution of annual levoglucosan measured throughout the San Joaquin Valley during CRPAQS (Watson, J., Roth, P., 2006).

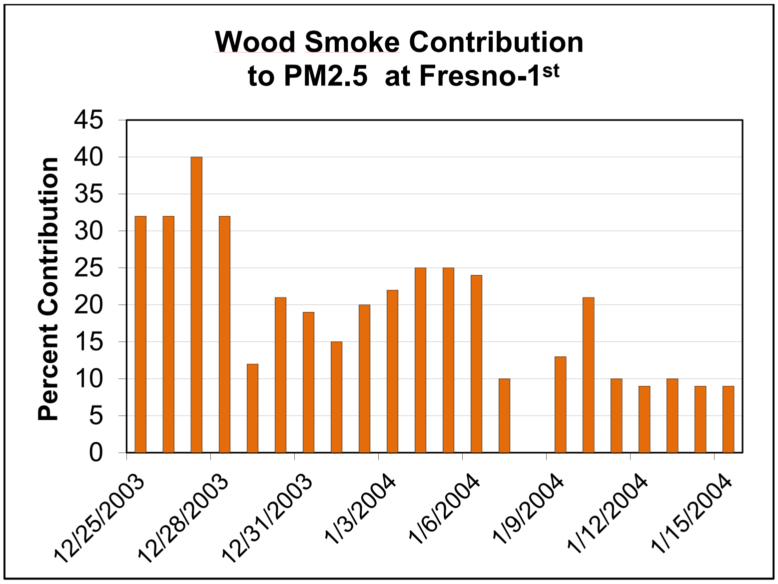


Levoglucosan Concentrations (ng/m3)	Annual Avg	Winter Avg*
FEL	6	26
CHL	7	32
YOSE	9	38
EDW	12	52
OCW	14	58
HELM	19	81
PIXL	19	82
ANGI	23	98
COP	32	138
BAC	49	209
BTI	50	215
SNF	57	244
SJ4	58	247
S13	63	269
LVR	68	291
FEDL	75	323
M14	101	433
FRS	121	521
SDP	128	551
FSF	202	868

**Predicted concentration based on mass concentration measurements*

Additional measurements of levoglucosan collected during the winter of 2003/2004 in the Fresno area showed wood smoke was a significant percentage of PM2.5 at all locations, ranging from 10 to 40 percent (Figure 28).

Figure 28. Wood smoke contribution to PM2.5 at Fresno-1st during a number of winter days in 2003 and 2004 (Gorin et al., 2005).



c. Source apportionment using source receptor models

Source receptor models (also known as observational models) can be used to determine the relative importance of the different types of PM2.5 emission sources at individual monitoring sites. The Chemical Mass Balance (CMB) model statistically relates measured chemical species of ambient PM2.5 to the chemical species emitted by diverse sources. The Positive Matrix Factorization (PMF) statistical model distinguishes correlation patterns among measured PM2.5 species to identify sources. Previous studies have applied source apportionment models to IMS-95 and CRPAQS data. For the present study, both CMB and PMF were applied to recent PM2.5 data collected in the San Joaquin Valley.

Prior Source Apportionment Studies

In earlier studies, Schauer and Cass, 2000 estimated source contributions to wintertime PM2.5 through CMB modeling of data collected during the IMS-95 field study. Chen et al., 2007, applied two types of multivariate statistical models, PMF and UNMIX, to identify sources contributing to wintertime PM2.5 during the CRPAQS field study. In addition, Chow et al., 2005, applied CMB to the CRPAQS data set. Table 3 summarizes the source contributions to wintertime PM2.5 estimated through these studies. In all cases, ammonium nitrate is the major source, contributing approximately 50 percent to wintertime PM2.5 throughout the Valley (23-site average); ranging from 40 and 50 percent at urban sites (Fresno and Bakersfield) to around 65 percent at rural sites (Kern Wildlife Refuge and Angiola). The combined biomass burning and cooking source, dominated by biomass burning, contributes over 25 percent of PM2.5

Table 3. Wintertime PM2.5 source contributions estimates for IMS-95 and CRPAQS.

	Source Contribution Estimates (% of PM2.5 mass)									
Study and Sites	*Salt*	*Dust*	*Exhaust*		*Biom Burn*	*Cook*	*Amm. Sulfate*	*Amm. Nitrate*	*Sec Org*[a]	*Misc*
			Gas	*Dies*						
IMS-95[1]										
Fresno avg. of 12/26-28/1995 and 1/4-6/1996	-	1.0	2.5	9.6	37.8	6.4	4.8	32.6	4.9	0.5
Bakersfield avg. of 12/26-28/1995 and 1/4-6/1996	-	1.5	3.4	9.5	18.6	5.1	7.5	41.6	12.1	0.7
Kern WR avg. of 12/26-28/1995 and 1/4-6/1996	-	0.9	0	5.0	0.5	0.0	7.9	66.8	15.6	3.2
CRPAQS, UNMIX[2]										
23-site avg. Nov. 2000 - Jan. 2001	0	3	15		24	5		51		2
CRPAQS, PMF[2]										
23-site avg. Nov. 2000 - Jan. 2001	0	5	10		23	3		48		11
CRPAQS, CMB[3]										
Fresno IOPs[4]	0.2	0.3	1.5	5.8	48.9		3.1	40.1		
Bakersfield IOPs[4]	0.2	1.2	6.4	4.5	30.4		3.9	53.5		
Angiola IOPs[4]	0.3	5.2	7.4	1.9	14.8		4.4	65.9		
Sierra Nevada Foothills IOPs[4]	0.2	1.2	4.0	7.4	41.8		4.7	40.6		

[1] Schauer and Cass, 2000.
[2] Chen et al., 2007.
[3] Chow et al., 2005.
[4] IOPs = Intensive Operating Periods, 12/15-18/200, 12/26-28/2000, 1/4-6/2001, and 1/31/2001- 2/3/2001.
[a] Secondary organic aerosol estimated from organic carbon not accounted for by primary source profiles.

valley wide, constituting the second major source at urban sites – with larger contributions at Fresno than at Bakersfield. In contrast, biomass burning and cooking are not a major sources at rural sites. Engine exhaust, dominated by diesel, is the third major source of directly emitted PM2.5, contributing approximately 10 to 15 percent to PM2.5 valley wide. Since secondary organics are estimated from the organic carbon not accounted for by the apportionment of other organic carbon sources, small changes in the organic carbon content in the chemical composition profiles for other sources may impact the estimate of the secondary organics contribution.

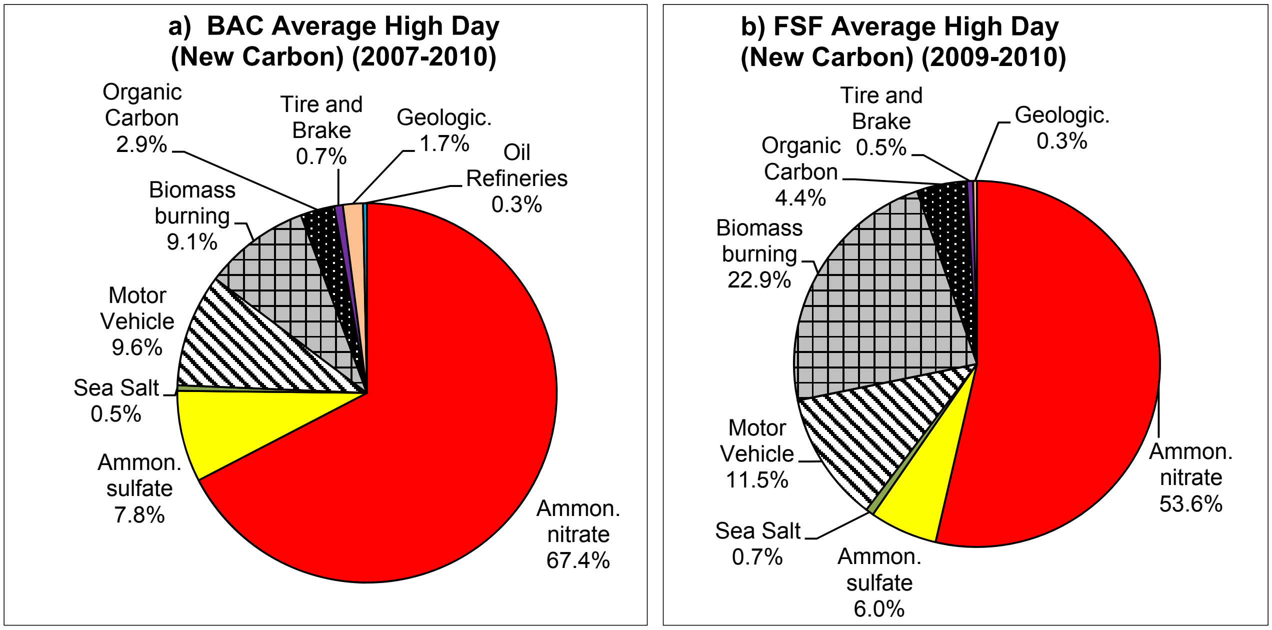
Recent Source Apportionment Studies

Chemical Mass Balance Modeling

Source contributions during high PM2.5 concentration days at Bakersfield-California (BAC) and Fresno –1st Street (FSF) were estimated by applying the CMB model version 8.2 to individual PM2.5 samples using PM2.5 source profiles developed during previous studies. The PM2.5 samples were from days measuring concentrations greater than 30 μg/m^3 between 2007 and 2010. Per U.S. EPA guidance, between 2007 and 2009, the carbon collection and analysis method was changed to improve comparability with the rural Interagency Monitoring of Protected Visual Environments (IMPROVE) PM2.5 carbon data. Since the new carbon method started operating in May 2007 at Bakersfield and in April 2009 at Fresno, the CMB analysis relied on 2007-2010 data from Bakersfield and 2009-2010 data from Fresno. Appendix 2 describes this CMB analysis in further detail.

Figure 29 shows the calculated contributions to ambient PM2.5 from sources included in the CMB model. Ammonium nitrate, the most significant source, contributed 67 percent at Bakersfield and 54 percent at Fresno-1st. Biomass burning, which included residential wood combustion and agricultural, prescribed burning, and likely also cooking, contributed nine percent at Bakersfield and 23 percent at Fresno. Motor vehicle exhaust (diesel and gasoline combined) accounted for ten percent at Bakersfield and 12 percent at Fresno-1st. Ammonium sulfate contributed eight percent at Bakersfield and six percent at Fresno-1st. Contributions of the remaining sources were minor at both sites.

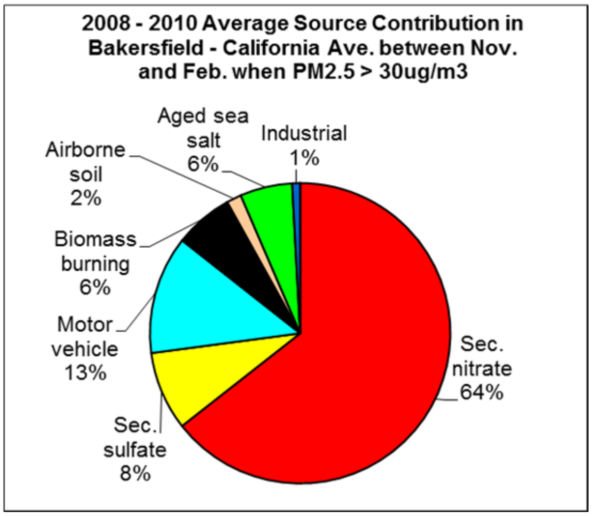
Figure 29. CMB model calculated 2007-2010 average PM2.5 source contributions of days with PM2.5 concentrations measuring over 30 µg/m^3 at a) Bakersfield-California (BAC) between 2007 and 2010 and b) Fresno-1st Street (FSF) between 2009 and 2010.

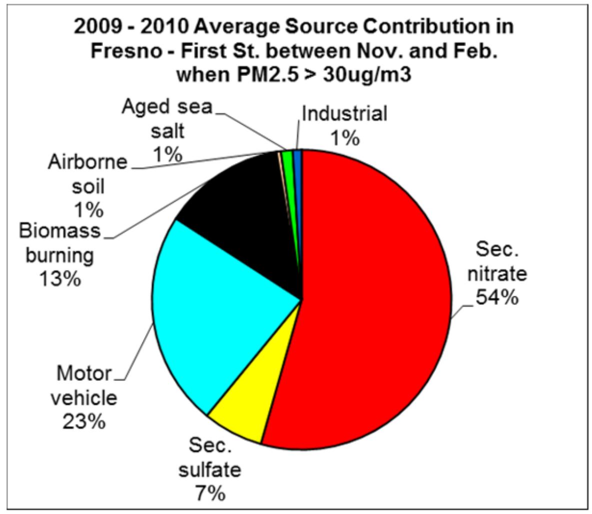


Positive Matrix Factorization

The PMF2 model was applied to the chemically speciated PM2.5 data collected at the Bakersfield-California and Fresno-1st Street monitoring sites. Bakersfield data from 2008-2010 and Fresno-1st data from 2009-2010 were used. Appendix 3 describes this PMF analysis in further detail. The average source contributions on days with PM2.5 concentrations measuring over 30 µg/m^3 are illustrated in Figure 30. Similar to the CMB results, ammonium nitrate contributes the most at both sites, 64 percent at Bakersfield and 54 percent at Fresno-1st. Motor vehicle exhaust contributes 13 percent at Bakersfield and 23 percent at Fresno-1st, while biomass burning (which includes residential wood combustion, agricultural burning, and likely also cooking) contributes six percent at Bakersfield and 13 percent at Fresno-1st. Secondary ammonium sulfate accounts for eight percent at Bakersfield and seven percent at Fresno-1st. Airborne soil and industrial sources are minor contributors.

Figure 30. Average high day source contributions estimated using PMF on days with PM2.5 concentrations measuring over 30 µg/m^3 at a) Bakersfield-California (BAC) between 2008 and 2010 and b) Fresno-1st Street (FSF) between 2009 and 2010.





While the absolute magnitude of the contributions estimated by the two models vary to some extent, taken together, the CMB and PMF source apportionment studies confirm the importance of secondary ammonium nitrate contributions to PM2.5 on high concentration days. In addition, motor vehicle exhaust and biomass burning were found to be significant contributors to primary PM2.5.

d. Photochemical modeling source apportionment

While observational models like CMB and PMF are most useful in identifying sources of primary PM2.5, photochemical models are needed to identify sources of secondary PM2.5. Ying et al. (2008, 2009) simulated the 2000/2001 CRPAQS PM2.5 episode using the source-oriented UCD-CIT air quality model. Source apportionment of primary PM2.5 in the SJV found elemental and organic carbon (EC and OC) to be the two largest components. Wood burning was the major OC source in the Valley, contributing approximately 50 percent to the total PM2.5. At Fresno, wood burning accounted for approximately 70 to 80 percent of the OC, while meat cooking accounted for approximately 10 to 15 percent. Diesel engines were identified as the major EC source. These results are generally consistent with those of the receptor modeling discussed above.

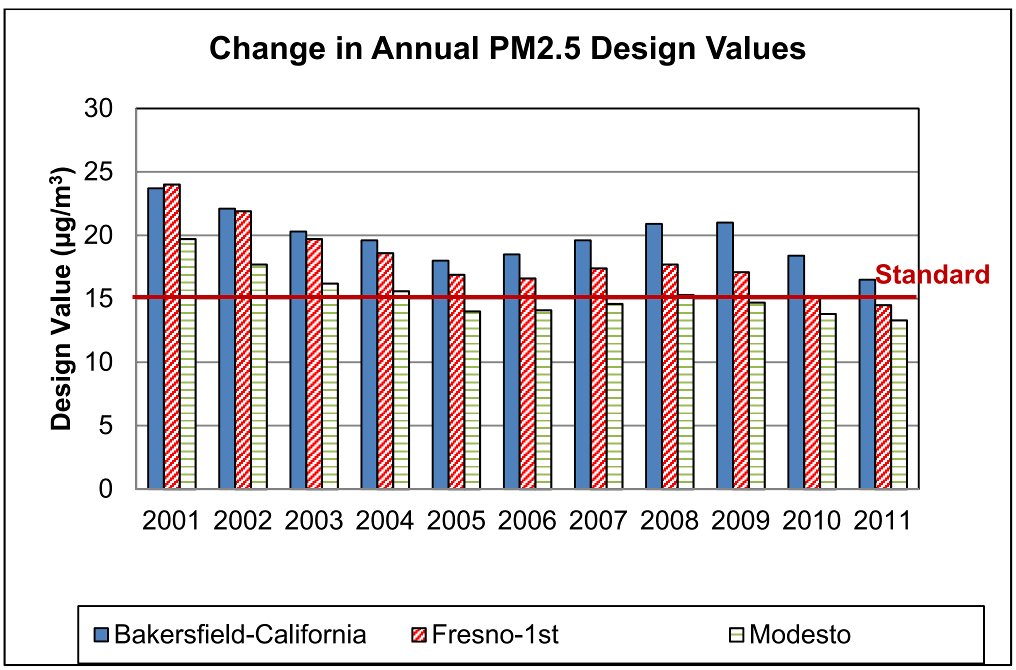
Source apportionment of secondary nitrate at Fresno revealed diesel engines were the largest contributor to nitrate, accounting for approximately 40 percent of the PM2.5 nitrate, while catalyst equipped gasoline engines accounted for approximately 20 percent. Agricultural sources accounted for approximately 80 percent of the PM2.5 ammonium.

8. PM2.5 AIR QUALITY PROGRESS

a. Annual PM2.5 trends

On an annual average basis, PM2.5 air quality has improved over the last ten years. As shown in Figure 31, annual design values at sites in the northern (e.g., Modesto), central (e.g., Fresno-1st) and southern regions (e.g., Bakersfield) in the Valley show progress towards attainment of the standard. The design value -- the metric used to determine compliance with the standard -- represents the average of three consecutive annual averages of the PM2.5 concentrations measured at a specific site (e.g. the 2011 PM2.5 annual design value is the average of the 2009, 2010, and 2011 annual average PM2.5 concentrations). If the annual design value is equal to or below 15.0 µg/m^3, the site attains the standard. Between 2001 and 2011, annual design values in the Valley declined between 30 and 40 percent. The largest decreases occurred in the northern and central Valley, where, based on 2011 design values, most sites attain the annual PM2.5 standard. While the southern Valley has shown less improvement, sites are nearing attainment, with design values about 10 to 20 percent over the standard. With on-going implementation of the 2008 PM2.5 Plan, air quality in the Valley is expected to continue to improve and reach attainment in 2014.

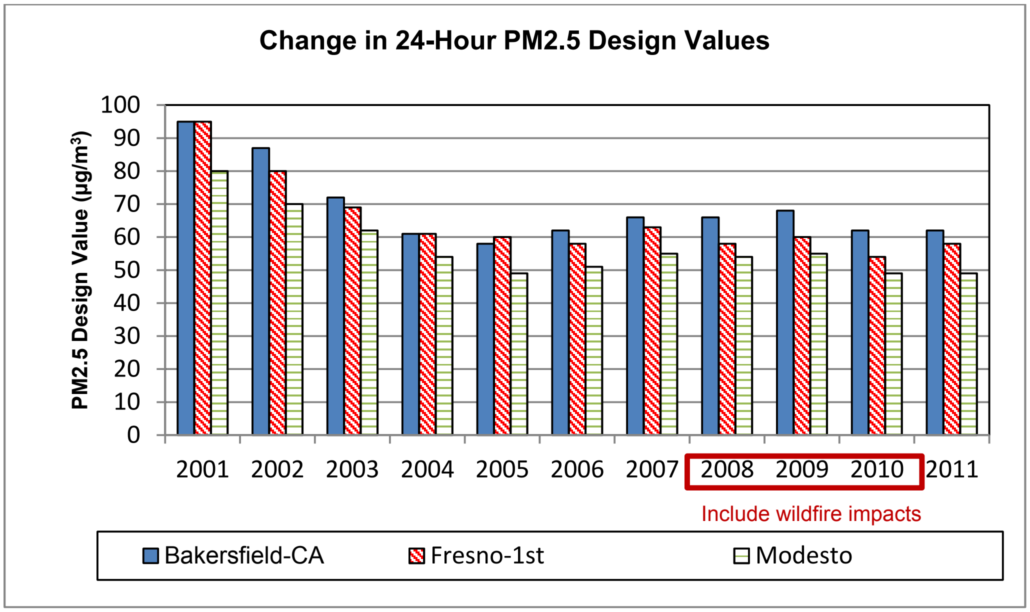
Figure 31. Trend in annual PM25 design values (2001-2011) at the Bakersfield-California, Fresno-1st, and Modesto monitoring sites.



b. 24-Hour PM2.5 trends

As illustrated in Figure 32, over the long-term, the 24-hour PM2.5 design values also show a downward trend. The most pronounced progress occurred between 2001 and 2003. Extensive wildfires occurred during the summer of 2008 in Northern California. These wildfires adversely impacted the 2008, 2009, and 2010 design values throughout the Valley, with a greater impact in the northern Valley. Overall, between 2001 and 2011, the 24-hour PM2.5 design values in the Valley have decreased between 30 and 55 percent.

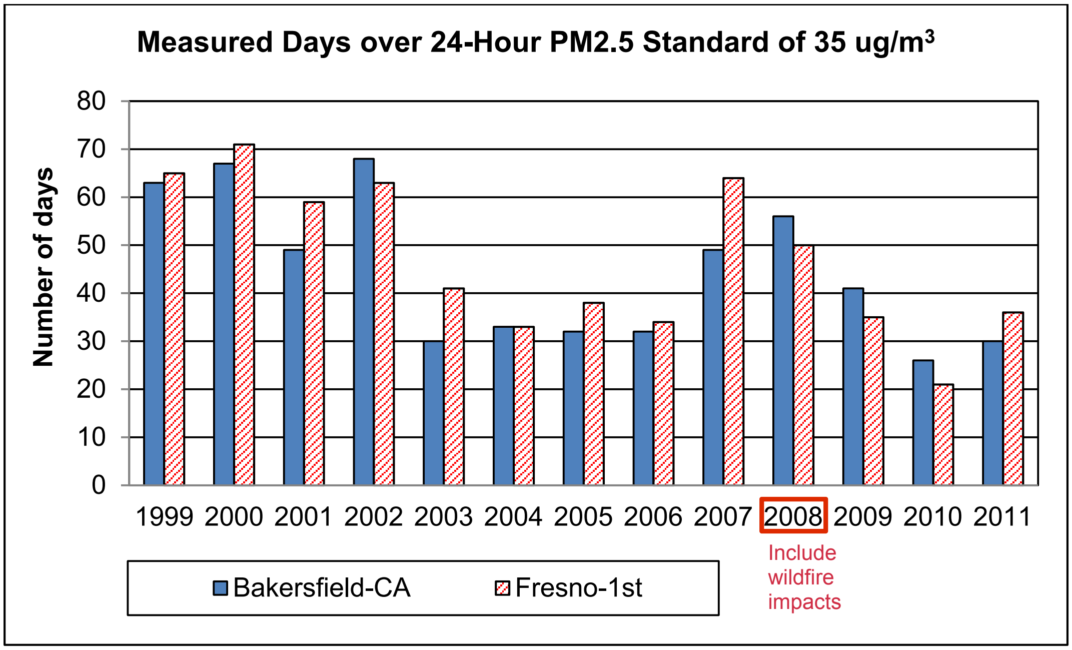
Figure 32. Trend in 24-Hour PM2.5 Design Values (2001-2011) at the Bakersfield-California, Fresno-1st, and Modesto monitoring sites.



Meeting the PM2.5 24-hour standard poses a significant challenge because the focus is on the most severe days, which are strongly influenced by meteorology as well as emissions from episodic activities, such as residential wood burning. Thus, evaluating multiple PM2.5 air quality parameters and the meteorology effects on air quality trends provides a broader picture of progress in the Valley.

Looking at the number of days with measured PM2.5 concentrations over the 35 µg/m^3 standard provides another way to assess PM2.5 trends. Over the long term, between 1999 and 2011, the number of days exceeding the standard decreased by about 50 percent at the Bakersfield-California site and by about 45 percent at the Fresno-1st site (Figure 33). The increase in the number of exceedance days in 2011 compared to 2010 was due to the very severe meteorological conditions experienced in the Valley during the winter of 2011. The Valley experienced similar meteorological conditions during the 1999-2000 and 2000-2001 winters. The total number of exeedance days, however, was much higher during these earlier years, providing evidence that the emission reductions achieved in the Valley have resulted in significant PM2.5 air quality improvement.

Figure 33. Trend in measured days over the 24-Hour standard of 35 μg/m^3 (1999-2011) at the Bakersfield-California and Fresno-1st monitoring sites.



c. Meteorology impacts on air quality

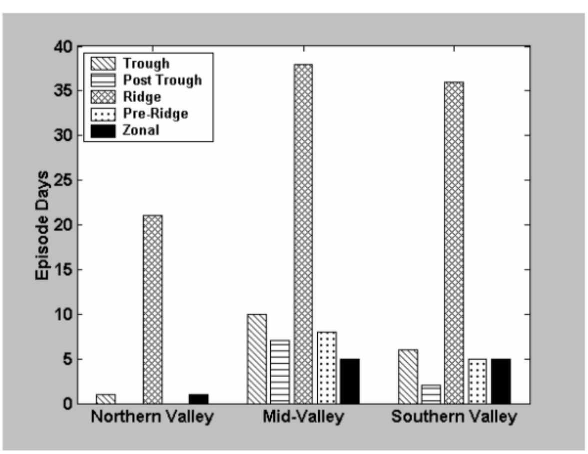
Although the San Joaquin Valley is large, almost 250 miles long and 80 miles wide, it has a reasonably uniform climatology characterized by hot, dry summers and cool, rainy winters. Mountains on the eastern, western, and southern edges create a long deep basin that can allow pollutants to accumulate under stagnant weather conditions.

The “Pacific High”, a semi-permanent subtropical high pressure system located off the west coast of North America, and the “Great Basin High”, a high pressure region that forms in the winter to the area east of the Sierra Nevada Mountains, are major influences on Valley weather, particularly in the winter. In turn, the strength and position of these high pressure regions are influenced by the strength of the El Nino/Southern Oscillation. El Nino years, characterized by warmer than normal temperatures in the equatorial Pacific and La Nina years, characterized by colder than normal temperatures, can alter the position of the Pacific High, allowing or blocking the passage of frontal systems through California and the San Joaquin Valley. A strong La Nina year can keep the Pacific High from moving south in the winter, diverting normal winter frontal systems northward, and resulting in drier conditions in California, particularly in the southern portions of the State. Due to decreases in the number and strength of frontal systems passing through the Valley, as well as increases in potential stagnant conditions, a strong La Nina year can result in higher than expected PM2.5 concentrations.

In a normal year, when the Pacific High moves south in winter and diminishes in strength, storms can penetrate further into the Valley, bringing clouds and rain. In between these storms, higher pressure can build, bringing mild, bright, sunny weather. A strong Great Basin High can direct winds into the Valley, cleaning out any accumulated particulates. When the Great Basin High is weak, cool, damp air can be trapped in the Valley, with stagnant conditions and poor ventilation lasting for days. The frontal systems which pass through the Valley in winter are weaker than those in the summer and the approach of a weak, slow-moving system can bring light surface winds with weak vertical mixing. The resulting stagnant conditions can persist for extended periods before the frontal system bringing precipitation and stronger winds finally passes through the area. The southern portion of the Valley is effectively blocked by the Tehachapis and the Coast Ranges to the south and west, leaving it dependent on frontal systems from the north for much needed precipitation and winds to scour out any accumulated pollutants. Stagnant conditions can lead to temperature inversions. Under normal conditions, temperature decreases with height, allowing free upward air flow and dispersion of emissions and pollutants. In contrast, a temperature inversion positions a layer of warm air above cooler air impeding upward air flow. Often the inversion layer is lower than the mountains surrounding the Valley providing a “cap” and effectively trapping pollutants. The frequency and intensity of the two high pressure systems and the speed and intensity of the periodic storm systems that clean the air are expected to cause large variations in year-to-year average wintertime PM2.5 concentrations.

Measurements conducted during the CRPAQS winter of 2000/2001 indicated that high PM2.5 concentrations usually occur during days dominated by a strong upper-level ridge of high pressure located over Central California (Figure 34) (MacDonald et al., 2006). These days are characterized by light winds, low mixing heights, and limited pollutant dispersion. These PM2.5 episodes can last weeks, making addressing the 24-hour PM2.5 standard in the Valley a significant challenge.

Figure 34. Frequency of high PM2.5 days in different regions of the San Joaquin Valley corresponding to different synoptic meteorological conditions during the CRPAQS winter of 2000/2001 (Mac Donald et al., 2006).



Examples of the impact of La Nina on Valley weather patterns can be seen during the winters of 2011/2012 and 2000/2001, the period during CRPAQS. As noted above, the winter of 2000/2001 was characterized by the persistence of strong surface high pressure that brought light-to-calm winds and stable, stagnant conditions to the Valley. Several fairly strong frontal systems crossed through the region, bringing precipitation, high wind speeds, and strong vertical mixing, allowing accumulated pollutants to disperse. The winter of 2011/2012 was also characterized by a strong surface high-pressure system, but frontal passages were weaker and drier with less vertical mixing, allowing stagnant conditions to continue for longer periods.

The graphs in Figures 35 and 36 compare PM2.5 concentrations measured at Bakersfield and Fresno, respectively, between November 1, 2011 and February 29, 2012 to the PM2.5 concentrations measured during the same four months (November through February) in earlier years (1999/2000 and 2000/2001). The 2011/2012 air quality was much better compared to earlier years for all air quality statistics. Peak 24-hour concentrations were over 40 percent lower. The average concentration during the four months period was also 40 percent lower. The number of days over the 24-hour standard of 35 µg/m^3 was cut by about 35 percent. Even more significant was the 70 percent decline in the number of days with very high concentrations (over 65 µg/m^3).

Figure 35. Comparison of the 2011/2012 PM2.5 episode to the CRPAQS episodes of 1999/2000 and 2000/2001 at Bakersfield-California.

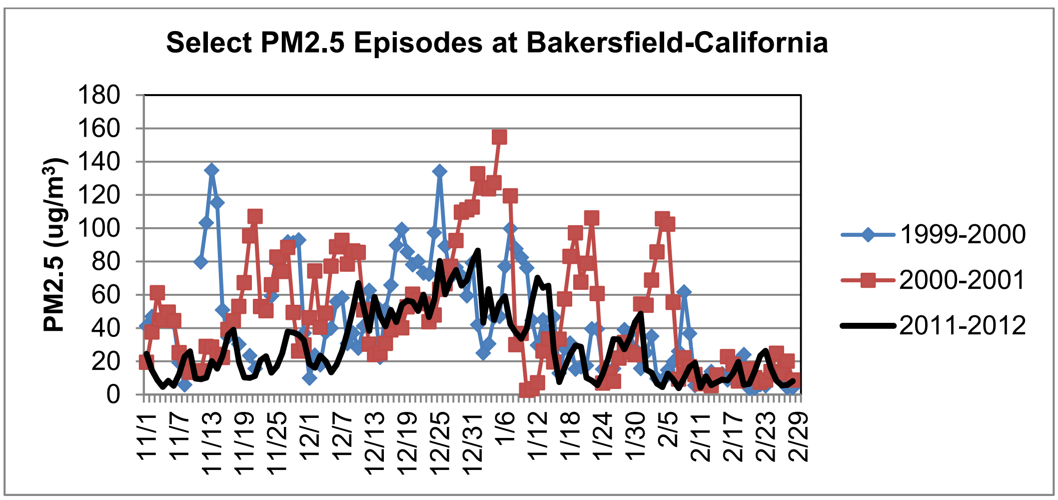
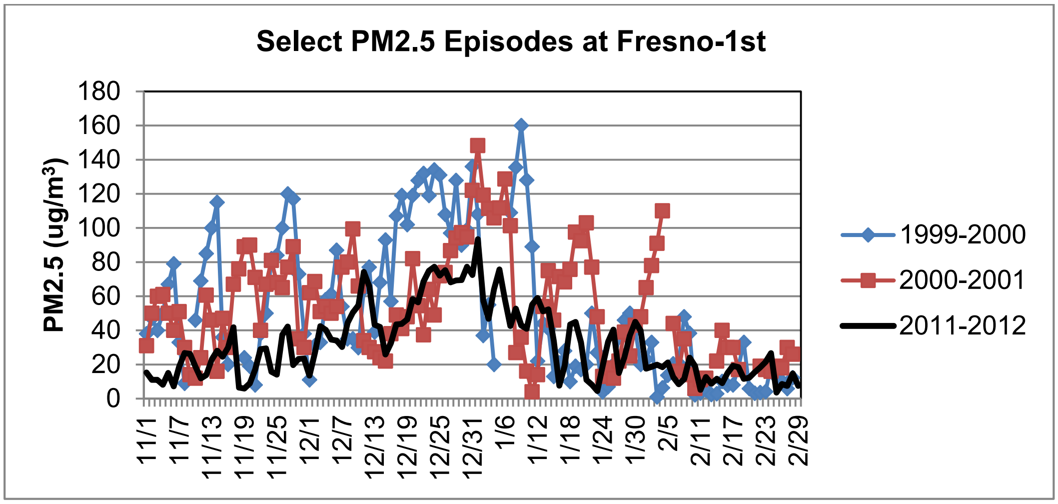


Figure 36. Comparison of the 2011/2012 PM2.5 episode to the CRPAQS episodes of 1999/2000 and 2000/2001 at Fresno 1st.



d. Annual trends adjusted for meteorology

To understand the effects of emission reductions on ambient PM2.5 concentration trends, the effects of meteorology need to be separated out as fully as possible. The Classification and Regression Trees (CART) method was used for this purpose in the SJV. CART-defined relationships developed for Bakersfield and Fresno accounted for most, but not all, of the effects of meteorology on the annual PM2.5 trends. One aspect that may not have been fully captured was the role of carryover of PM2.5 during extended duration episodes. Further analysis is underway to better address this impact within the CART analysis. Appendix 4 describes the current CART analysis in further detail.

The meteorology-adjusted (met-adjusted) trends in the figures below integrate the CART-defined meteorology-effects. For example, in years with meteorology conditions more conducive to PM2.5 formation, the PM2.5 concentrations were adjusted downward. Conversely, the PM2.5 concentrations were adjusted upward in years with meteorology conditions less conducive to PM2.5 formation.

Met-adjusted trends are designed to be better indicators than the observed trends for showing the effects of changing emissions. At Bakersfield, the resulting meteorology-adjusted trend between 1999 and 2010 indicates greater decline in PM2.5 concentrations than the unadjusted trend (Figure 37), while at Fresno the two trends are generally similar (Figure 38). Overall, the meteorology-adjusted trends indicate that between 1999 and 2010, the annual average PM2.5 concentrations decreased about 40 to 50 percent at both locations due to emission reductions.

Figure 37. Observed and met-adjusted PM2.5 trends in Bakersfield.

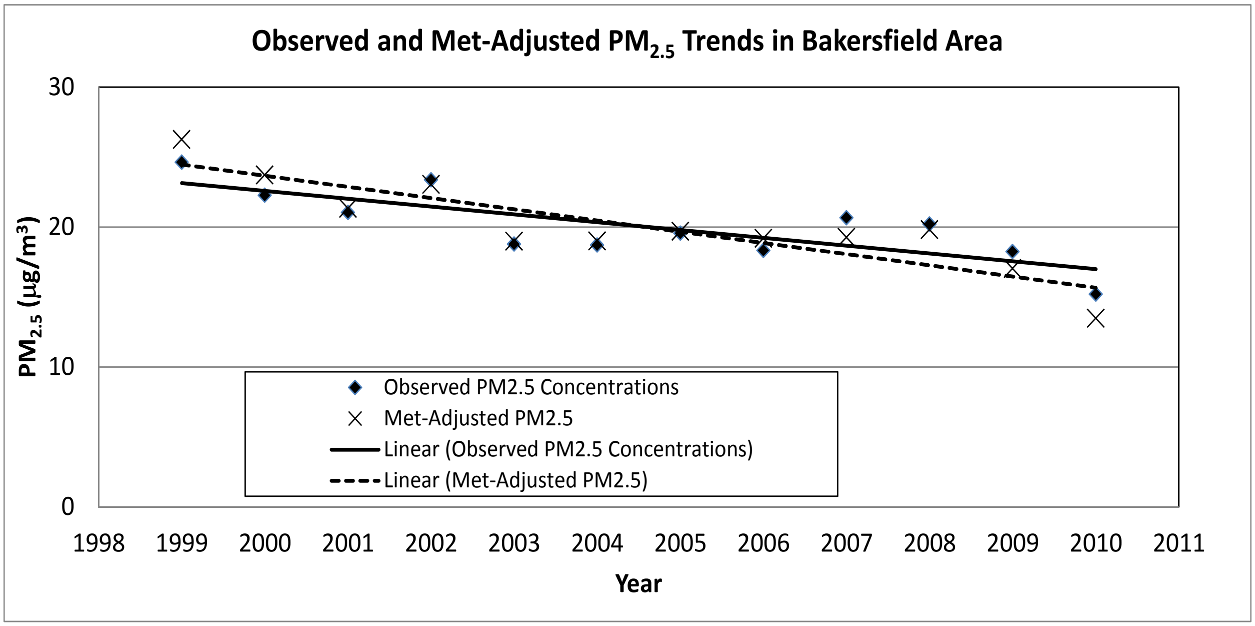
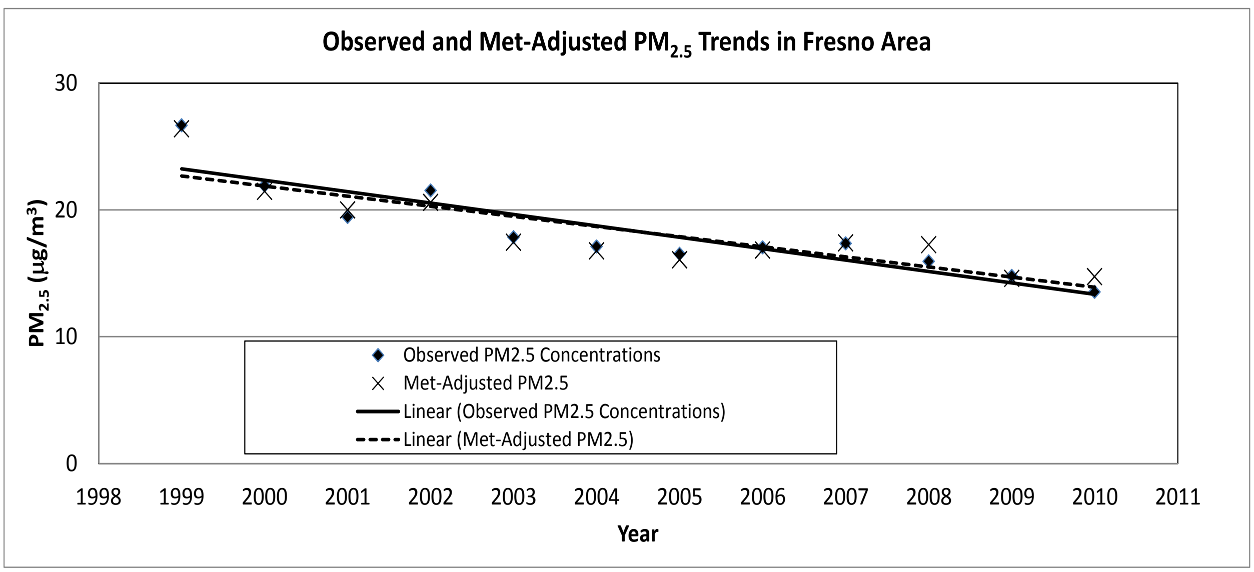


Figure 38. Observed and met-adjusted PM2.5 trends in Fresno.



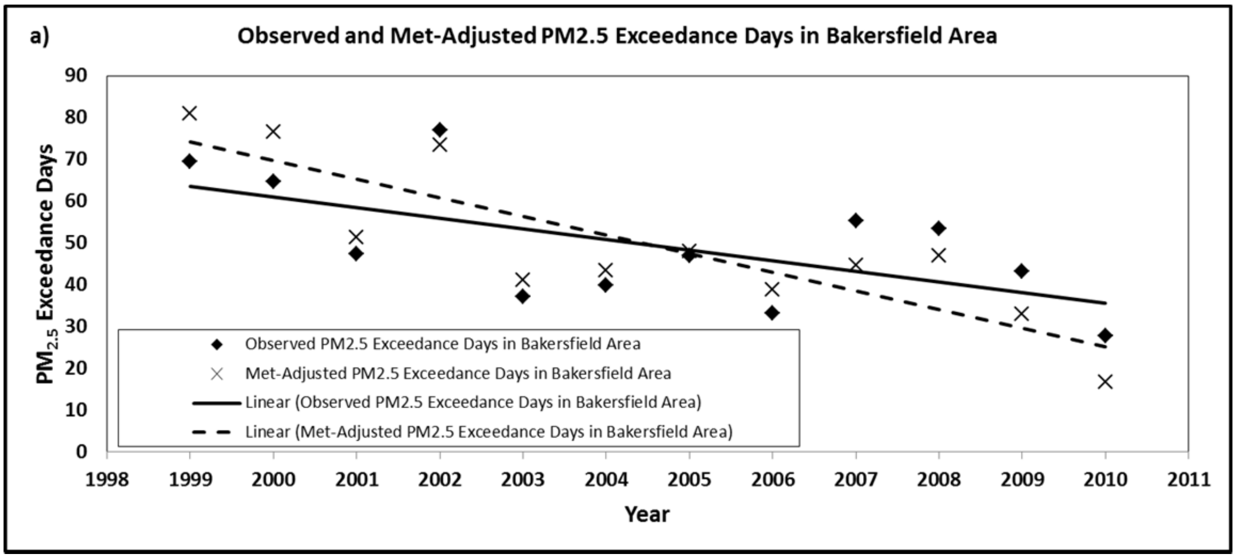
e. 24-hour trends adjusted for meteorology

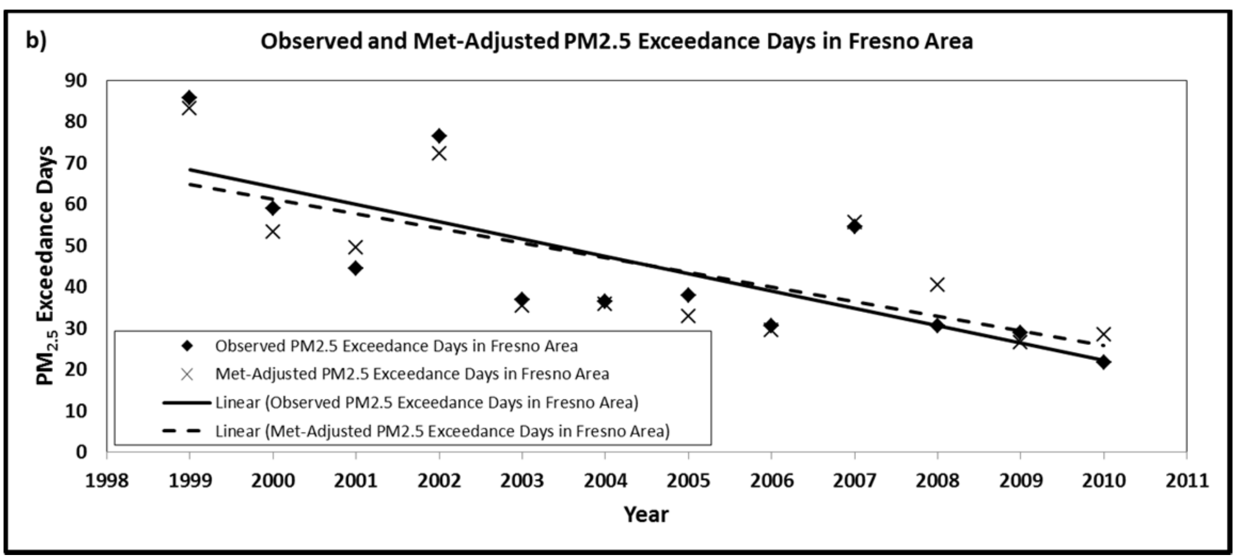
Similar to annual average trends, the number of exceedance days that occur each year can be strongly affected by differences in meteorological conditions from year to year. Figure 39 shows observed and met-adjusted trends for PM2.5 exceedance days in the Bakersfield and Fresno areas. The observed values each year may differ from those in

Figure 33 for several reasons including a) they are averages of multiple sites in each area, b) more days could be included where missing values could be imputed (missing values were filled in using relationships in existing data), and c) some days with incomplete meteorological data could not be included in the analysis.

The met-adjusted trend for Bakersfield shows a stronger decline compared to the observed trend, while in Fresno the observed and met-adjusted trends are similar. The decrease from 1999 through 2010 for the met-adjusted trend is 60 to 65 percent in both areas.

Figure 39. Observed and met-adjusted trends for PM2.5 exceedance days in a) the Bakersfield area and b) the Fresno area.

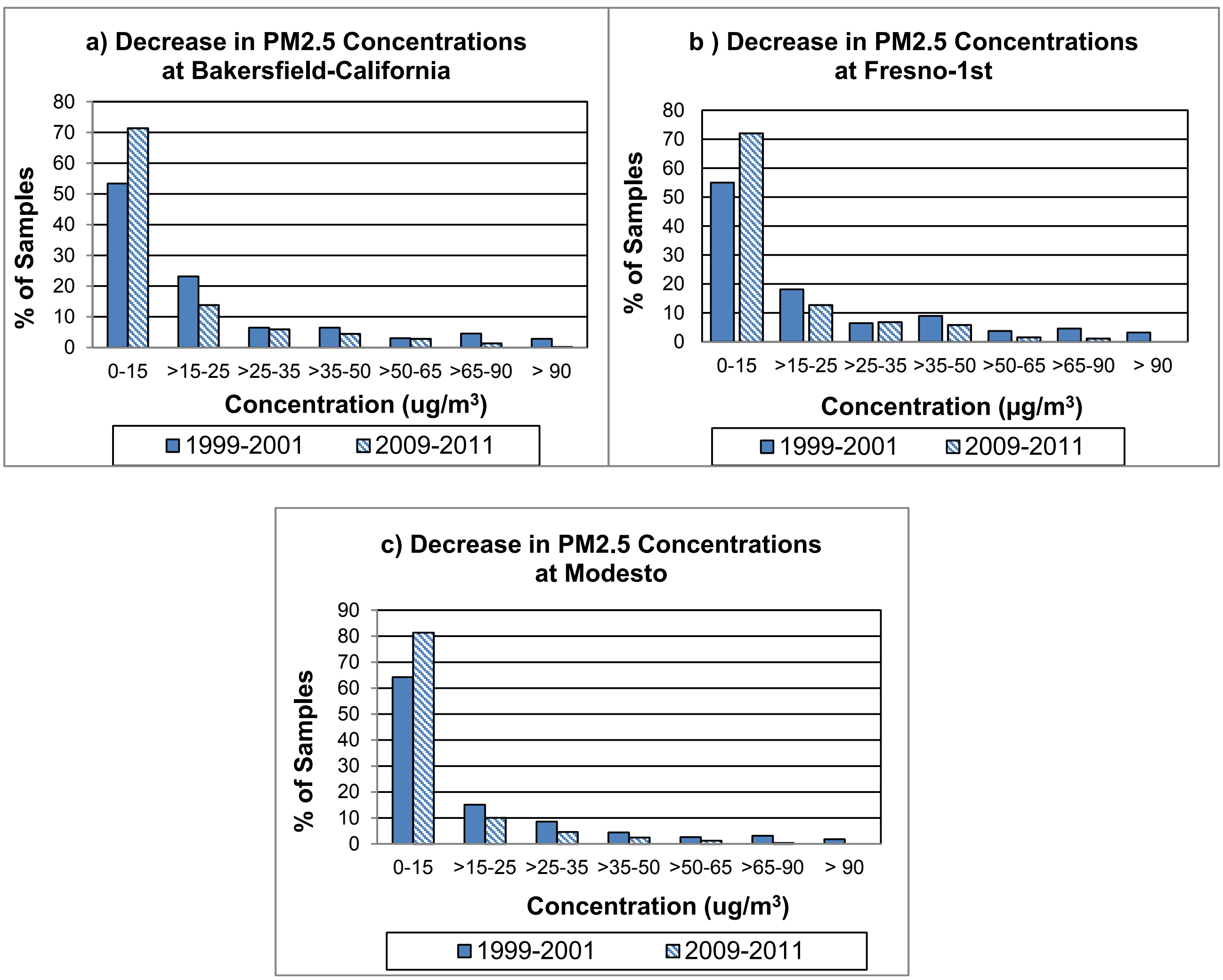




f. Trends in 24-hour, seasonal, and hourly PM2.5

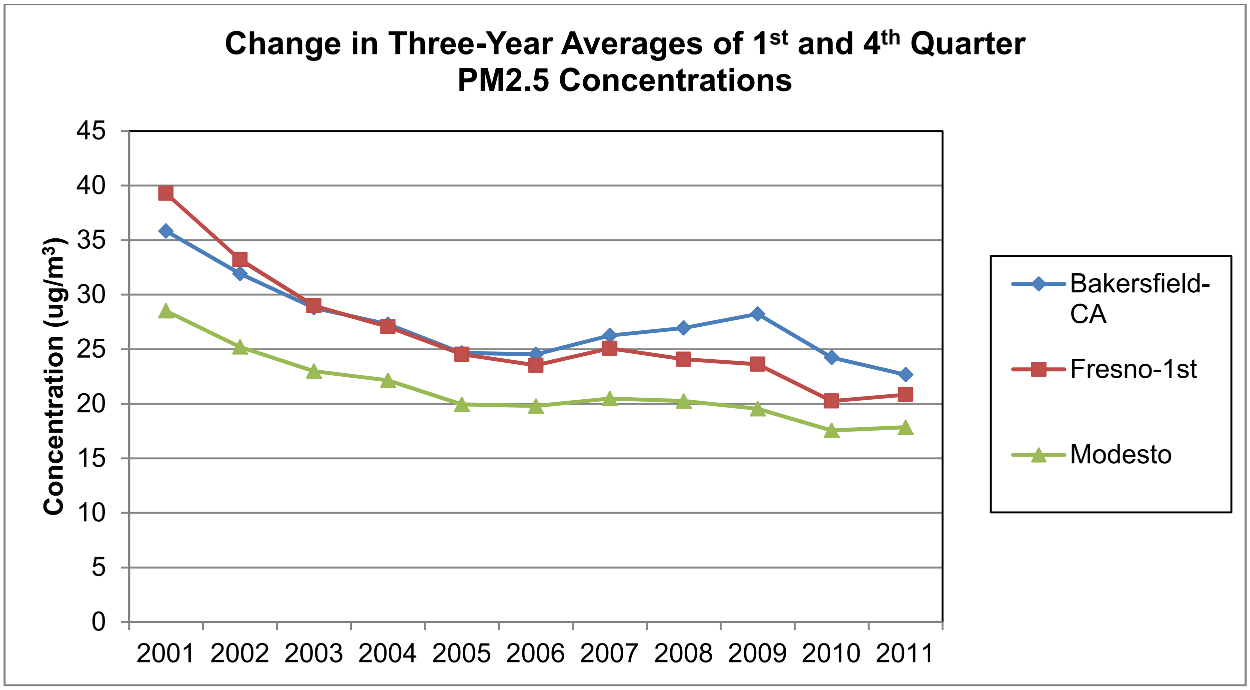
Comparing the change in the frequency distribution of 24-hour PM2.5 concentrations over the last decade provides another means of looking at air quality changes over the years. As illustrated in Figure 40, the fraction of days recording PM2.5 over the 24-hour standard of 35 µg/m^3 decreased between the three-year periods of 1999-2001 and 2009-2011 at the three monitoring sites shown. At Bakersfield, the frequency decreased from over 15 to less than ten percent, at Fresno from 20 to less than ten percent, and at Modesto from about ten percent to less than five percent. In contrast, during these same periods, the fraction of days recording concentrations at or below the annual standard increased from about 50 up to 70 percent at Bakersfield, from 55 up to 70 percent at Fresno, and from about 65 up to 80 percent at Modesto.

Figure 40. Change in PM2.5 concentration frequency distribution between the 1999-2001 and 2009-2011 periods at the a) Bakersfield-California, b) Fresno-1st, and c) Modesto monitoring sites.



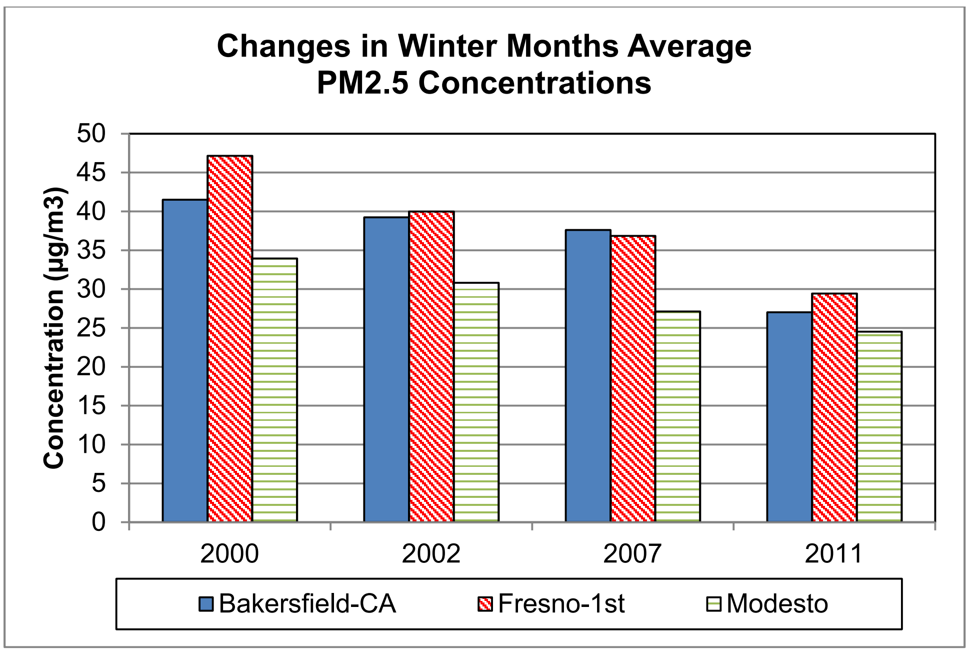
In the San Joaquin Valley, PM2.5 concentrations over the 24-hour standard occur during the winter season. Figure 41 illustrates the overall downward trend in the three-year averages of 1st and 4th quarter (Q1+Q4) PM2.5 concentrations between the periods of 1999-2002 and 2009-2011. Over the long-term, Q1+Q4 average PM2.5 concentrations decreased by 37 percent at Bakersfield and Modesto and 47 percent at Fresno. Most recently, between the periods of 2004-2006 and 2009-2011, Q1+Q4 average PM2.5 concentrations decreased by eight percent at Bakersfield, 11 percent at Fresno, and ten percent at Modesto.

Figure 41. Change in three-year averages of 1st and 4th quarter PM2.5 concentrations at the Bakersfield-California, Fresno-1st, and Modesto monitoring sites.



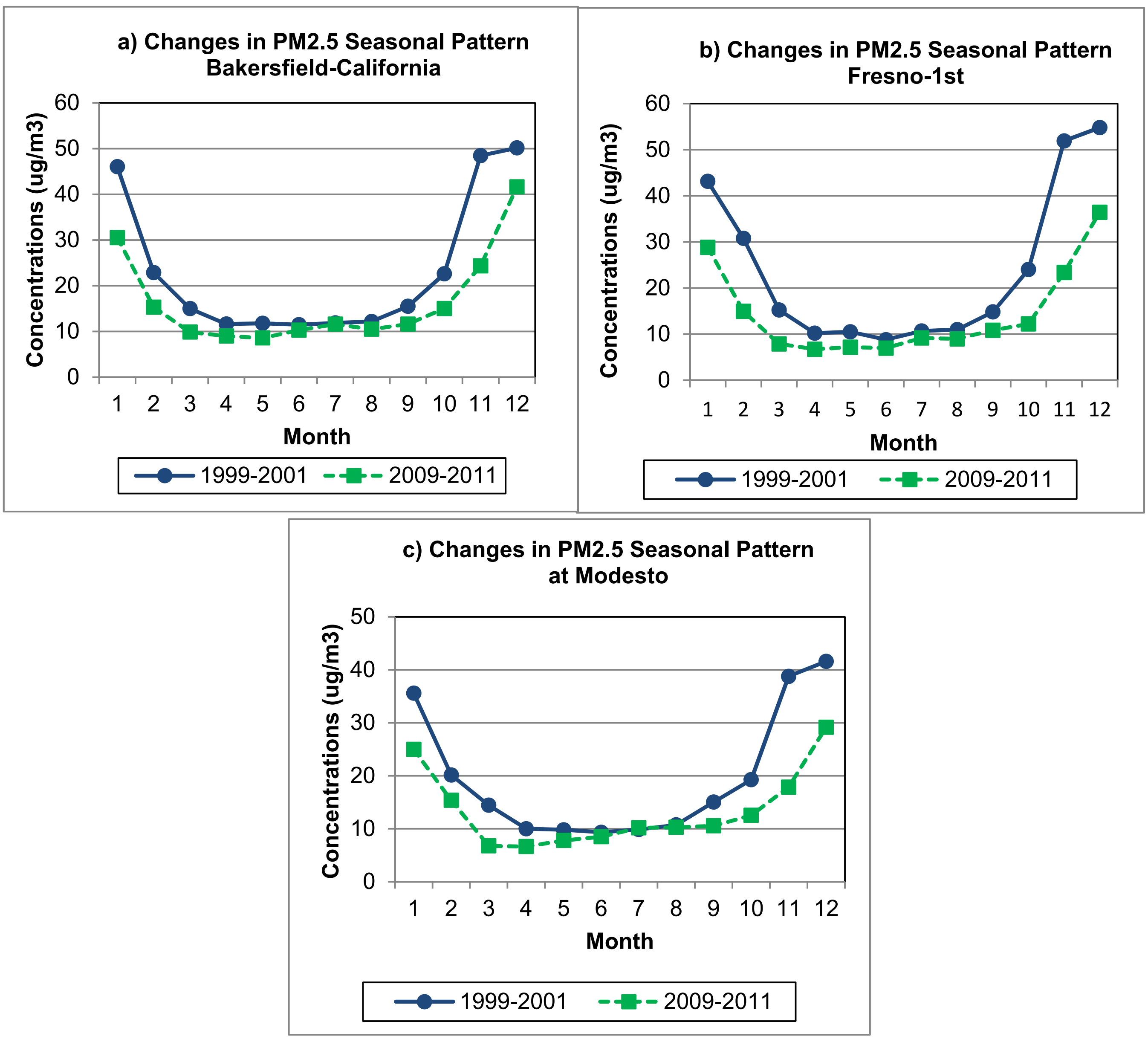
Focusing on changes in winter (November through February) average PM2.5 concentrations in years when meteorological conditions were most conducive to PM2.5 formation and accumulation provides further insight into PM2.5 air quality progress. These years include 2000, 2002, 2007, and 2011, which as illustrated on Figure 33, also had the highest numbers of days measuring over the 24-hour PM2.5 standard. Figure 42 illustrates the decrease in the winter average PM2.5 concentrations in these four years at the Bakersfield-California, Fresno-1st, and Modesto monitoring sites. Comparing 2000 to 2011, winter average PM2.5 concentrations decreased by about 35 percent in Bakersfield, about 40 percent in Fresno, and about 30 percent in Modesto. Comparing the more recent years of 2007 and 2011, winter average PM2.5 concentrations decreased by about 30 percent in Bakersfield, 20 percent in Fresno, and ten percent in Modesto.

Figure 42. Changes in winter-months average (January, February, November, December) PM2.5 concentrations at the Bakersfield-California, Fresno-1st and Modesto monitoring sites among years with most PM2.5 conducive meteorology.



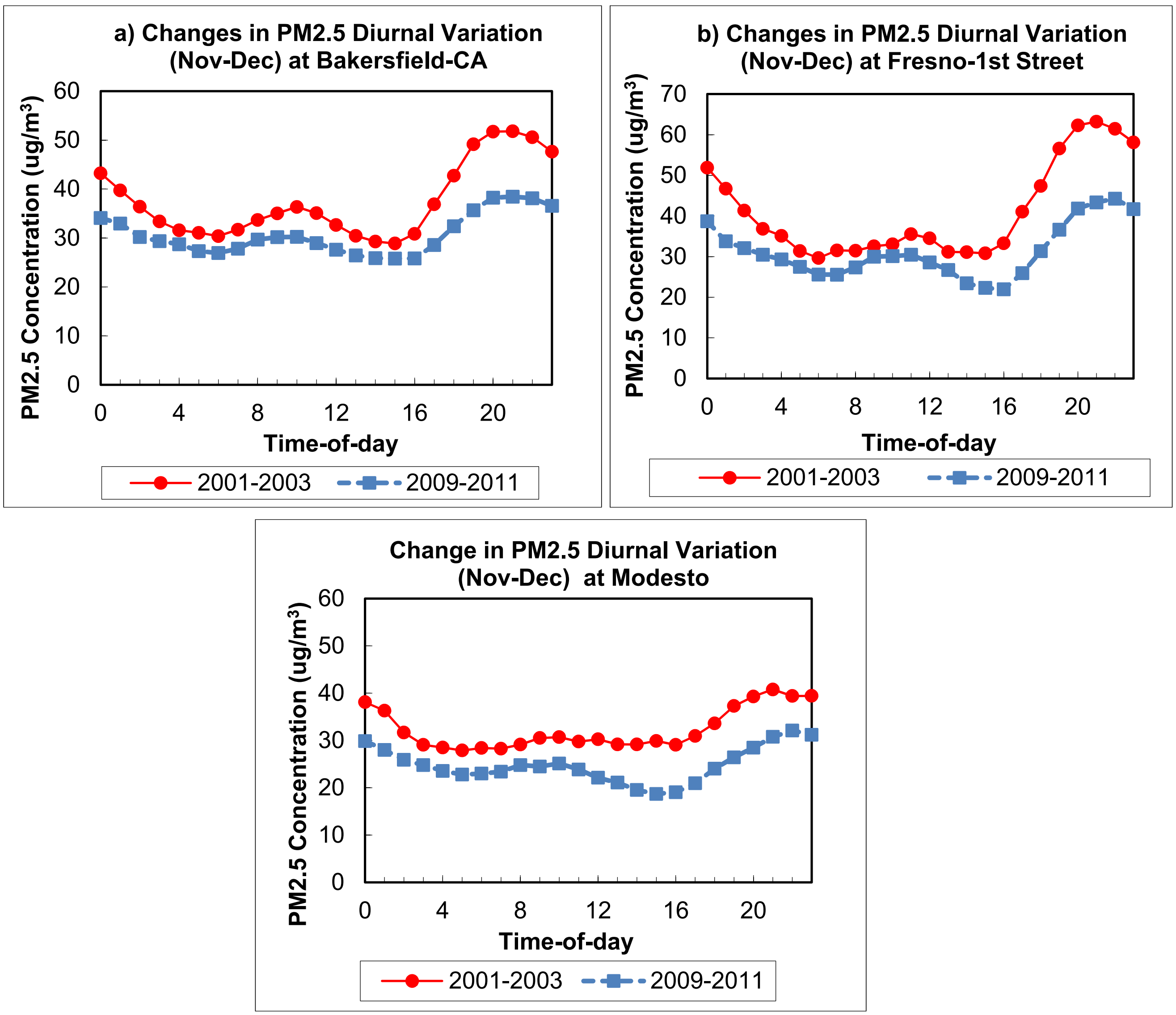
Progress in PM2.5 is further corroborated by comparing changes in monthly average PM2.5 concentrations between 1999-2001 and 2009-2011 (Figure 43). The overall PM2.5 seasonal pattern has not changed; however the average monthly concentrations have decreased. The most significant improvements in PM2.5 have been achieved during the winter months.

Figure 43. Changes in PM2.5 monthly concentrations between the 1999-2001 and 2009-2011 three-year periods at the a) Bakersfield-California, b) Fresno-1st, and c) Modesto monitoring sites.



Comparing changes in PM2.5 diurnal patterns offers further insights into the progress achieved. Figure 44 illustrates changes in the three-year averages of hourly PM2.5 concentrations recorded during November and December between 2001-2003 and 2009-2011 at a) Bakersfield-California, b) Fresno-1st, and c) Modesto. The overall diurnal patterns have not changed, yet hourly concentrations have decreased throughout the day. Peak daytime concentrations decreased approximately 20 percent, and peak nighttime concentrations approximately 30 percent.

Figure 44. Changes in the average November-December PM2.5 hourly concentrations between the 1999-2001 and 2009-2011 three-year periods at the a) Bakersfield-California, b) Fresno-1st, and c) Modesto monitoring sites.



g. Chemical composition trends

As previously discussed, PM2.5 concentrations measured at monitoring sites in the SJV have decreased from the 1999-2001 to the 2009-2011 three-year periods. Trends in individual PM2.5 chemical components, as well as emission inventory trends were evaluated to highlight the main chemical components leading to the progress in PM2.5 air quality and to evaluate the response to State and District control programs.

Speciation monitors in the SJV collect data on PM2.5 chemical composition. Figures 45, 46, and 47 illustrate the trends in the individual PM2.5 components at Bakersfield, Fresno, and Modesto. Between 2007 and 2009, the carbon collection and analysis method was changed to improve comparability with the rural IMPROVE PM2.5 carbon data. Since the change was implemented mid-year, there are gaps in carbon data for years with a mix of the old and new methods.

Ammonium nitrate, ammonium sulfate, and carbon compounds are the major constituents of PM2.5. On an annual average basis, concentrations of these key constituents have all shown significant decreases. Ammonium nitrate concentrations in the Valley declined about 40 percent between 2002 and 2011. During the same time-frame, concentrations of ammonium sulfate and carbon compounds declined about 20 to 30 percent. The most significant declines occurred between 2002 and 2003, and again between 2007 and 2010.

Figure 45. Trends in PM2.5 chemical components at Bakersfield.

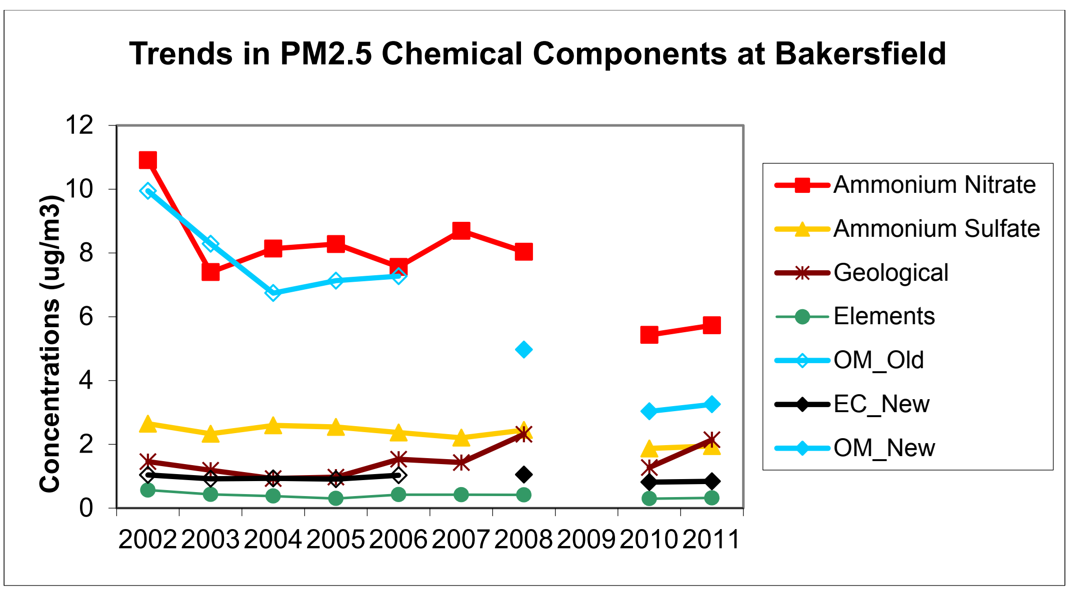


Figure 46. Trends in PM2.5 chemical components at Fresno-1st.

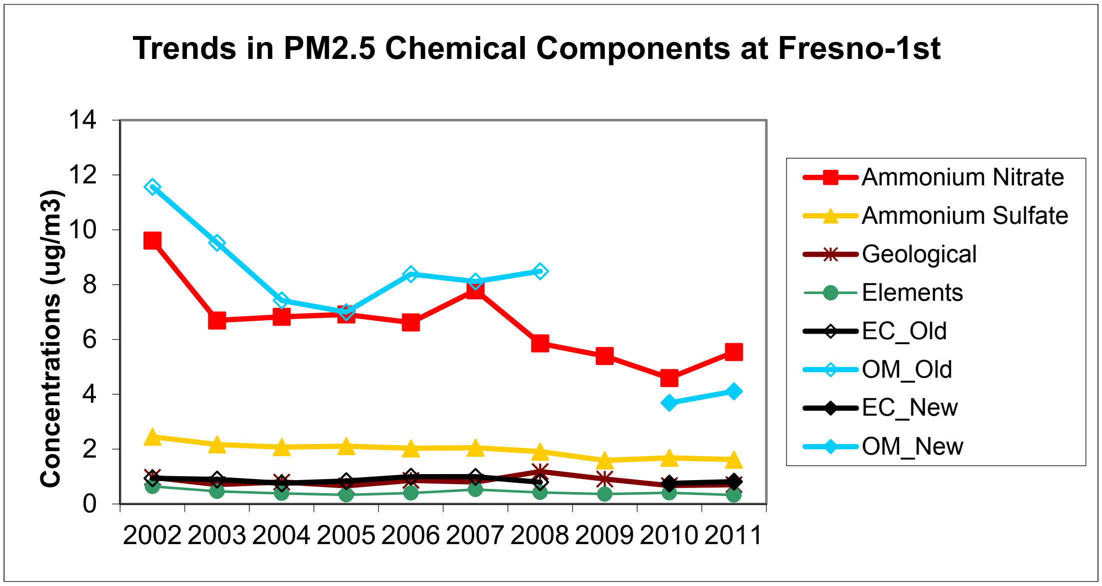
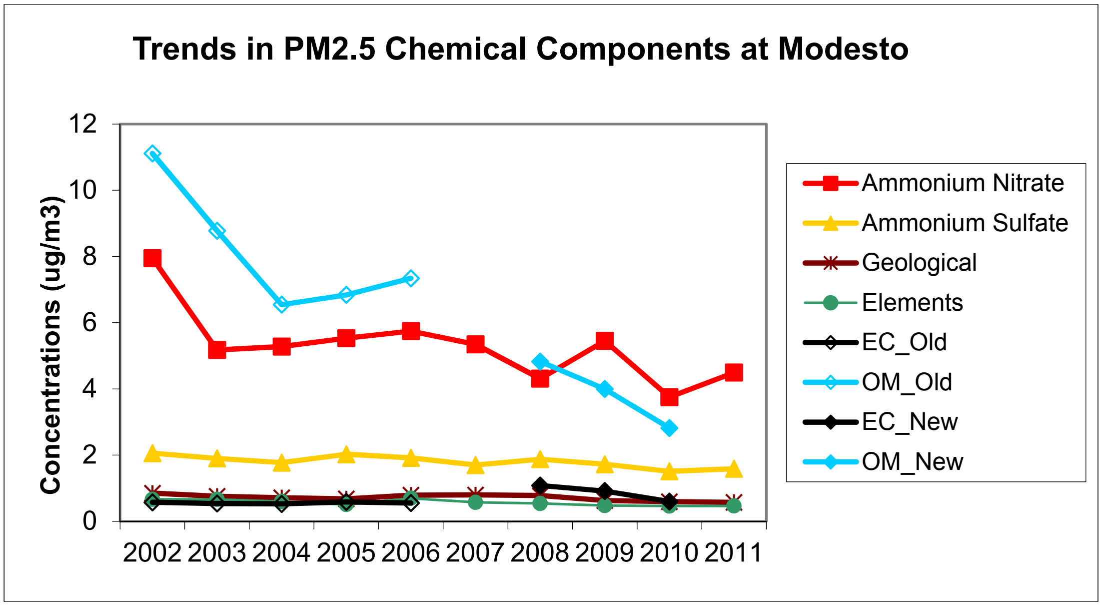


Figure 47. Trends in PM2.5 chemical components at Modesto.



The 2012 SJV PM2.5 Plan's Appendix A describes further analyses on PM2.5 air quality trends.

h. Emission inventory trends

As specified by U.S. EPA's PM2.5 implementation rule, required PM2.5 plan precursors are directly emitted PM2.5, NOx, and SOx. As discussed in sections 5 and 6, VOCs and ammonia are not significant precursors in terms of reducing PM2.5 concentrations. Figure 48 illustrates wintertime emission trends in the San Joaquin Valley air basin from 2000 through 2011 for the three key precursors.

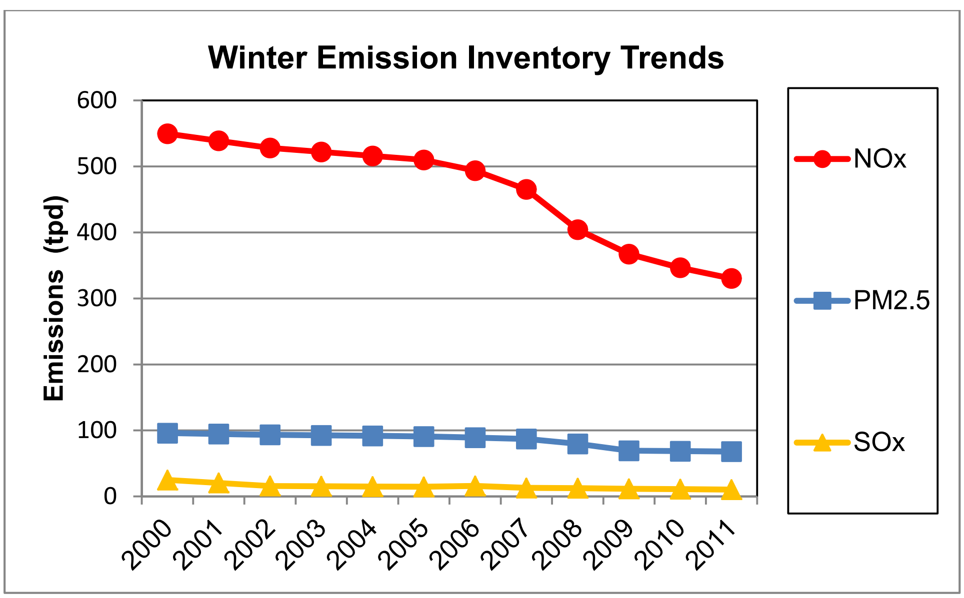
- NOx emissions have decreased by 219 tons per day (tpd) or 40 percent. Major reductions occurred in emissions from heavy-duty diesel trucks, stationary combustion sources, and other mobile sources (e.g., farm and off-road equipment, trains)

- Direct PM2.5 emissions decreased by 28 tpd or about 30 percent. Major reductions occurred in emissions from residential wood combustion and entrained dust.

- SOx decreased by 15 tpd or about 60 percent. Major reductions occurred in emissions from stationary fuel combustion sources and industrial processes.

The combined downward trends in PM2.5 components and emissions of PM2.5, NOx, and SOx indicate that the ongoing control program has had substantial benefits in improving air quality in the SJV and that further emission reductions in the future are expected to provide continuing progress towards attaining the 24-hour PM2.5 standard.

Figure 48. PM2.5 and PM2.5 precursor winter emission trends in the San Joaquin Valley.



9. LINKING AIR QUALITY TRENDS TO EMISSION REDUCTIONS

a. NOx control

Programs aimed at reducing NOx emissions have played an important role in reducing nitrate concentrations and, consequently, overall PM2.5 concentrations in the Valley. As discussed in section 5, previous studies have identified NOx as the limiting precursor for ammonium nitrate formation. As a result, NOx emissions and PM2.5 nitrate levels track each other over the years. Trends in estimated NOx emissions, as well as monitored ambient concentrations, are compared with trends in measured PM2.5 nitrate concentrations. As illustrated in Figure 49, between 2004 and 2011, Valley NOx emissions decreased by about one third, with a commensurate reduction of 30 percent in PM2.5 nitrate concentrations. Furthermore, the reductions in NOx emissions were also reflected in the corresponding reduction in the ambient gaseous NOx concentrations. Figures 50 and 51 show a strong correlation between trends in PM2.5 nitrate concentrations and ambient NOx concentrations at the Bakersfield and Fresno sites. Between 2004 and 2011, concentrations of both PM2.5 nitrate and NOx decreased approximately 30 percent.

Figure 49. Comparison between trends in Valley wide winter average NOx emission and PM2.5 nitrate concentrations at Bakersfield and Fresno. Emissions and concentrations are presented as three-year winter averages.

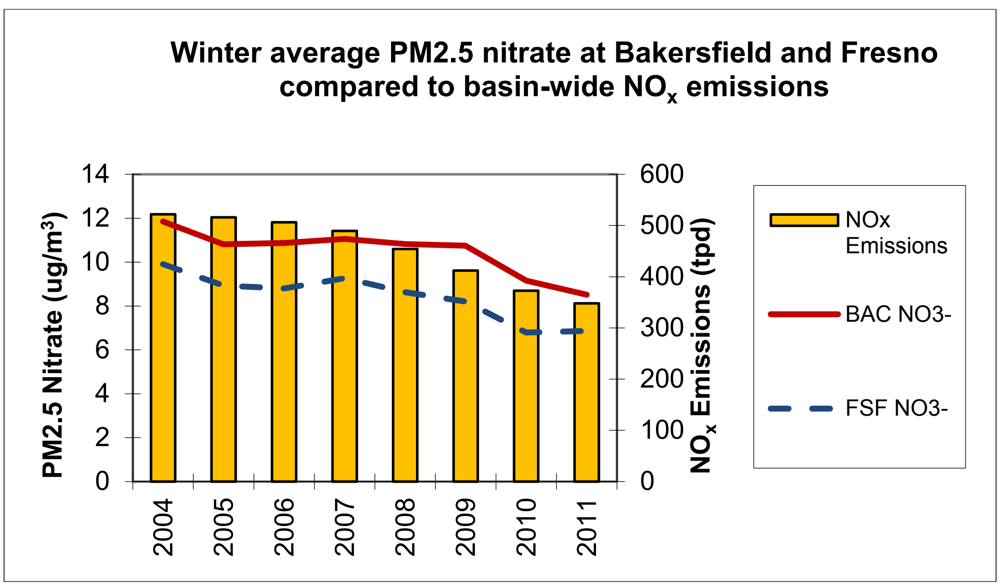


Figure 50. Comparison of trends in wintertime PM2.5 nitrate and NOx concentrations in Bakersfield. Concentrations are presented as three-year winter averages.

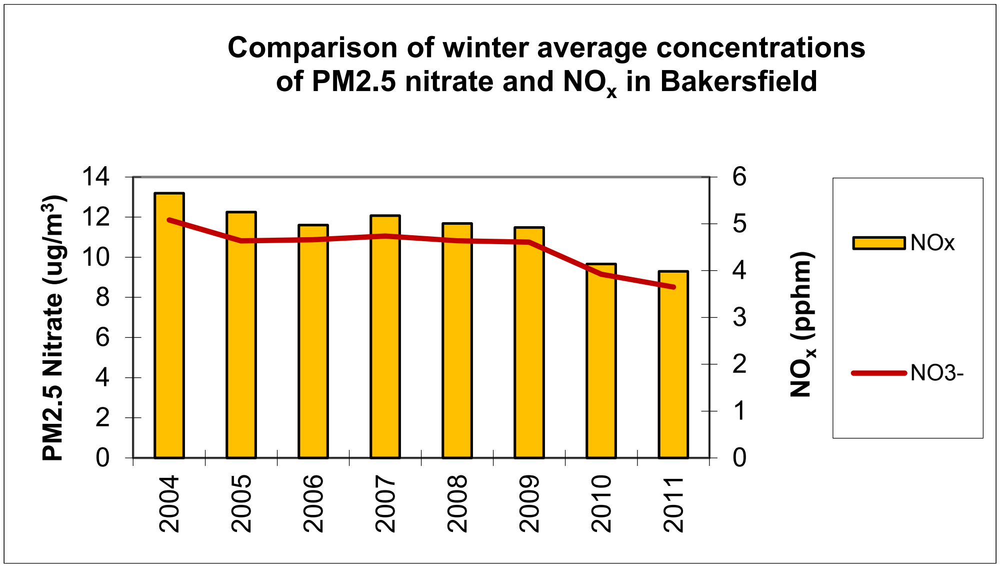
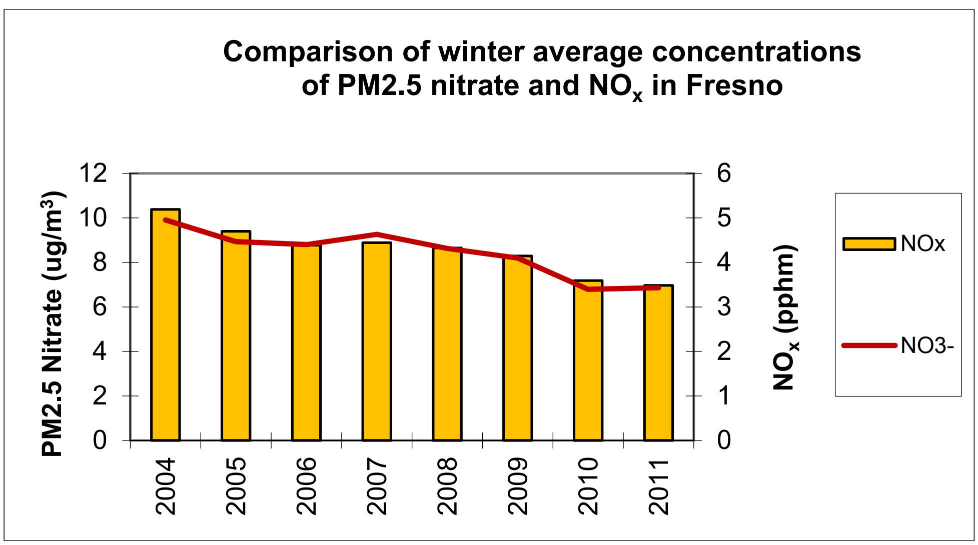
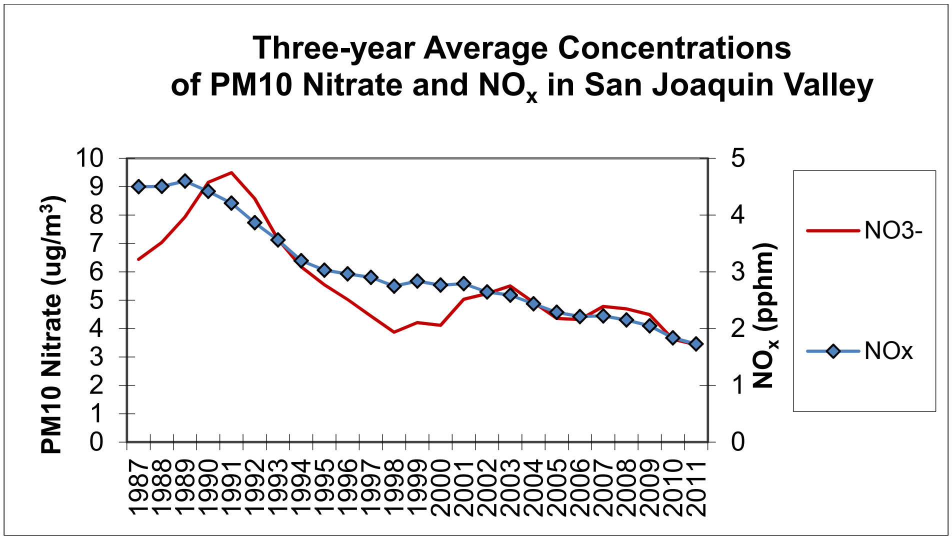


Figure 51. Comparison of trends in wintertime PM2.5 nitrate and NOx concentrations in Fresno. Concentrations are presented as three-year winter averages.



Because the PM2.5 chemical speciation network is just over ten years old, data from the PM10 ion analysis network were also used to assess longer-term trends. Although, the earlier data do not meet the strict quality assurance/quality control requirements of the PM2.5 chemical speciation network, they do provide a historical perspective. The highest PM10 nitrate concentrations were measured in the Valley in early 90's. Since then, concentrations of both PM10 nitrate and NOx have decreased about 60 percent (Figure 52). The yearly variability in the ammonium nitrate concentrations reflects the effects of the varying meteorology on ammonium nitrate formation.

Figure 52. Long-term trends in three-year average concentrations of PM10 nitrate and NOx in the San Joaquin Valley.



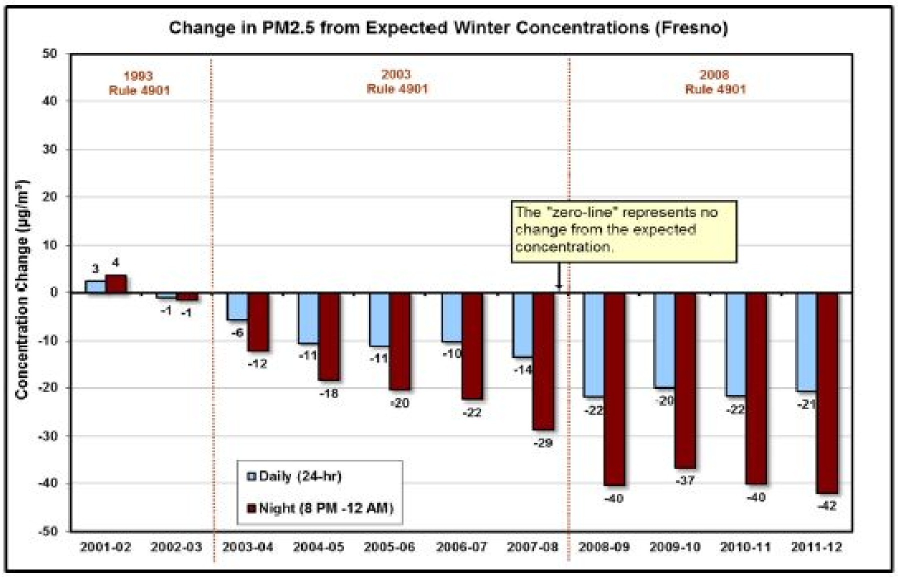
b. Residential wood burning controls

As previously discussed, annual average concentrations of PM2.5 carbon components have decreased about 20 to 30 percent since 2002. The decrease in the carbon component reflects substantial benefits from the implementation of District Rule 4901, which prohibits residential wood-burning on days when high concentrations of PM2.5 are predicted. In addition, as part of the District's stringent smoke management program, agricultural burning is prohibited on those same days. Through a series of Rule 4901 amendments, the PM2.5 threshold for calling no-burn days was established in 2003 at 65 $\mu g/m^3$ and subsequently tightened to 30 $\mu g/m^3$ in 2008. District staff analyzed the effect that Rule 4901 has had on PM2.5 in the Fresno area using a statistical model developed to quantify PM2.5 reductions attributable to the 2003 and 2008 rule amendments. Based on PM2.5 concentration relationships to meteorological variables before the wood-burning curtailments came into effect, the model predicts what the PM2.5 concentrations would have been if the curtailments had not been adopted. These expected concentrations are then compared to the measured concentrations. This analysis is further described in the 2012 SJV PM2.5 Plan's Appendix A.

The analysis results indicate that as of the 2011-2012 wood-burning season, 24-hour average PM2.5 levels in Fresno have improved by 41 percent (21 $\mu g/m^3$) since the 2003 and 2008 amendments to Rule 4901 (Figure 53). This improvement is especially marked in PM2.5 concentrations measured during the evening hours of 8:00 p.m. to 12:00 a.m. The average evening PM2.5 concentrations have improved by 50 percent (42 $\mu g/m^3$) over the same time period. As shown in this analysis, the 2008 amendment to Rule 4901 has approximately doubled the seasonal improvements in PM2.5 attributable to the 2003 amendments.

Rule 4901 will continue to play an important role in reducing PM2.5 concentrations throughout the San Joaquin Valley both within and beyond the timeframe of this plan.

Figure 53: Effect of SJVAPCD's Rule 4901 on PM2.5 concentrations in Fresno.



10. MODELED ATTAINMENT DEMONSTRATION

a. Modeling results

Consistent with U.S. EPA guidelines, air quality modeling was done to predict future PM2.5 concentrations at each monitoring site in the San Joaquin Valley. This modeling shows attainment of the 24-hour PM2.5 standard by 2019 in all counties except Kings and Kern, based on implementation of the ongoing control program. In these counties, additional focused emission reductions are needed to provide for attainment. As required by U.S. EPA, additional analyses has been done to confirm that attainment is predicted throughout each county (i.e. in each modeled grid cell). The “Attainment Demonstration” chapter of the District’s plan provides an overview of the photochemical modeling performed. Additional information on the periods modeled, the models selected, and model application can be found in the Modeling Protocol document prepared for this effort.

The air quality modeling analysis includes new emission reductions each year between now and 2019 from implementation of a combination of adopted ARB and District programs. As a result, most sites in the northern and central Valley are expected to attain by 2019. As required by U.S. EPA, the modeling replicates the base year 2007 meteorological conditions for each calendar day in the year 2019. The 2007 meteorological conditions included several periods of time especially conducive to the formation of PM2.5.

Given the past effectiveness of District programs to curtail residential wood burning, ARB staff then modeled a scenario with an enhanced curtailment program, which would be designed to prevent wood burning on days that may lead up to a PM2.5 exceedance. The modeling results for this scenario indicate that only one site (Bakersfield-California) would not attain the standard with this additional level of control. The predicted design values for each site from this modeling scenario are shown in Table 4.

Table 4. 2019 Modeled 24-hour PM2.5 Design Values.

Monitoring Site	Design Value ($\mu g/m^3$)
Bakersfield - California	35.7
Bakersfield - Planz	32.9
Corcoran - Patterson	32.1
Visalia - N. Church	29.4
Fresno - Hamilton	28.6
Fresno-1st	30.5
Clovis	28.6
Merced	22.6
Modesto	24.7
Stockton	21.4

b. Benefits of emission reductions from on-going programs

The implementation of new reductions from California's on-going emission control programs will provide the major portion of the emission reductions needed to attain the 24-hour PM2.5 standard throughout the San Joaquin Valley in 2019. The PM2.5 design value at the Bakersfield-California site must decrease by approximately 45 percent to demonstrate attainment. Between 2007, the base year used in the photochemical modeling attainment demonstration, and 2019, implementation of these control programs will reduce NOx emissions by 55 percent. Previous sections of this WOE document have demonstrated that prior reductions in NOx have resulted in commensurate reductions in ambient concentrations of nitrate. This is consistent with modeled predictions that demonstrate a nearly 45 percent reduction in ammonium nitrate concentrations. In addition, while directly emitted PM2.5 emissions in aggregate are decreasing by nearly 30 percent, a major focus of the attainment control strategy is further curtailment of residential wood burning. Ambient measurements and modeling studies have shown the large contribution that residential wood burning has on PM2.5 exceedance days. In addition, prior District analysis has demonstrated the significant benefits of past implementation of wood burning curtailment. Therefore, the substantial continuing reductions that will result from implementation of the ongoing control program, coupled with an enhanced residential burning curtailment program, are consistent with the benefits predicted in the modeled attainment demonstration.

As a result of the overall control program, coupled with the enhanced wood burning curtailment measure, ammonium nitrate concentrations are predicted to decrease by nearly 45 percent, organic carbon concentrations by approximately 65 percent, and elemental carbon concentrations by nearly 80 percent. A comparison of the concentrations of the main chemical constituents in 2007 to that predicted in 2019 at three sites (Modesto, Fresno-1st, and Bakersfield-California) illustrates the significant reductions in these components (Table 5).

Table 5. Comparison of the concentration of chemical constituents for 2007 and 2019 design values at selected sites.

Component (ug/m^3)	Bakersfield – Calif.		Fresno-1st		Modesto	
	2007	**2019**	**2007**	**2019**	**2007**	**2019**
Ammonium Nitrate	41.1	22.6	32.1	17.0	28.5	15.6
Ammonium Sulfate	4.7	4.4	3.2	2.5	3.1	2.7
Organic Carbon	15.2	6.6	22.9	8.9	19.7	4.6
Elemental Carbon	2.2	0.5	2.8	0.6	1.6	0.3

c. Evaluation of precursor sensitivity

Effectiveness of Valley wide emission reductions

In order to determine where to focus the remaining emission reductions needed to bring Bakersfield-California into attainment, as well as identify the attainment plan precursors, ARB staff conducted additional modeling sensitivity runs to assess the relative efficacy of further reductions of different PM2.5 precursors. U.S. EPA's PM2.5 implementation rule specifies that a precursor is considered "significant" for control strategy development purposes when a significant reduction in the emissions of that precursor pollutant leads to a significant decrease in PM2.5 concentrations. Such pollutants are known as "PM2.5 attainment plan precursors" (72 FR 20586). The U.S. EPA's implementation rule also establishes a presumption that PM2.5, NOx, and SOx are attainment plan precursors, while VOCs and ammonia are not. In the past for the annual PM2.5 plan, PM2.5, NOx, and SOx were identified and approved as the only attainment plan precursors by U.S. EPA. Results of the annual PM2.5 modeling showed that of these three pollutants, reductions in directly emitted PM2.5 was the most effective. However, because emissions change over time, it is important to continue to assess the attainment plan precursors each time a plan is developed.

Additional photochemical modeling analyses were therefore conducted to understand the relative effectiveness of emission reductions for primary PM2.5 and precursors throughout the Valley in 2019. In these analyses, the model was run with varying combinations of valley wide precursor emission reductions from anthropogenic sources:

- NOx vs. PM2.5
- NOx vs. Ammonia
- NOx vs. VOCs
- NOx vs. SOx

Table 6 compares the modeled effect on the 2019 design value obtained at each monitoring site from a 25 percent reduction in the specified precursor. Consistently, direct PM2.5 productions have the most benefit, followed by NOx reductions. Reductions in ammonia and SOx provide much smaller benefits, while reductions in VOCs result in very small disbenefits at many sites. Table 7 presents this same information, but normalized to reflect the reduction in design value per ton of each precursor reduced. On this basis, valley wide reductions in PM2.5 are approximately four times as effective as NOx, and approximately five times as effective as SOx. In contrast, reductions in ammonia are approximately nine times less effective than NOx, and as noted above, reductions in VOCs result in either no impact of very small disbenefits.

Table 6. Modeled reduction in 2019 PM2.5 design value resulting from 25 percent reduction in valley wide precursor emissions.

Monitoring Site	PM2.5 Reduction (µg/m^3)				
	Primary PM2.5	**NOx**	**Ammonia**	**SOx**	**VOC**
Bakersfield -California	4.44	3.75	0.55	0.18	- 0.10
Bakersfield-Planz	3.80	3.64	0.58	0.19	-0.06
Visalia	3.51	3.10	0.37	0.09	-0.06
Corcoran	3.34	3.99	0.70	0.08	-0.20
Fresno-1st	4.12	2.62	0.51	0.09	0.03
Fresno-Hamilton	3.73	2.57	0.50	0.11	0.05
Clovis	3.29	3.17	0.55	0.09	0.00
Modesto	2.49	1.76	0.43	0.17	0.03
Merced	2.54	2.31	0.34	0.11	-0.01
Stockton	1.87	1.30	0.48	0.20	0.03

Table 7. Modeled PM2.5 air quality benefit per ton of valley wide precursor emission reductions.

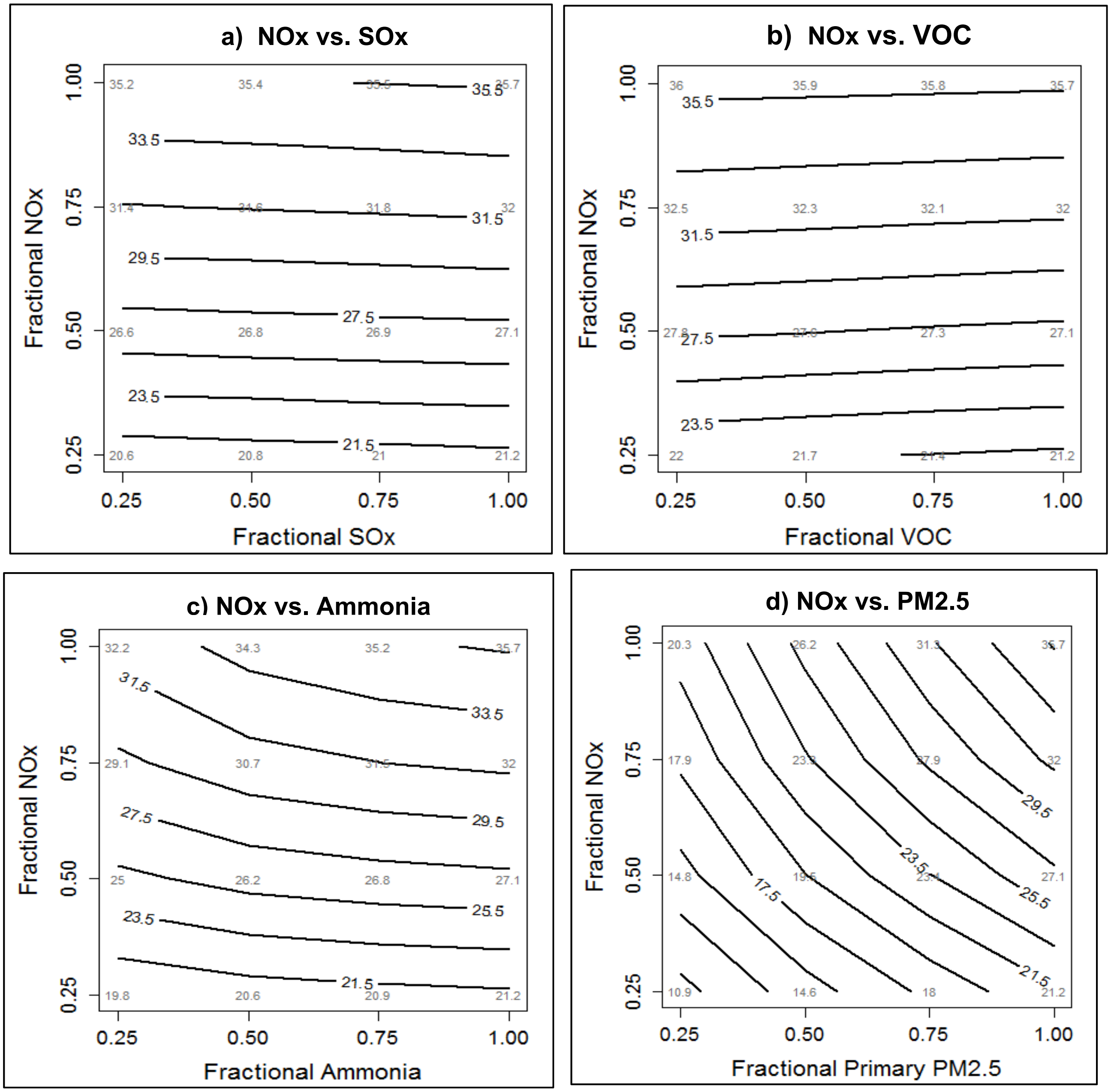
Monitoring Site	PM2.5 Benefit (µg/m^3 per ton reduction)				
	Primary PM2.5	**NOx**	**Ammonia**	**SOx**	**VOC**
Bakersfield-California	0.34	0.08	0.008	0.08	-0.001
Bakersfield-Planz	0.29	0.08	0.009	0.08	-0.001
Visalia	0.27	0.07	0.005	0.04	-0.001
Corcoran	0.25	0.09	0.010	0.04	-0.003
Fresno-1st	0.31	0.06	0.008	0.04	0.000
Fresno-Hamilton	0.28	0.06	0.007	0.05	0.001
Clovis	0.25	0.07	0.008	0.04	0.000
Modesto	0.19	0.04	0.006	0.08	0.000
Merced	0.19	0.05	0.005	0.05	0.000
Stockton	0.14	0.03	0.007	0.09	0.000

The results of these modeling sensitivity runs were also plotted on isopleth diagrams which reflect the change in the 2019 design value at each level of emission reduction. Isopleth diagrams for the Bakersfield-California site are shown in Figures 54 (a) through (d) to illustrate the overall nature of the modeled response:

- While reducing SOx results in less sulfuric acid and subsequent ammonium sulfate formation, SOx reductions have only a small effect on the predicted design value since ammonium sulfate is a small component of measured PM2.5.
- Reducing VOCs leads to very small increases in the design value because these reductions have the effect of making more NOx available for nitric acid, and subsequent ammonium nitrate formation.
- Because ammonia is much more abundant than NOx, the atmosphere is more responsive to reductions in NOx as compared to ammonia. Reductions in NOx in turn have significant benefits as ammonium nitrate is a large component of measured PM2.5.
- Reductions in directly emitted PM2.5 result in significant benefits due to the reduction in organic carbon which is a large component of measured PM2.5.

These modeling results, along with the findings from past modeling and monitoring studies highlight that reductions in directly emitted PM2.5 and NOx provide the greatest benefit in further reducing PM2.5 concentrations and making progress towards attainment. Given that significant reductions in VOCs and ammonia do not provide significant air quality benefits, per U.S. EPA guidance, the 24-hour PM2.5 attainment plan precursors are directly emitted PM2.5, NOx, and SOx.

Figure 54. Bakersfield–California Isopleth Diagrams.



Effectiveness of localized emission reductions

The valley wide precursor sensitivity modeling demonstrates that on a relative basis the greatest benefits are achieved from reductions in sources of directly emitted PM2.5, followed by NOx. Due to the stagnant conditions that occur during wintertime episodes, and the local nature of directly emitted PM2.5 carbon sources in particular, Kern County specific model sensitivity runs were also conducted to evaluate the benefits of emission reductions focused on the nonattainment sub-area. The Kern County sensitivity runs demonstrated that:

- One ton per day of directly emitted PM2.5 reductions provides a 1 $\mu g/m^3$ improvement in the Bakersfield-California design value;
- One ton per day of NOx reductions provides for a 0.12 $\mu g/m^3$ improvement in the Bakersfield-California design value;
- One ton per day of SOx reductions provides for a 0.21 $\mu g/m^3$ improvement in the Bakersfield-California design value;
- One ton per day of ammonia reductions provides for a 0.02 $\mu g/m^3$ improvement in the Bakersfield-California design value; and
- One ton per day of VOC reductions has no effect on the Bakersfield-California design value.

An examination of sources surrounding the Bakersfield-California monitoring site was then conducted in order to identify potential PM2.5 and NOx sources for further control. The forecasted 2019 PM2.5 and NOx gridded emission inventories were evaluated, focusing on the winter months of November through February when the majority of PM2.5 exceedances occur. The top five emission sources of PM2.5 and NOx in the 9 grid cells (3x3 grid cells, each measuring 4 km x4 km) centered on the Bakersfield-California monitoring site are shown in Figures 55 and 56. The main combustion sources of PM2.5 are commercial cooking, residential fuel combustion, and on-road vehicles. The main NOx source is on-road vehicles, with smaller contributions from off-road equipment, residential fuel combustion, and trains. This analysis suggests that for PM2.5, a focused effort to further reduce residential wood burning and limit emissions from commercial cooking operations would have significant benefits in reducing PM2.5 concentrations in the Bakersfield area. Key NOx sources include on- and off-road mobile sources which are already the focus of ongoing control programs.

Figure 55. 2019 top five wintertime PM2.5 emission sources within the Bakersfield-California 9-grid cell area (3x3 grid cells, each measuring 4 km x 4 km with the Bakersfield-California monitor located in the center cell). Wintertime emissions expressed as an average of January, February, November and December emissions.

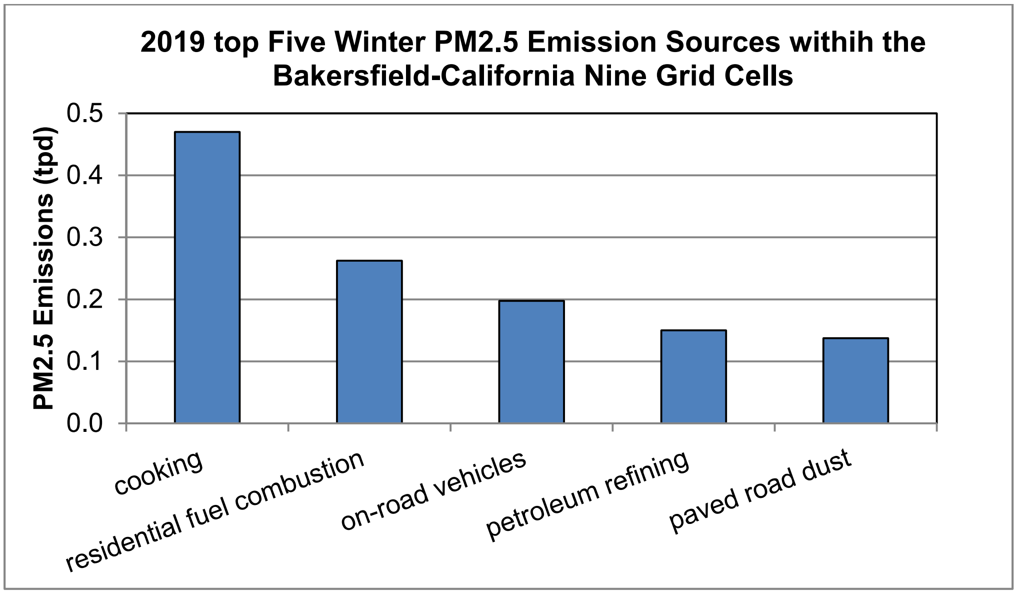
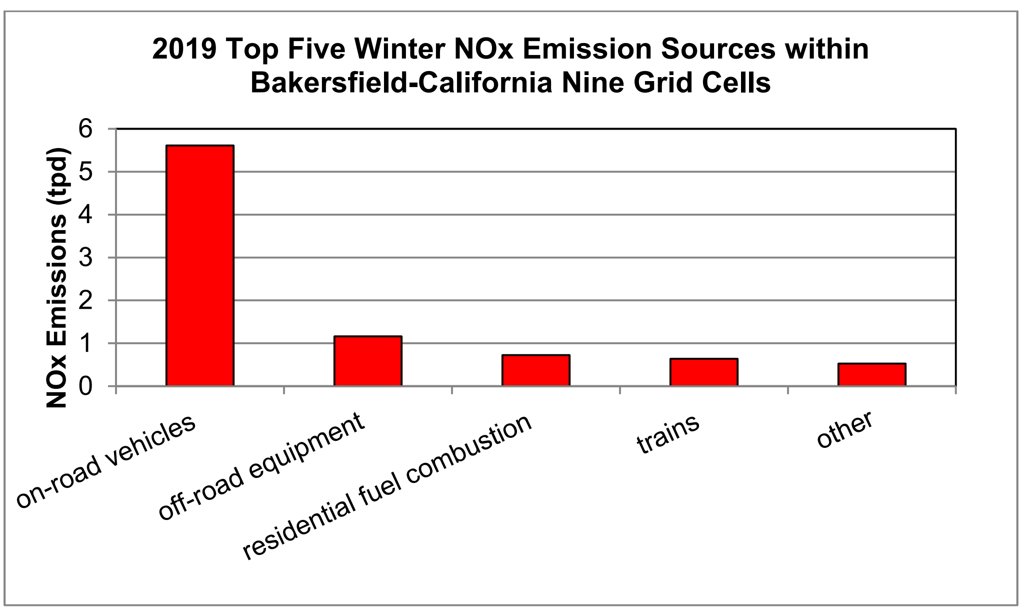


Figure 56. 2019 top five wintertime NOx emission sources within the Bakersfield-California 9-grid cell area (3x3 grid cells, each measuring 4 km x 4 km with the Bakersfield-California monitor located in the center cell). Wintertime emissions expressed as an average of January, February, November and December emissions.



d. Demonstrating attainment at Bakersfield-California

While adoption of a more stringent wood burning curtailment program brings the Bakersfield-California site very near attainment, further reductions are needed to meet the attainment target of 35.4 μg/m^3. Based upon the precursor sensitivity analysis and evaluation of the localized inventory discussed in the previous section, further control of PM2.5 emissions from commercial cooking operations was identified as the most effective approach to provide the emission reductions needed to reach attainment. The final attainment demonstration for the Bakersfield-California design site is provided in Table 8 below:

Table 8. Attainment Demonstration for the Bakersfield-California Design Value Site.

2007 Design Value (μg/m^3)	2019 Design Value with Wood Burning Program Enhancement (μg/m^3)	2019 Final Design Value (μg/m^3)
65.6	35.7	≤35.4

Note: The benchmark for attainment is a design value that is equal to or less than 35.4 μg/m^3.

As noted above, the design value in the center column of the table reflects the implementation of ongoing control programs, as well as implementation of an enhanced residential wood burning curtailment program. The final design value reflects the combined impact of further reductions in commercial cooking, as well as a small increase in motor vehicle emissions due to updated vehicle activity data from the San Joaquin Valley Metropolitan Planning Organizations (MPOs). Based on a modeling sensitivity run, implementation of further controls on commercial cooking is expected to result in a 0.6 μg/m^3 reduction in the baseline design value. The revised MPO activity data represents approximately one percent of Valley wide NOx emissions. Based on modeling sensitivity runs, this is estimated to result in a design value increase of 0.2 μg/m^3. In aggregate, the modeling demonstrates a design value that meets U.S. EPA's attainment target of 35.4 μg/m^3.

11. SUMMARY

Consideration of the entirety of information presented in the weight of evidence provides a consistent assessment that supports the modeled attainment date of 2019. The substantial continuing reductions that will result from implementation of the ongoing control program, coupled with new measures addressing residential wood burning and cooking, are consistent with the results predicted in the modeled attainment demonstration. This weight of evidence assessment is based upon the following factors:

- Over the last decade significant progress has occurred in reducing 24-hour PM2.5 concentrations. The 24-hour design value has decreased by over 30 µg/m^3, while the number of exceedance days has declined by nearly 50 percent. Meteorologically adjusted trends for the Bakersfield area show an even greater reduction in exceedance days, with a decline of over 60 percent.

- Evaluation of the air quality model response to emission reductions, as well as model sensitivity runs demonstrates that reductions in directly emitted PM2.5 have the greatest impact per ton of emissions, followed by NOx. For example, in Kern County, PM2.5 emission reductions are approximately eight times more effective than NOx.

- Both receptor and photochemical grid based modeling have identified residential wood burning as a significant contributor to wintertime PM2.5 concentrations. The reductions in the organic carbon component of PM2.5 that have occurred can be linked to implementation of the District's residential wood burning curtailment program.

- Evaluation of emissions inventory data, monitoring studies, and photochemical modeling indicate that controlling NOx emissions is the most effective strategy to reduce ammonium nitrate concentrations.

- The decrease in ammonium nitrate concentrations observed at Valley monitoring sites tracks concurrent reductions in NOx emissions as well as trends in gaseous NOx concentrations.

- Substantial NOx and PM2.5 emission reductions will occur between 2007 and 2019 due to the implementation of on-going measures and additional new measures. As a result of these programs, NOx emissions will decrease by over 50 percent, and PM2.5 emissions by nearly 30 percent.

- The modeled attainment demonstration predicts that all sites in the Valley will attain by 2019. This modeling assessment is consistent with the benefits seen from previous reductions in the sources and pollutants being addressed as part of the attainment strategy.

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San Joaquin Valley PM2.5 Weight of Evidence Analysis

Appendix 1

California Regional PM10/PM2.5 Air Quality Study

Publications

CALIFORNIA REGIONAL PM10/PM2.5 AIR QUALITY STUDY PUBLICATIONS

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San Joaquin Valley PM2.5 Weight of Evidence Analysis

Appendix 2

PM2.5 Source Apportionment for the San Joaquin Valley Air Basin Using the Chemical Mass Balance Receptor Model

PM2.5 Source Apportionment for the San Joaquin Valley Air Basin Using the Chemical Mass Balance Receptor Model

1) Data Collection and Screening

PM2.5 chemical composition data collected at the Bakersfield-California and Fresno-1st Street sites were used for the Chemical Mass Balance (CMB) analysis. The two sites are part of the Chemical Speciation Network (CSN) and use the SASS (Spiral Aerosol Speciation Sampler, Met One, Grants Pass, OR.) for data collection. The Bakersfield-California and Fresno-1st samplers are configured with several channels, each channel containing one 47mmfilter with a 6.7 L/min flow rate. One channel contains a Whatman Teflon®-membrane filter for mass by gravimetry and elements by XRF. Another channel includes a magnesium oxide-coated aluminum (Al) honeycomb after the cyclone followed by a Nylasorb nylon-membrane filter for water-soluble anions i.e., NO_3^- and $SO_4^=$) and cations (i.e., ammonium [NH_4^+] and water-soluble sodium [Na^+] and potassium [K^+]) by IC. In the past, another channel containing a Whatman QMA quartz-fiber filter was used for OC and EC analysis by the STN thermal/optical transmittance (TOT) protocol. In recent years changes were made to the carbon sampling and analysis method. The collection method changed from the MetOne SASS to the URG3000N sampler, which is very similar to the IMPROVE module C sampler. The analytical method was changed from the NIOSH-like thermal optical transmittance (TOT) method to IMPROVE_A thermal optical reflectance (TOR). A new backup quartz filter is also collected using the URG3000N to help assess artifacts. The backup filter is placed behind the routine quartz sampler filter. This change took place on May 3, 2007 at Bakersfield and April 1, 2009 at Fresno.

Due to the change in carbon collection and analysis method, several data sets were generated for CMB modeling to allow separate analysis of old and new carbon data. Throughout this document we will refer to 'old carbon' data and 'new carbon' data. Old carbon data were collected using the SASS sampler and analyzed using the NIOSH-like thermal optical transmittance (TOT) method. New carbon data were collected using the modified IMPROVE version II Module C sampler, the URG3000N, and analyzed using the IMPROVE-A thermal optical reflectance (TOR) method. Both old and new carbon data were corrected for sampling artifacts prior to running CMB.

2) Data Preparation

Organic carbon (OC) data were corrected for sampling artifacts prior to running CMB. Old carbon data, collected using the SASS sampler and analyzed using the NIOSH-like thermal optical transmittance (TOT) method, were corrected by subtracting a California network-wide average organic carbon blank of 1 ug/m3 from the measured OC concentration. New carbon data were adjusted by subtracting network-wide monthly average concentrations measured on a backup filter from daily measurements of organic carbon [88370]. The monthly average backup concentrations are shown in Table 1.

Table 1. Organic Carbon Monthly Average Concentrations on Backup Filter

Month	1	2	3	4	5	6	7	8	9	10	11	12
Avg Blank Value (ug/m3)	0.66	0.54	0.48	0.43	0.43	0.48	0.54	0.49	0.53	0.50	0.60	0.57

3) Source Profiles

The major source types which have been found to contribute to primary PM2.5 in the San Joaquin Valley are motor vehicle exhaust, vegetative burning, geological material, marine-derived aerosols, residual or crude oil combustion, and tire and brake wear. Most of the source profiles applicable to the San Joaquin Valley were determined during the California Regional PM10/PM2.5 Air Quality Study (CRPAQS) or earlier. Therefore, the profiles used in this analysis, listed in Table 4, are the same profiles that were used in the previous analysis for the 2008 San Joaquin Valley PM2.5 Plan.

Motor vehicle profiles for diesel (DIES) and gasoline (GAS) (Fujita et al., 2005) were used in modeling PM2.5 concentrations. Since more specific organic markers for gasoline and diesel were not available at the receptor site, the two profiles were collinear and had to be combined into a single profile representing motor vehicle emissions. Diesel and gasoline vehicle emissions source profiles were combined in proportions equivalent to their county-level contributions to the PM2.5 emissions to produce a single emission-weighted overall source profile. Table 2 lists PM2.5 emissions (EMFAC 2011, July 2011) that were used as a basis for creating county-based composite profiles for Bakersfield and Fresno.

Table 2. Average 2004-2010 PM2.5 Exhaust Emissions (tons per day)

County		Gasoline Vehicles	Diesel Vehicles
Kern County	2004-2006 (K6GASDIE)	0.12	2.54
	2008-2010 (K9GASDIE)	0.09	1.88
Fresno County	2004-2006 (F6GASDIE)	0.12	1.33
	2008-2010 (F9GASDIE)	0.08	0.97

Table 3. Source Profiles (as Percent of the PM2.5 Mass) Used in the CMB Modeling

PNO	38			35			13			18			41			54			32		
SOURCE	AMNIT			AMSUL			WBOakEuc			AgBWheat			OC			MARINE75			TireBrke		
N3IC	77.50	±	7.75	0.00	±	0.00	0.57	±	0.07	0.16	±	0.02	0.00	±	0.00	22.88	±	2.60	0.19	±	1.14
S4IC	0.00	±	0.00	72.70	±	7.27	1.30	±	0.83	0.44	±	0.04	0.00	±	0.00	7.20	±	0.82	0.78	±	2.10
N4CC	22.55	±	2.26	27.30	±	2.73	0.58	±	0.47	0.59	±	0.04	0.00	±	0.00	0.00	±	0.10	0.16	±	0.73
NAAC	0.00	±	0.00	0.00	±	0.00	0.38	±	0.15	0.54	±	0.04	0.00	±	0.00	28.80	±	3.27	0.10	±	0.42
KPAC	0.00	±	0.00	0.00	±	0.00	2.89	±	0.45	6.79	±	0.50	0.00	±	0.00	1.07	±	0.12	0.05	±	0.17
OCTC	0.00	±	0.00	0.00	±	0.00	59.58	±	4.75	57.03	±	4.54	100.00	±	10.00	0.00	±	0.10	18.81	±	24.53
ECTC	0.00	±	0.00	0.00	±	0.00	5.20	±	1.12	10.31	±	0.85	0.00	±	0.00	0.00	±	0.10	4.55	±	5.99
ALXC	0.00	±	0.00	0.00	±	0.00	0.07	±	0.05	0.07	±	0.01	0.00	±	0.00	0.00	±	0.00	0.32	±	1.89
SIXC	0.00	±	0.00	0.00	±	0.00	0.22	±	0.10	0.13	±	0.01	0.00	±	0.00	0.01	±	0.00	0.69	±	1.81
PHXC	0.00	±	0.00	0.00	±	0.00	0.00	±	0.01	0.00	±	0.01	0.00	±	0.00	0.00	±	0.00	0.00	±	0.05
CLXC	0.00	±	0.00	0.00	±	0.00	1.72	±	2.02	6.16	±	0.44	0.00	±	0.00	38.74	±	4.40	0.04	±	0.08
KPXC	0.00	±	0.00	0.00	±	0.00	2.86	±	0.93	5.50	±	0.39	0.00	±	0.00	1.07	±	0.12	0.10	±	0.36
CAXC	0.00	±	0.00	0.00	±	0.00	0.15	±	0.10	0.10	±	0.03	0.00	±	0.00	1.10	±	0.12	0.28	±	1.04
TIXC	0.00	±	0.00	0.00	±	0.00	0.01	±	0.02	0.01	±	0.01	0.00	±	0.00	0.00	±	0.00	0.03	±	0.38
MNXC	0.00	±	0.00	0.00	±	0.00	0.01	±	0.00	0.00	±	0.00	0.00	±	0.00	0.00	±	0.00	0.48	±	0.29
FEXC	0.00	±	0.00	0.00	±	0.00	0.09	±	0.06	0.07	±	0.00	0.00	±	0.00	0.00	±	0.00	58.11	±	31.26
CUXC	0.00	±	0.00	0.00	±	0.00	0.01	±	0.00	1.02	±	0.07	0.00	±	0.00	0.00	±	0.00	0.16	±	0.69
ZNXC	0.00	±	0.00	0.00	±	0.00	0.04	±	0.02	0.01	±	0.00	0.00	±	0.00	0.00	±	0.00	0.35	±	2.37
BRXC	0.00	±	0.00	0.00	±	0.00	0.00	±	0.00	0.03	±	0.00	0.00	±	0.00	0.18	±	0.02	0.00	±	0.01
RBXC	0.00	±	0.00	0.00	±	0.00	0.01	±	0.00	0.00	±	0.00	0.00	±	0.00	0.00	±	0.00	0.01	±	0.01
SRXC	0.00	±	0.00	0.00	±	0.00	0.00	±	0.00	0.00	±	0.00	0.00	±	0.00	0.02	±	0.00	0.23	±	0.66
PBXC	0.00	±	0.00	0.00	±	0.00	0.00	±	0.00	0.00	±	0.00	0.00	±	0.00	0.00	±	0.00	0.06	±	0.03
VAXC	0.00	±	0.00	0.00	±	0.00	0.00	±	0.00	0.00	±	0.00	0.00	±	0.00	0.00	±	0.00	0.00	±	0.00
NIXC	0.00	±	0.00	0.00	±	0.00	0.00	±	0.00	0.00	±	0.00	0.00	±	0.00	0.00	±	0.00	0.00	±	0.00

Table 3, continued.

PNO	79			80			83			84			66			67			85			86		
SOURCE	F6GASDIE			K6GASDIE			F9GASDIE			K9GASDIE			FDFREANN			FDKERANN			CHCRUC			SFCRUC		
N3IC	0.22	±	1.24	0.16	±	1.24	0.21	±	1.24	0.16	±	1.24	0.02	±	0.28	0.05	±	0.16	0.00	±	0.05	0.00	±	0.01
S4IC	2.77	±	7.25	2.60	±	7.25	2.74	±	7.25	2.61	±	7.25	0.56	±	0.72	0.47	±	0.29	14.72	±	6.24	20.32	±	4.24
N4CC	0.98	±	3.24	0.89	±	3.24	0.96	±	3.24	0.89	±	3.24	0.04	±	0.18	0.13	±	0.20	0.76	±	0.08	0.01	±	0.01
NAAC	0.00	±	0.00	0.00	±	0.00	0.00	±	0.00	0.00	±	0.00	0.17	±	0.07	0.26	±	0.24	0.25	±	0.06	0.76	±	0.40
KPAC	0.10	±	0.08	0.10	±	0.08	0.10	±	0.08	0.10	±	0.08	0.27	±	0.12	0.80	±	1.25	0.01	±	0.01	0.06	±	0.01
OCTC	43.05	±	27.33	42.40	±	27.33	42.93	±	27.33	42.41	±	27.33	14.34	±	8.66	10.29	±	5.32	1.99	±	1.33	0.09	±	0.12
ECTC	50.59	±	17.73	51.50	±	17.73	50.75	±	17.73	51.49	±	17.73	1.92	±	1.29	0.69	±	0.72	3.01	±	1.12	0.00	±	0.07
ALXC	0.11	±	0.14	0.11	±	0.14	0.11	±	0.14	0.11	±	0.14	9.97	±	2.95	7.67	±	2.53	0.00	±	0.05	0.00	±	0.01
SIXC	1.14	±	4.12	0.99	±	4.12	1.11	±	4.12	0.99	±	4.12	26.77	±	9.63	22.05	±	5.29	0.00	±	0.08	0.01	±	0.02
PHXC	0.14	±	0.51	0.13	±	0.51	0.14	±	0.51	0.13	±	0.51	0.33	±	0.91	0.33	±	0.91	0.00	±	0.57	0.00	±	0.17
CLXC	0.07	±	0.30	0.06	±	0.30	0.07	±	0.30	0.06	±	0.30	0.11	±	0.08	0.46	±	0.48	0.05	±	0.01	0.02	±	0.00
KPXC	0.07	±	0.08	0.07	±	0.08	0.07	±	0.08	0.07	±	0.08	2.30	±	0.92	3.26	±	1.59	0.00	±	0.00	0.04	±	0.01
CAXC	0.50	±	1.42	0.49	±	1.42	0.50	±	1.42	0.49	±	1.42	3.01	±	0.67	5.54	±	3.03	0.00	±	0.03	0.06	±	0.00
TIXC	0.01	±	0.08	0.01	±	0.08	0.01	±	0.08	0.01	±	0.08	0.48	±	0.05	0.44	±	0.24	0.01	±	0.00	0.01	±	0.00
MNXC	0.00	±	0.01	0.00	±	0.01	0.00	±	0.01	0.00	±	0.01	0.11	±	0.02	0.11	±	0.08	0.00	±	0.00	0.01	±	0.00
FEXC	0.44	±	0.44	0.44	±	0.44	0.44	±	0.44	0.44	±	0.44	5.30	±	0.58	5.09	±	2.84	0.71	±	0.09	0.21	±	0.02
CUXC	0.01	±	0.05	0.01	±	0.05	0.01	±	0.05	0.01	±	0.05	0.02	±	0.00	0.01	±	0.01	0.01	±	0.01	0.00	±	0.00
ZNXC	0.27	±	0.41	0.26	±	0.41	0.27	±	0.41	0.26	±	0.41	0.14	±	0.08	0.07	±	0.05	0.01	±	0.00	0.26	±	0.03
BRXC	0.03	±	0.06	0.03	±	0.06	0.03	±	0.06	0.03	±	0.06	0.01	±	0.00	0.00	±	0.00	0.00	±	0.00	0.00	±	0.00
RBXC	0.00	±	0.00	0.00	±	0.00	0.00	±	0.00	0.00	±	0.00	0.01	±	0.00	0.01	±	0.00	0.00	±	0.00	0.00	±	0.00
SRXC	0.00	±	0.00	0.00	±	0.00	0.00	±	0.00	0.00	±	0.00	0.03	±	0.01	0.03	±	0.01	0.00	±	0.00	0.00	±	0.00
PBXC	0.01	±	0.03	0.01	±	0.03	0.01	±	0.03	0.01	±	0.03	0.18	±	0.13	0.09	±	0.32	0.00	±	0.00	0.00	±	0.00
VAXC	0.00	±	0.00	0.00	±	0.00	0.00	±	0.00	0.00	±	0.00	0.00	±	0.00	0.00	±	0.00	0.42	±	0.04	0.82	±	0.06
NIXC	0.00	±	0.00	0.00	±	0.00	0.00	±	0.00	0.00	±	0.00	0.00	±	0.00	0.00	±	0.00	2.48	±	0.25	0.79	±	0.09

Biomass burning was represented using an agricultural burning profile (AgBWheat) from June through October and a composite residential wood burning profile (WBOakEuc) the rest of the year. The agricultural burning profile (AgBWheat) was based on burning of wheat stubble (Fitz et al., 2000). The residential wood burning profile (WBOakEuc) was used to represent residential wood combustion during colder months and was calculated as an average of oak and eucalyptus.

Geological material in the San Joaquin Valley comes from a variety of sources, including roads (paved and unpaved), agricultural operations such as land preparation and harvesting, construction, and soil erosion. The Central California Fugitive Dust Characterization Study acquired 47 samples from 37 areas (Chow et al., 2003). These included: 1) paved road dust from urban and rural areas, 2) unpaved road dust, 3) agricultural soil from five crop fields (almond, cotton, grape, safflower, and tomato), 4) dairy and feedlot soil, 5) salt buildup deposits from irrigation canal drainages, and 6) building construction/earthmoving soil.

In addition to these latest profiles, some older soil profiles collected in the Valley in the late 80's were also used to create composite profiles that best represent fugitive dust sources at each site in the San Joaquin Valley. Information on the relative fractions of paved and unpaved road dust, as well as agricultural dust, along with information on the seasonality of agricultural operations and predominant crop types were used to determine which source profiles to include in each composite. Site specific composite profiles were then used in the CMB analysis. Table 3 lists geological profiles included in the composites created for modeling PM2.5 concentrations. Appendix A includes additional information about geological profiles.

Table 4. Geological Composite Source Profiles

Composite Profile ID	Sample ID	% Weight	Applicable Area
FDKERANN	SOIL31	25	Bakersfield
	FDPVR1	25	
	FDCTF	25	
	SOIL13	25	
FDFREANN	SOIL03	70	Fresno
	FDALM	10	
	FDGRA1	10	
	FDTOM1	10	

Sea salt was represented using a reacted sea salt profile, MARINE75, in which 25 percent of the Cl was replaced by nitrate on a molar basis (Chow et al., 1996a).

Tire and brake samples were collected as part of the 'Development of a Gas and Particulate Matter Organic Speciation Profile Database' conducted by CE-CERT (Fitz et al., 2000). Tire and brake samples were composited into a single weighted average profile. The two profiles were weighted based on EMFAC 2011 emissions, which estimate a 9 to 1 ratio of brake emissions to tire emissions.

Secondary nitrate and sulfate were represented by pure ammonium nitrate (NH_4NO_3) and ammonium sulfate $(NH_4)_2SO_4$. A "pure" OC profile was used to represent other unidentified primary sources, contributions from secondary OC, and the possible positive OC sampling artifacts.

Crude-oil combustion profiles were included to help explain ambient concentrations of vanadium (V) and nickel (Ni). The profile representing the Santa Fe crude-oil broiler at the Westside Kern County oil field helped to explain vanadium and nickel concentrations at Bakersfield, while the crude-oil profile representing the Chevron Racetrack boiler at the Kern River oil field provided a better fit at Fresno.

4) Fitting Species

Table 5 lists fitting species used in CMB runs.

Table 5. CMB Fitting Species

Nitrate	Silicon	Zinc
Sulfate	Chlorine	Bromine
Ammonium	Potassium	Rubidium
Soluble Sodium	Calcium	Strontium
Soluble Potassium	Titanium	Lead
Organic Carbon	Manganese	Vanadium
Elemental Carbon	Iron	Nickel
Aluminum	Copper	

5) Runs

PM2.5 chemical composition data were collected on a one in three days schedule at each site. Table 6 shows the number of samples included under each scenario.

Table 6. Number of Samples included in the CMB Runs

Site	Old Carbon	New Carbon
BAC	157	267
FSF	390	200

Data for each sampling day were run individually under several scenarios. Each run included the following profiles: ammonium nitrate, ammonium sulfate, motor vehicle, fugitive dust, tire and brake wear, marine, and in the case of Bakersfield, crude oil combustion. In the case of Fresno, the crude oil combustion profile was included only when it was necessary to explain the vanadium and nickel contributions. Biomass burning and 'other OC' profiles were included as needed. First, all data were run with a biomass burning profile (AgBWheat from June through October, WBoakEuc the rest of the year) and the 'other OC'. The results were examined to determine if all source contributions were positive and performance parameters were within acceptable ranges. If using the biomass burning profile along with the 'other OC' gave unsatisfactory results, the data were run again using just one of the two profiles, as described below.

1. Run 1 included a biomass burning profile and 'other OC'.
2. Run 2 included a biomass burning profile but not the 'other OC' profile. It was geared towards days when primary sources of organic carbon (biomass burning, motor vehicle exhaust, and geological material) sufficiently accounted for the ambient organic carbon.
3. Run 3 included 'other OC' but no biomass burning profile. It was geared towards days with no biomass burning and applied only when soluble potassium concentration was reported as zero.

Data from several runs were combined into a single data file to best represent source contributions. Data were combined as follows:

1. Days with estimated positive contributions from wood burning and 'other OC' were included in the composite file.
2. Days with estimated negative contributions from 'Other OC' were treated as follows:
    a. If there should have been no burning on that day because the soluble potassium concentration was zero, run 3 which includes the 'other OC' and no wood burning was utilized.
    b. If there could have been wood burning because the soluble potassium concentration was greater than zero, run 2 which includes biomass burning was used.
3. Occasionally, the results were still unsatisfactory and profiles were adjusted individually for a particular day.

Composite files were used for subsequent analysis. Table 7 shows the number of data points from each run included in the composite file.

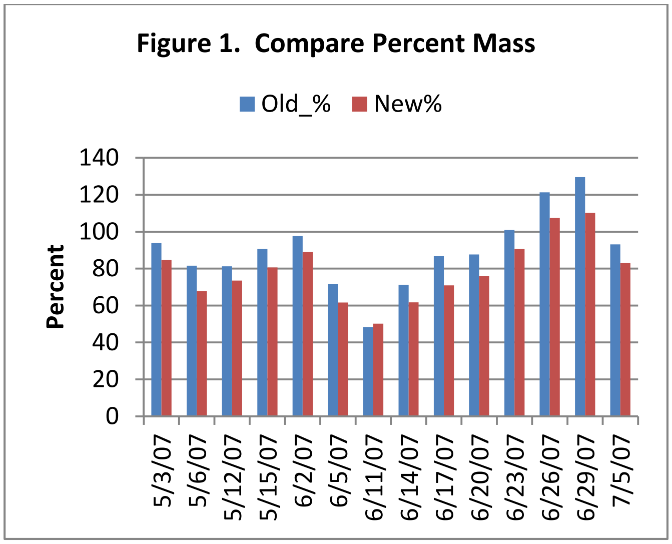
Table 7. Data included in the composite file*.

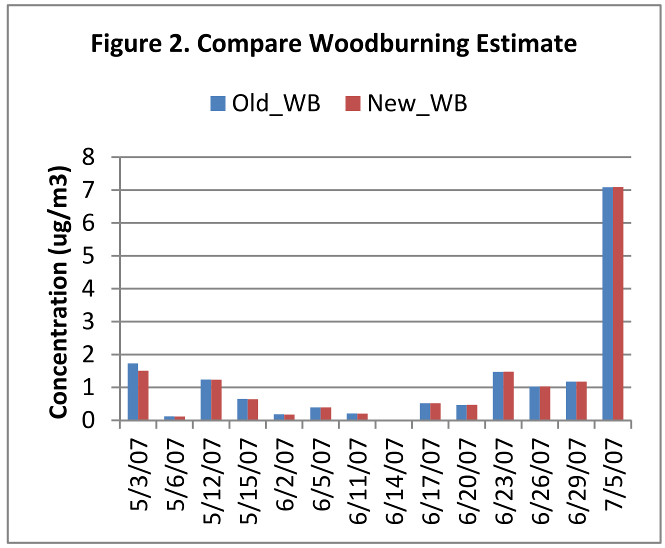
Site	Carbon Type	Run 1		Run2	Run 3	Special Run
		WBOakEuc	AgBWheat			
BAC	Old	68	41	4	16	5
BAC	New	80	113	28	12	0
FSF	Old	176	105	7	40	9
FSF	New	52	66	21	56	6

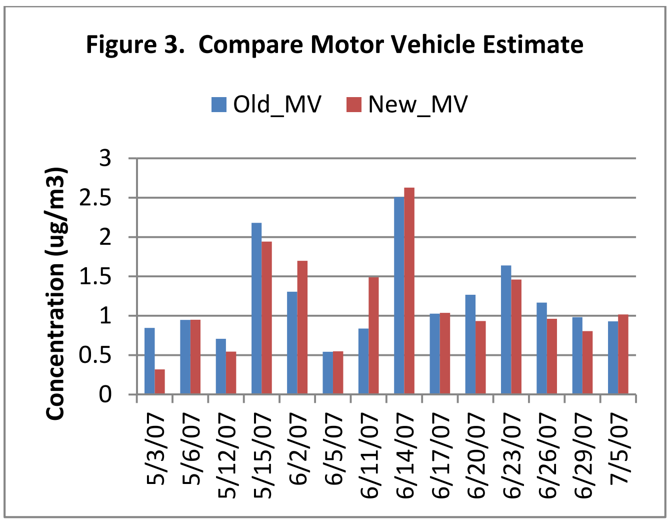
* Data with performance measures far exceeding the acceptable criteria were not included in the composite

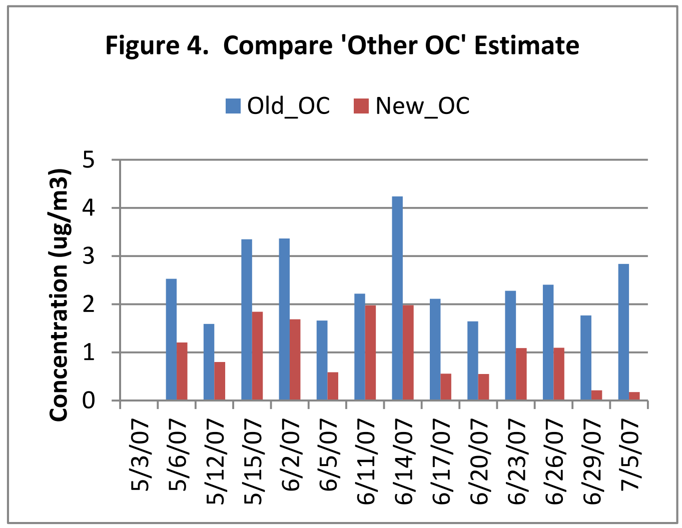
6) Comparison of CMB Estimates using Old and New Carbon

The Bakersfield-California site has 14 days with parallel old and new carbon data. Since these data were collected during the low season, the average PM2.5 concentration was only 13.6 ug/m3. The CMB model was applied to the old and new carbon data to evaluate the impact of changing carbon collection and analysis on source contribution. Using the old carbon, 10 percent more of the mass was apportioned to sources. Regardless of what carbon data were used, the model apportioned almost the same concentration to each source, except ‘other OC’. Using the old carbon data, on average, 2.5 ug/m3 was assigned to the ‘other OC’. Switching to the new carbon data reduced the ‘other OC’ estimate to 1 ug/m3. There were also several days when the motor vehicle contribution estimate differed slightly depending on which carbon data were used. Even though, on average there is no difference in measured EC between the old and new carbon method, on these particular days the measurements differed and that difference was reflected in the motor vehicle contribution. The new OC measurement is, on average, about 50 percent lower compared to the old one. This impacts how much mass gets apportioned to the ‘other OC’ but has no impact on motor vehicle or biomass burning contributions. Figures 1 through 4 compare percent of mass and contribution from major carbon sources using old and new carbon data.









7) Results

The CMB model was applied to 424 samples at BAC (157 with old carbon and 267 with new carbon) and 590 samples at FSF (390 with old carbon and 200 with new). Source contribution estimates were averaged to determine a typical contribution. Separately, days with concentrations greater than 30 ug/m3 were averaged to determine the typical contribution on a high PM2.5 day.

Performance measures and statistics used to evaluate the validity of CMB source apportionments include chi-square, r-square, and percent of mass accounted for by the estimated source contributions. The target values for these performance measures are chi-square less than 4, r-square greater than 0.8, and percent of mass accounted for by the estimated source contributions between 80% and 120%. The average performance measures for both sites were within the acceptable limits as shown in Tables 8 and 10.

The results are discussed separately for each site for two reasons. First of all, each site switched to the new method at a different time. Second of all, 2009 had to be excluded from the annual average calculation at Bakersfield due to missing data.

a) Bakersfield (BAC)

The average PM2.5 concentration based on old carbon data for 2006 was 20.5 ug/m3. Based on the new carbon data, the 2008 and 2010 average PM2.5 concentration was 18.6 ug/m3. Between 2006 and 2007 (old carbon data) there were 29 high days with chemical composition data. The average PM2.5 concentration on these days was 47 ug/m3,. Between 2007 and 2010 (new carbon data), there were 36 high days with chemical composition data, with the average PM2.5 concentration of 46.7 ug/m3. Sources identified by the CMB accounted for 79 to 94 percent on annual basis and 94 to 95 percent on high days.

i) Annual

Ammonium nitrate dominated the PM2.5 mass contributing 42 to 47 percent of mass. Ammonium sulfate and biomass burning were the next most important sources contributing 10 to 12 percent of mass. Biomass burning contributed 9 to 10 to percent of the mass. The ‘Other OC’ contribution depended on the carbon data method; using old carbon apportioned 16 percent of mass to the ‘other OC’ while using new carbon reduced that contribution to 8 percent. Geological material comprised 7 to 10 percent of the mass. Each of the remaining sources (tire and brake wear, sea salt, and oil combustion) contributed no more than 1 percent of the mass.

ii) High Days

The ammonium nitrate contribution was even more significant on high days, ranging from 59 to 67 percent. Biomass burning and motor vehicles each contributed 9 to 13 percent. The ‘Other OC’ contribution ranged from 3 percent using new carbon to 10 percent using old carbon. Geological material contributed about 2 percent. Each of the remaining sources, tire and brake wear, sea salt, and oil combustion contributed less than 1 percent of the mass.

b) Fresno (FSF)

The average PM2.5 concentration based on old carbon data for 2006 to 2008 was 20.3 ug/m3. Based on the new carbon data, the 2010 average PM2.5 concentration was 14.2 ug/m3. Between 2006 and 2009 (old carbon data) there were 67 high days with chemical composition data. The average PM2.5 concentration on these days was 46.3 ug/m3. Between 2009 and 2010 (new carbon data), there were 22 high days with chemical composition data, with the average concentration of 40.6 ug/m3. Sources identified by the CMB accounted for 74 to 97 percent of the mass on an annual basis and 82 to 93 percent on high days.

i) Annual

Ammonium nitrate dominated the PM2.5 mass contributing 40 to 43 percent of the mass. Biomass burning contributed about 16 percent of the mass. Motor vehicles contributed slightly less, 11 to 13 percent. The ammonium sulfate contribution was 9 to 11 percent. The ‘Other OC’ contribution, once again, depended on carbon data; using old carbon apportioned 18 percent of mass to the ‘other OC’ while using new carbon reduced that contribution to 9 percent. Geological material comprised 4 to 6 percent of the mass. Each of the remaining sources contributed no more than 1 percent of the mass.

ii) High Days

The ammonium nitrate contribution was even more significant on high days when 52 to 54 percent of the mass was ammonium nitrate. Biomass burning was the second most significant source, contributing 19 to 23 percent. The motor vehicle contribution ranged from 9 to 12 percent. The ‘Other OC’ ranged from 4 percent using new carbon data to 13 percent using old carbon data. The remaining sources contributed less than 1 percent of the mass.

Table 8. BAC Source Contribution (ug/m3)

Source	Profile Name	Annual Average 2006			Annual Average 2008 and 2010			High Days (>=30 ug/m3) 2006-2007			High Days (>=30 ug/m3) 2007-2010		
# of samples	Obs Count	90			138			29			36		
Mconc	Mconc	20.5	±	1.1	18.6	±	1.0	47.0	±	2.4	46.7	±	2.4
Cconc	Cconc	19.4	±	1.5	15.6	±	1.2	45.0	±	3.1	43.9	±	3.1
Rsquare	Rsquare	0.9			0.9			0.9			0.9		
CHIsquare	CHIsquare	3.1			2.7			1.8			1.4		
%MASS	%MASS	94.3			79.3			95.5			93.8		
AMNIT	AMNIT	8.2	±	0.8	7.4	±	0.7	26.7	±	2.5	29.6	±	2.5
AMSUL	AMSUL	2.0	±	0.6	1.9	±	0.5	2.5	±	1.2	3.4	±	1.3
Biomass burning	Seasonal*	1.9	±	0.4	1.5	±	0.3	5.7	±	1.0	4.0	±	0.7
Motor Vehicle	K9GASDI**	2.4	±	1.0	1.9	±	0.6	4.2	±	1.6	4.2	±	1.4
OC	OC	3.2	±	1.1	1.2	±	0.7	4.3	±	1.7	1.3	±	1.2
Tire and Brake	TireBrk	0.2	±	0.1	0.2	±	0.1	0.3	±	0.2	0.3	±	0.2
Sea Salt	MARINE75	0.1	±	0.1	0.1	±	0.1	0.3	±	0.1	0.2	±	0.1
Geological	FDKERANN	1.3	±	0.3	1.6	±	0.3	0.7	±	0.3	0.8	±	0.3
Oil Refinery	SFCRUC	0.3	±	0.1	0.1	±	0.1	0.3	±	0.3	0.2	±	0.3

Table 9. BAC Source Contribution (%)

Source	Profile Name	Annual Average 2006	Annual Average 2008 and 2010	High Days (>=30 ug/m3) 2006-2007	High Days (>=30 ug/m3) 2007-2010
# of samples	Obs Count	90	138	29	36
AMNIT	AMNIT	42.2	46.8	59.3	67.4
AMSUL	AMSUL	10.2	11.9	5.6	7.8
Biomass burning	Seasonal*	9.6	9.3	12.8	9.1
Motor Vehicle	KGASDI**	12.3	11.8	9.3	9.6
OC	OC	16.2	7.7	9.5	2.9
Tire and Brake	TireBrk	1.0	1.3	0.7	0.7
Sea Salt	MARINE75	0.4	0.5	0.6	0.5
Geological	FDKERANN	6.7	10.3	1.6	1.7
Oil Refinery	SFCRUC	1.3	0.5	0.6	0.3

* AgBWheat from June through October, WBoakEuc the rest of the year
** K6GASDIE for old carbon and K9GASDIE for new carbon

Figure 5. BAC 2006 Average Old Carbon

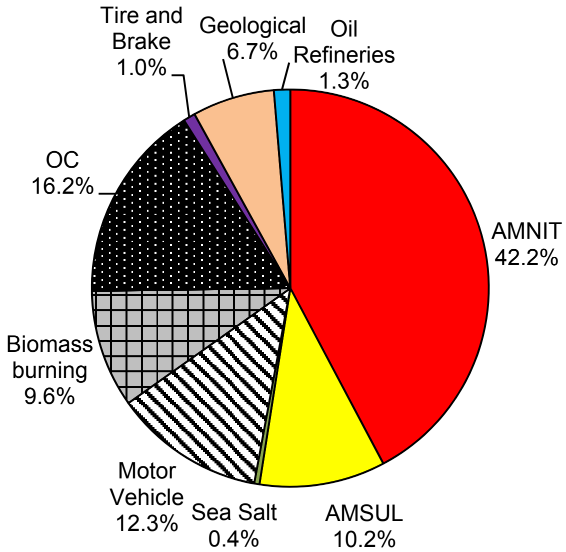


Figure 6. BAC 2008 and 2010 Average New Carbon

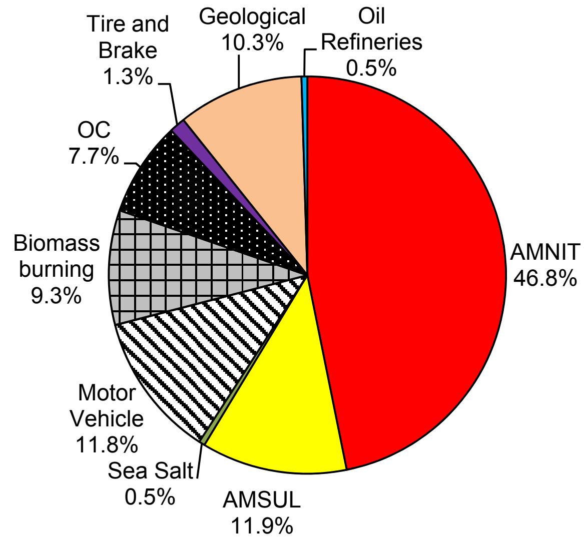


Figure 7. BAC Average High Day Old Carbon (2006-2007)

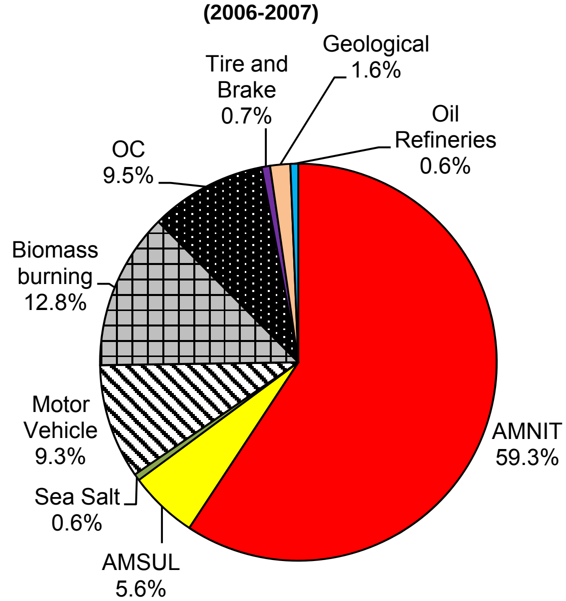


Figure 8. BAC Average High Day New Carbon (2007-2010)

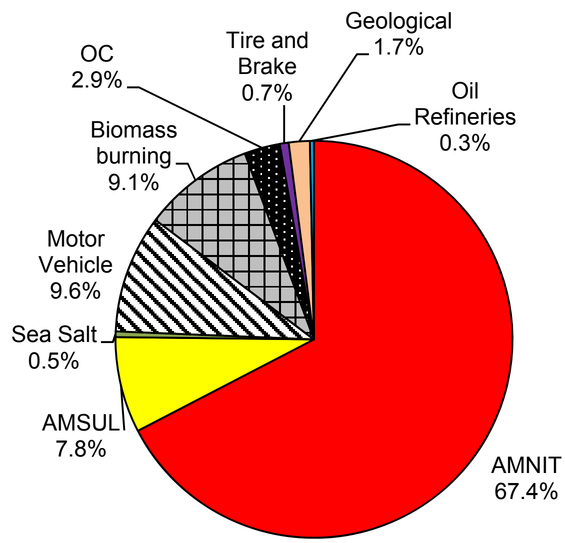


Table 10. FSF Source Contribution (ug/m3)

Source	Profile Name	Annual Average 2006-2008			Annual Average 2010			High Days (>=30 ug/m3) 2006-2009			High Days (>=30 ug/m3) 2009-2010		
# of samples	Obs Count	275			105			67			22		
Mconc	Mconc	20.3	±	1.1	14.2	±	0.8	46.3	±	2.3	40.6	±	2.1
Cconc	Cconc	19.0	±	1.5	10.8	±	0.8	43.0	±	2.9	33.1	±	2.3
Rsquare	Rsquare	0.8			0.9			0.9			0.9		
CHIsquare	CHIsquare	4.3			3.5			1.7			1.4		
%MASS	%MASS	96.7			74.3			92.9			81.5		
AMNIT	AMNIT	7.5	±	0.7	4.7	±	0.5	22.4	±	2.1	17.8	±	1.7
AMSUL	AMSUL	1.7	±	0.5	1.2	±	0.4	2.1	±	1.1	2.0	±	1.0
Biomass burning	Seasonal*	3.1	±	0.5	1.7	±	0.3	8.0	±	1.2	7.6	±	1.1
Motor Vehicle	FGASDI**	2.1	±	0.9	1.4	±	0.5	4.0	±	1.5	3.8	±	1.3
OC	OC	3.3	±	1.1	1.0	±	0.5	5.7	±	2.0	1.5	±	1.3
Tire and Brake	TireBrk	0.1	±	0.1	0.1	±	0.1	0.2	±	0.1	0.2	±	0.1
Sea Salt	MARINE75	0.1	±	0.1	0.1	±	0.1	0.2	±	0.2	0.2	±	0.2
Geological	FDFREANN	0.8	±	0.2	0.6	±	0.1	0.2	±	0.2	0.1	±	0.1
Oil Combustion	CHCRUC	0.01	±	0.0				0.1	±	0.0	0.0	±	0.0

Table 11. FSF Source Contribution (%)

Source	Profile Name	Annual Average 2006-2008	Annual Average 2010	High Days (>=30 ug/m3) 2006-2009	High Days (>=30 ug/m3) 2009-2010
# of samples	Obs Count	275	105	67	22
AMNIT	AMNIT	40.0	43.2	52.0	53.6
AMSUL	AMSUL	9.1	11.4	4.9	6.0
Biomass burning	WBOakEuc	16.5	15.7	18.7	22.9
Motor Vehicle	F9GASDI	11.1	13.3	9.3	11.5
OC	OC	17.5	9.2	13.4	4.4
Tire and Brake	TireBrk	0.8	0.8	0.5	0.5
Sea Salt	MARINE75	0.6	0.9	0.5	0.7
Geological	FDFREANN	4.2	5.6	0.5	0.3
Oil Combustion	CHCRUC	0.1	0.0	0.1	0.0

* AgBWheat from June through October, WBoakEuc the rest of the year
** F6GASDIE for old carbon and F9GASDIE for new carbon

Figure 9. FSF 2006-2008 Average Old Carbon

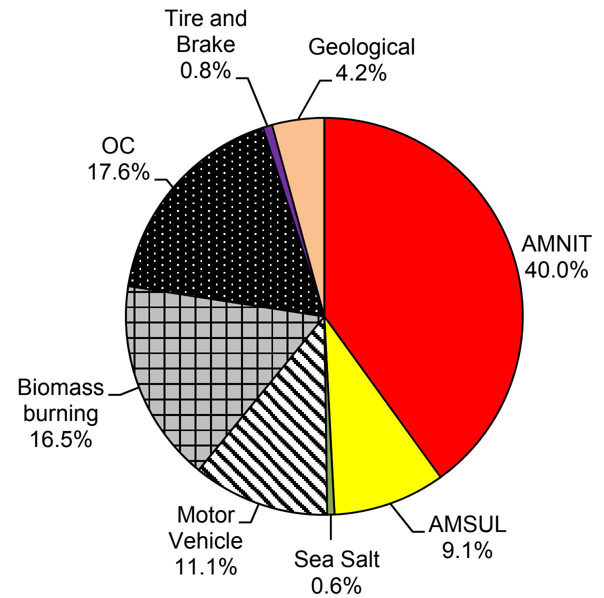


Figure 10. FSF 2010 Average New Carbon

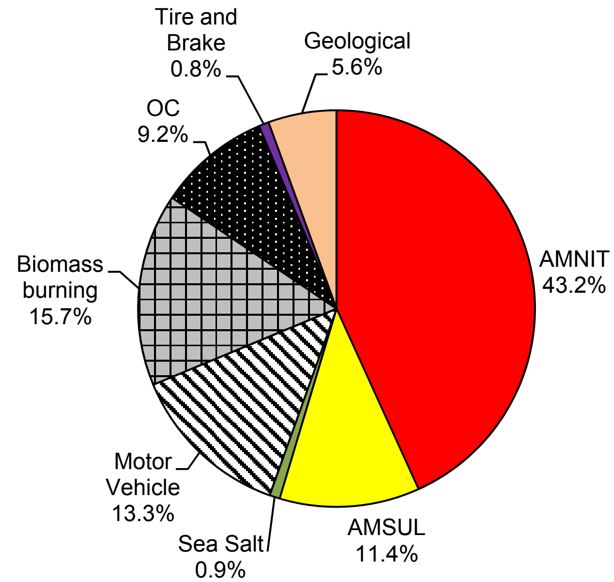


Figure 11. FSF Average High Day Old Carbon (2006-2009)

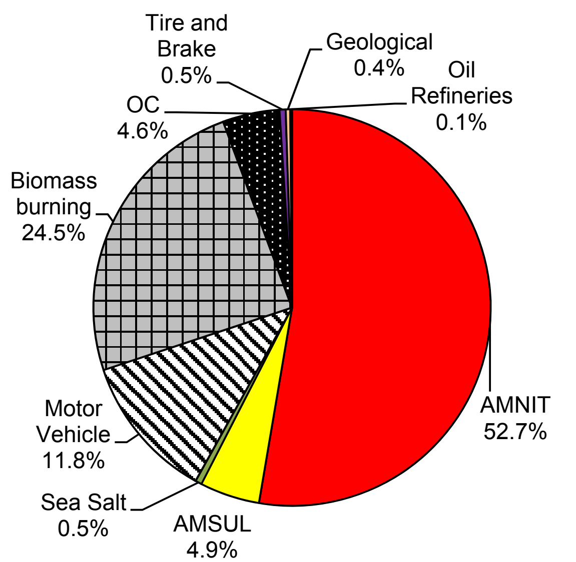
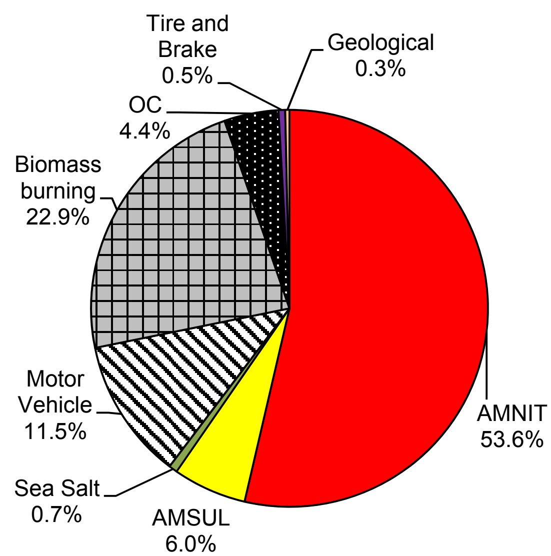


Figure 12. FSF Average High Day New Carbon (2009-2010)



Contributions on individual exceedance days are illustrated in Figures 13 through 16. The highest contribution from each source is also summarized in Tables 10 and 11.

Figure 13. PM2.5 Source Contribution on High Days 2006-2007
Bakersfield, Old Carbon

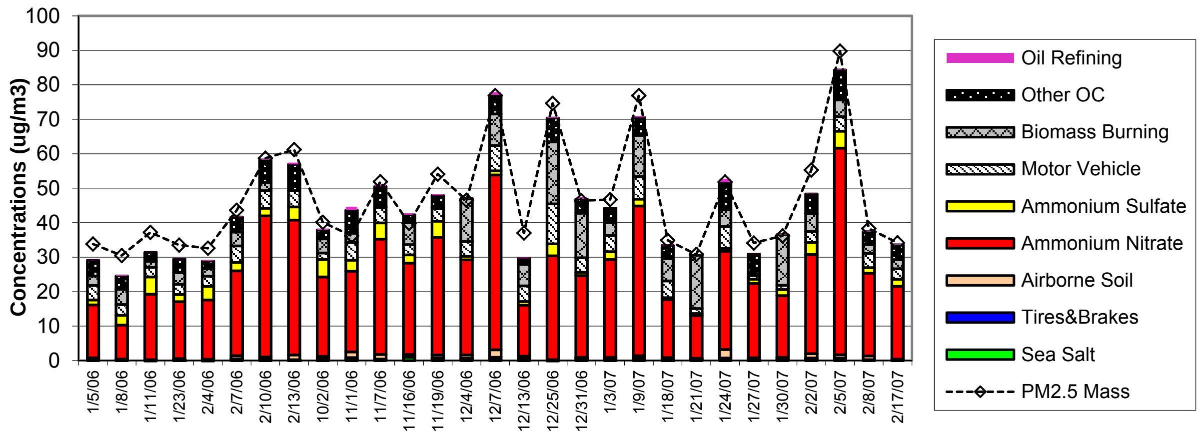


Figure 14. PM2.5 Source Contribution on High Days 2007-2010
Bakersfield, New Carbon

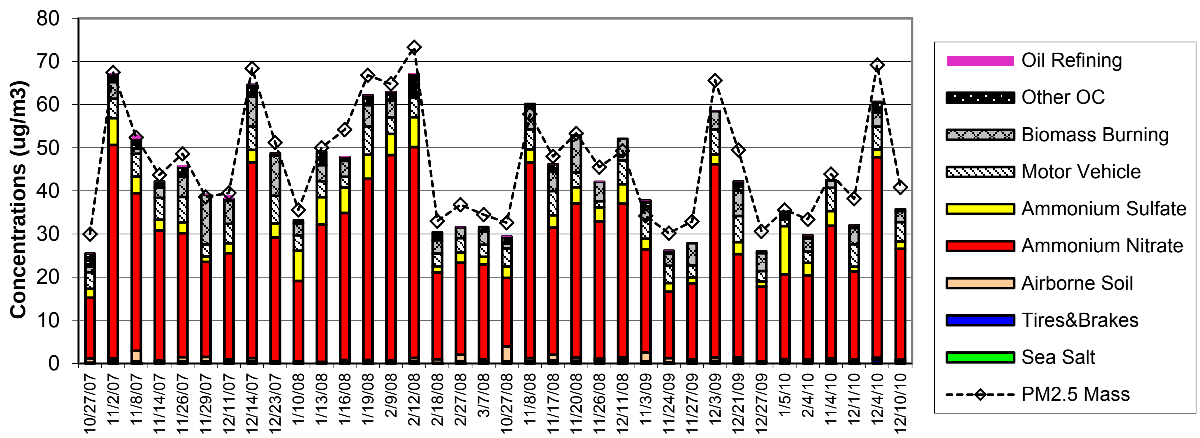


Figure 15. PM2.5 Source Contribution on High Days 2006-2009
Fresno, Old Carbon

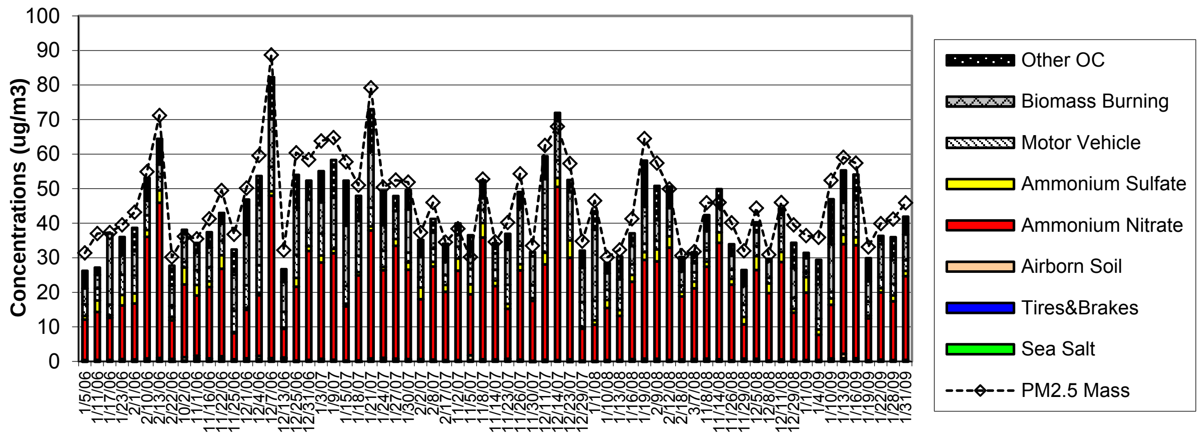


Figure 16. PM2.5 Source Contribution on High Days 2009-2010
Fresno, New Carbon

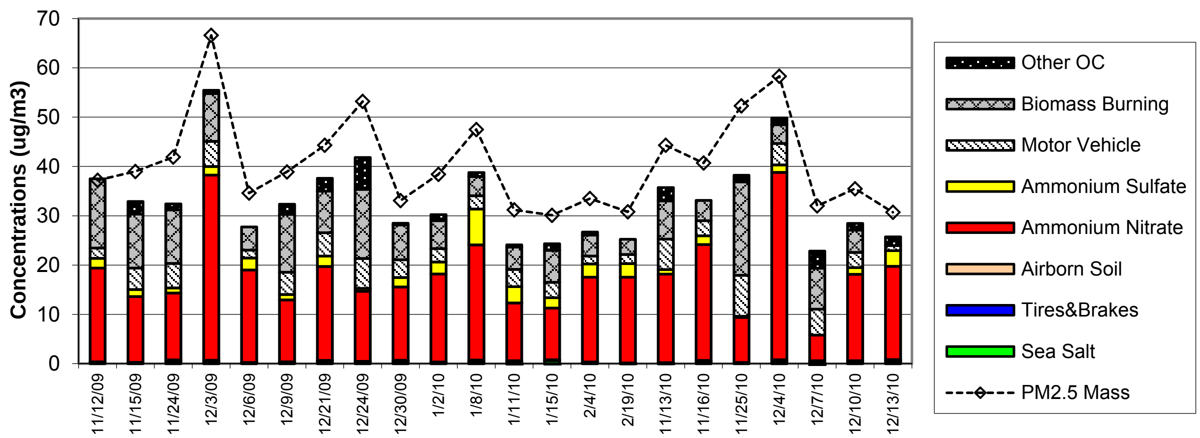


Table 12. BAC Highest Contribution by Source

Source	Old Carbon		New Carbon	
	Contribution (ug/m3)	Date	Contribution (ug/m3)	Date
Ammonium Nitrate	60	2/5/07	50	2/12/08
Ammonium Sulfate	5	10/2/06	11	1/5/10
Biomass Burning	18	12/25/06	12	11/29/07
Motor Vehicle	12	12/25/06	7	1/19/08
Other OC	9	2/5/07	5	2/12/08
Tire & Brake	0.6	1/24/07	0.8	12/4/10
Sea Salt	1	11/16/06	0.7	11/26/08
Geological	2.5	11/24/07	2.5	11/8/07
Oil Combustion	1	11/24/07	1	11/8/07

Table 13. FSF Highest Contribution by Source

Source	Old Carbon		New Carbon	
	Contribution (ug/m3)	Date	Contribution (ug/m3)	Date
Ammonium Nitrate	50	12/14/07	38	12/4/10
Ammonium Sulfate	5	12/23/07	7	1/8/10
Biomass Burning	21	1/1/08	19	11/25/10
Motor Vehicle	8	12/4/06	8	11/25/10
Other OC	13	1/19/08	6	12/24/09
Tire & Brake	0.6	12/7/06	0.4	11/24/09
Sea Salt	0.6	2/9/08	0.4	12/10/10
Geological	1.4	11/8/07	0.6	12/4/10
Oil Combustion	2	2/8/07		

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Fujita. E. M., Campbell, D., Zielinska, B., and Chow, J. C.: Kansas City PM Characterization Study, Round 1 Testing Report – Addendum A, Chemical Speciation, prepared for the U.S. Environmental Protection Agency, Desert Research Institute, Reno, NV, 2005.

Appendix A

Summary of Geological Profiles Used in CMB Modeling

Source Type	Subtype	County	Sample ID	Source
FDKERANN				
Agricultural Soil		Kern	Soil 31	Houck, et al, 1989
Paved Road	Urban	Kern	FDPVR1	Central California Fugitive Dust Study
Animal Husbandry	Feedlot (Composite)	Kern&Fresno	FDCTF	
Unpaved Road Dust	Unpaved Parking lot	Kern	Soil 13	Houck, et al, 1989
FDFREANN				
Paved Road		Fresno	Soil 03	Houck, et al, 1989
Agricultural Soil	Almonds (Composite)	Kern, Fresno, King, and Madera	FDALM	Central California Fugitive Dust Study
Agricultural Soil	Grapes	Fresno	FDGRA1	
Agricultural Soil	Tomato (Composite)	Fresno	FDTOM1	

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San Joaquin Valley PM2.5 Weight of Evidence Analysis

Appendix 3

Source Apportionment of PM2.5 Measured at the Fresno and Bakersfield Chemical Speciation Network Sites in San Joaquin Valley Using the Positive Matrix Factorization Model

Source Apportionment of $PM_{2.5}$ Measured at the Fresno and Bakersfield Chemical Speciation Network Sites in San Joaquin Valley Using the Positive Matrix Factorization Model

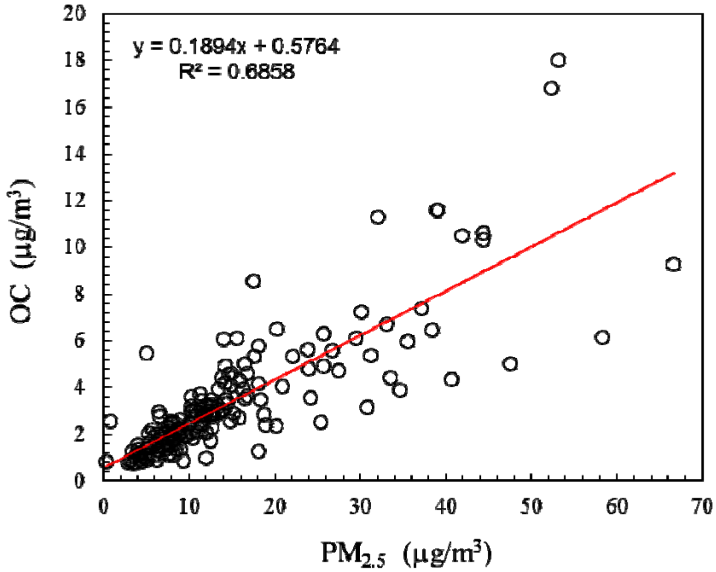
Sample Collection and Data Screening

$PM_{2.5}$ chemical speciation samples were collected on a one-in-three day schedule at the Fresno-First St. and Bakersfield-California Ave. Chemical Speciation Network (CSN) monitoring sites located in the San Joaquin Valley (SJV). There were good agreements between $PM_{2.5}$ data collected by the speciation samplers and the collocated Federal Reference Method (FRM) samplers in matched Fresno data (*340 samples, slope* = 1.00, *Intercept* = 1.08, r^2 = 0.97) and Bakersfield (*175 samples, slope* = 0.94, *Intercept* = 0.92, r^2 = 0.94) between 2008 and 2010.

The Thermal Optical Transmittance (TOT) protocol had been used to analyze carbon mass collected on the quartz filters. This method was changed to the Thermal Optical Reflectance (TOR) protocol and TOR organic carbon (OC) and elemental carbon (EC) concentrations were available starting from January 2008 and April 2009 at the Bakersfield and Fresno monitoring sites, respectively. Only the speciation data for which TOR OC and EC concentrations were available were considered in this source apportionment study.

Since a carbon denuder that minimizes the positive sampling artifact caused by adsorption of gaseous organic materials was not included upstream of quartz filter in the CSN samplers, and none of the reported CSN data were blank corrected, an integrated OC artifact concentration that includes OC adsorption and desorption was estimated utilizing the intercept of the regression of OC concentrations against $PM_{2.5}$ mass concentrations (Tolocka et al. 2001, Kim et al. 2005). Samples for which $PM_{2.5}$ or OC concentrations had an error flag and samples for which the $PM_{2.5}$ or OC data were not available were excluded from the regression analysis between $PM_{2.5}$ and OC concentrations. Comparing co-located $PM_{2.5}$ data measured by CSN and FRM samplers, and comparing $PM_{2.5}$ and Sulfur (S) concentrations, outliers were censored for the two data sets. Using 189 data points out of 353 data points between 2009 and 2010 at Fresno and 187 data points out of 192 data points at Bakersfield between 2008 and 2010, the intercept s of 0.576 $\mu g/m^3$ and 1.480 $\mu g/m^3$ in $PM_{2.5}$ regression against OC concentrations are considered to be the integrated OC artifact concentrations at Fresno and Bakersfield, respectively (Figure 1). The OC concentrations analyzed in this study were corrected by subtracting the integrated OC artifact concentrations.

Fresno-First St.



Bakersfield-California Ave.

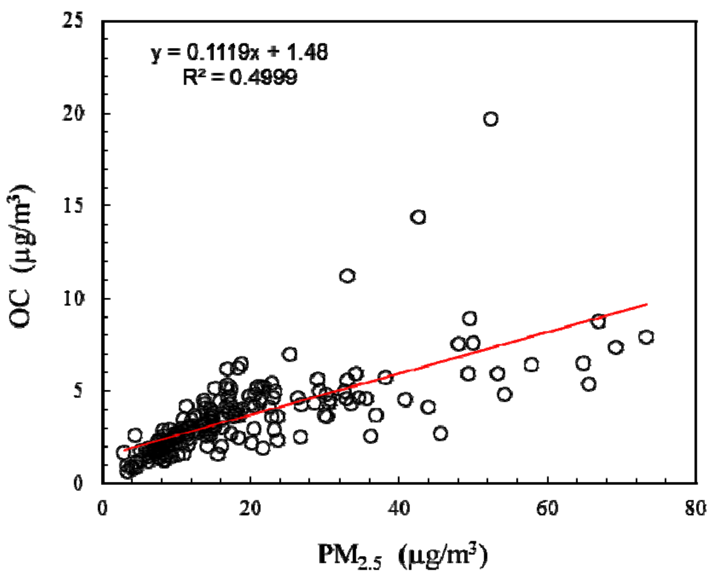


Figure 1. OC artifact estimations: $PM_{2.5}$ concentrations versus OC concentrations.

The Positive matrix factorization model version 2 (PMF2) model was used for the source apportionment of $PM_{2.5}$ at the Fresno and Bakersfield monitoring sites. Samples were excluded from the data set for which the $PM_{2.5}$, artifact corrected OC, or EC data were not available or below zero, or for which $PM_{2.5}$ artifact corrected OC, or EC had an error flag. Samples for which the sum of all measured species were larger than twice the $PM_{2.5}$ concentrations or the sum of all measured species were less than 50% of $PM_{2.5}$ concentrations were also excluded. Finally, samples that contain fireworks particles collected on Independence Day and New Year's Day were excluded since they had unusually high concentrations of OC, EC, K^+, Na^+ and metals. Overall, 10.3% of the Fresno data and 16.5% of the Bakersfield data were excluded in this study.

For the chemical species screening, X-Ray Fluorescence (XRF) S was excluded from the analyses to prevent double counting of mass concentrations. Due to the higher analytical precision compared to XRF Na and XRF K, IC Na^+ and IC K^+ were included in the analyses. Chemical species below MDL values more than 90% were excluded. As recommended by Paatero and Hopke (2003), the species that had a Signal-to-Noise (*S/N*) ratio below 0.2 were excluded. Thus, a total of 174 samples and 21 species including $PM_{2.5}$ mass concentrations collected between April 2009 and December 2010 were used for the Fresno site. For the Bakersfield site, a total of 147 samples and 24 species including $PM_{2.5}$ mass concentrations collected between January 2008 and December 2010 were used. Since new TOR OC and EC concentrations were not accompanied by detection limit and uncertainty values, a comprehensive set of uncertainty structure (i.e., 7% of measured concentration) estimated by Kim et al. (2005) and 0.1 $\mu g/m^3$ of detection limit value estimated from the State and Local Air Monitoring Stations (SLAM) speciation data were used in this study. Summaries of $PM_{2.5}$ speciation data are provided in Tables A1 and A2 in the Appendix.

The procedure of Polissar et al. (1998) was used to assign input data for PMF2. The measurement values are used for the input concentration data, and the sum of the analytical uncertainty and one-third of the detection limit value is used as the input uncertainty data assigned to each measured value. Concentration values below the detection limit are replaced by half of the detection limit values, and their input uncertainties are set at five-sixth of the detection limit values. Missing values are replaced by the geometric mean of the measured values for each species. To down-weight these replaced data and then to reduce their influence on the solution, their accompanying uncertainties are set at four times the geometric mean value. The conditional probability function (CPF) analysis was used to estimate the possible directions of the local source impacts (Kim and Hopke, 2004). The CPF was calculated for each source using the PMF2 source contributions coupled with wind data. As recommended by Paatero and Hopke (2003), which is to down-weight the variable in the analysis so that the noise does not compromise the solution, it was found necessary to increase the input uncertainties of OC, EC, and Cl by a factor of 3 for the Fresno data and OC and Na^+ by a factor of 3 for the Bakersfield data to obtain physically interpretable PMF2 results.

PMF Results

Seven major sources were resolved from PMF2 analyses for both sites (matrix rotational parameter: Fresno FPEAK = 0.1; Bakersfield FPEAK = 0). The comparison of the reconstructed $PM_{2.5}$ contributions (sum of contributions from all sources) with measured $PM_{2.5}$ concentrations shown in Figure 2 indicates that the resolved sources effectively reproduce the measured values and account for most of the variation in the $PM_{2.5}$ concentrations (*slope* = 0.88, r^2 = 0.95 for Fresno data; *slope* = 0.93, r^2 = 0.91 for Bakersfield data).

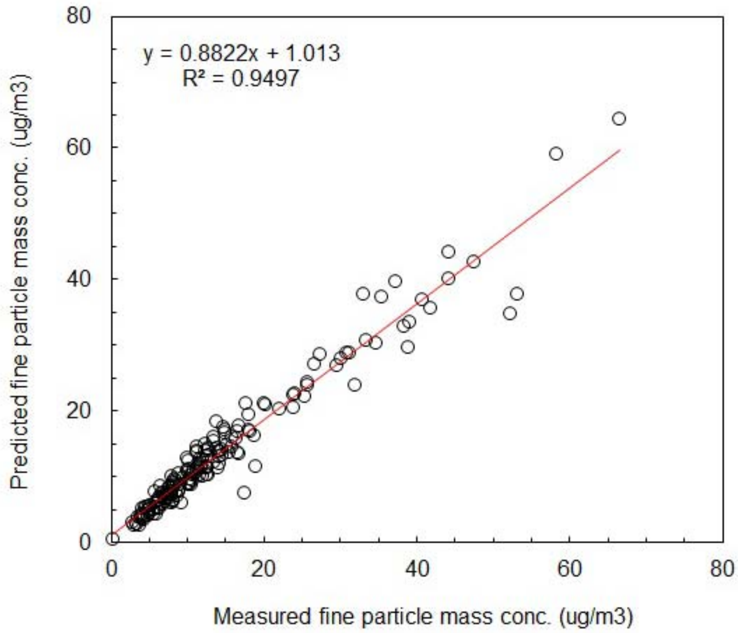
Average Source Contributions

As shown in Figure 3 and Table A3 which present average source contributions, secondary nitrate contributed the most at both sites (35% at the Fresno site, 41% at the Bakersfield site). The pie charts indicate that three major sources (i.e., secondary nitrate, secondary sulfate, and motor vehicle) contributed 74% of $PM_{2.5}$ concentrations at both sites. Figure 4 shows monthly average source contributions. Secondary nitrate, motor vehicle, and biomass smoke contributed the most in winter. The source profiles, corresponding source contributions, weekday/weekend variations, monthly averaged source contributions, and potential source directions are presented in Figures A1 through A10 in the Appendix.

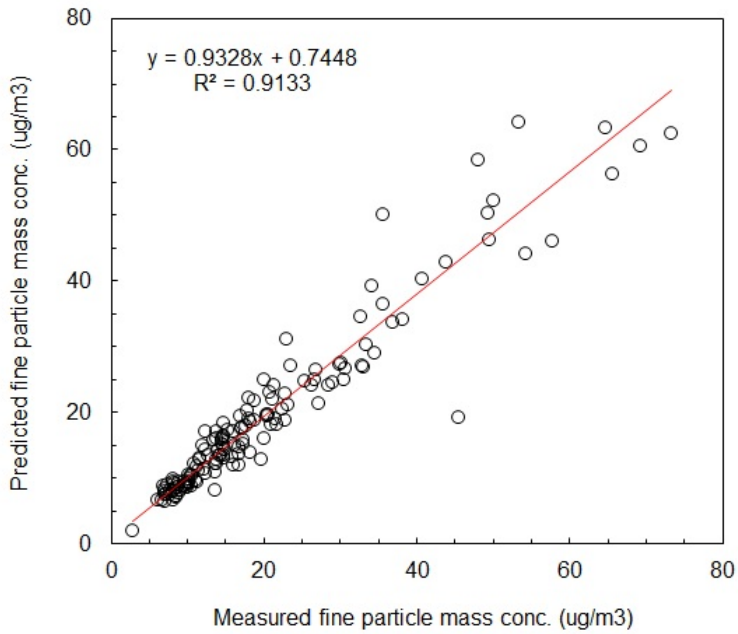
The secondary nitrate factor was identified by its high concentration of NO_3^- and NH_4^+. It consisted of NH_4NO_3 and several minor species such as secondary OC and EC that transport together. It contributed the most at both sites, accounting for 35% and 41% of the $PM_{2.5}$ mass concentrations at Fresno and Bakersfield, respectively. Bakersfield showed higher secondary nitrate concentrations than Fresno. Secondary nitrate particles had winter- high trends at both sites. Secondary sulfate was identified by its high concentration of SO_4^{2-} and NH_4^+ and accounted for 27% and 20% of the $PM_{2.5}$ mass concentration at Fresno and Bakersfield, respectively. Secondary nitrate and secondary sulfate did not show clear weekday/weekend variations. Secondary sulfate showed seasonal variations with higher concentrations in summer when the photochemical activity was highest at both sites. The CPF plots for secondary nitrate pointed S and NE at both sites. The CPF plots for secondary sulfate pointed SE at the Fresno site and SW at the Bakersfield site.

The motor vehicle factor was identified by its high concentration of OC, EC, NO_3^-, and minor species such as Fe (Watson et al., 1994). Motor vehicle emissions contributed 12% and 13% of the $PM_{2.5}$ mass concentrations at Fresno and Bakersfield, respectively. Motor vehicle emissions did not show clear weekday/weekend variations at either site, however there was a winter-high seasonal trend.

The biomass smoke factor was characterized by OC, EC, and K^+ (Watson et al., 2001) and contributed 11% and 10% to the $PM_{2.5}$ mass concentrations at Fresno and Bakersfield, respectively. The biomass smoke category reflects contributions from residential wood burning and smoke from commercial cooking. The biomass smoke did not show weekday/weekend variations. The biomass smoke did show winter-high trends suggesting that it was mostly contributed by residential wood burning. The CPF plots for the biomass smoke pointed to high contributions from NE and S at both sites.



Fresno-First St.



Bakersfield-California Ave.

Figure 2. Measured versus PMF predicted $PM_{2.5}$ mass concentrations.

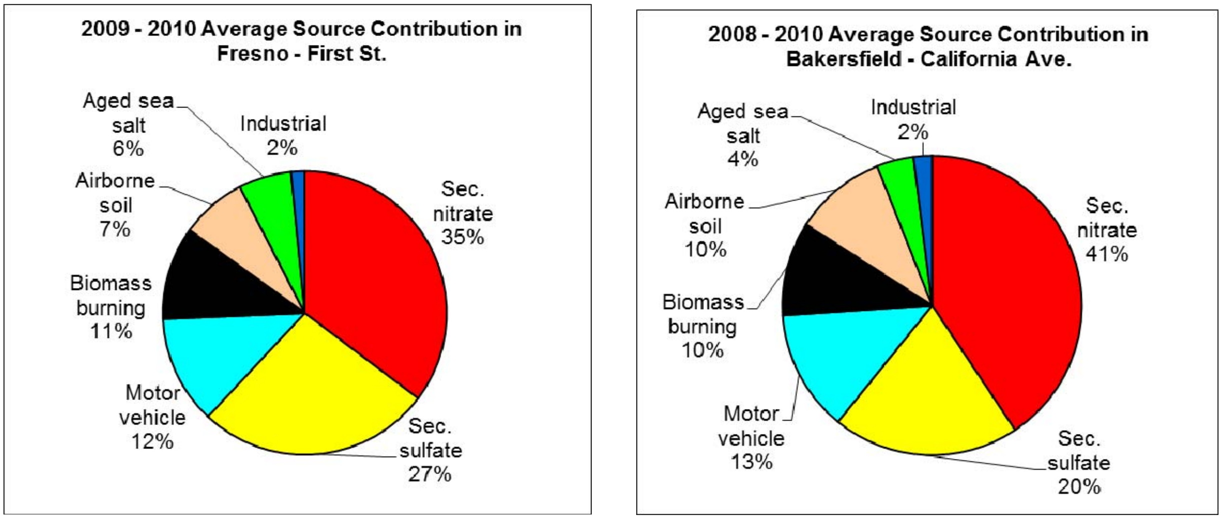


Figure 3. Average source contributions.

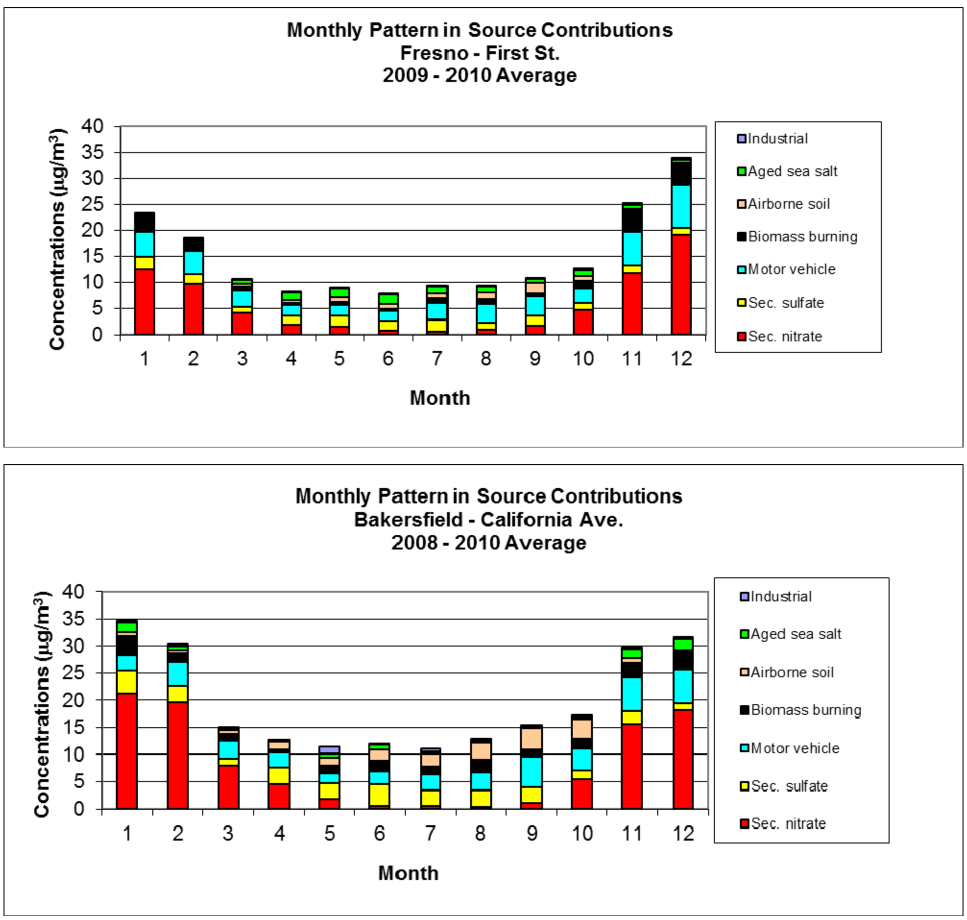
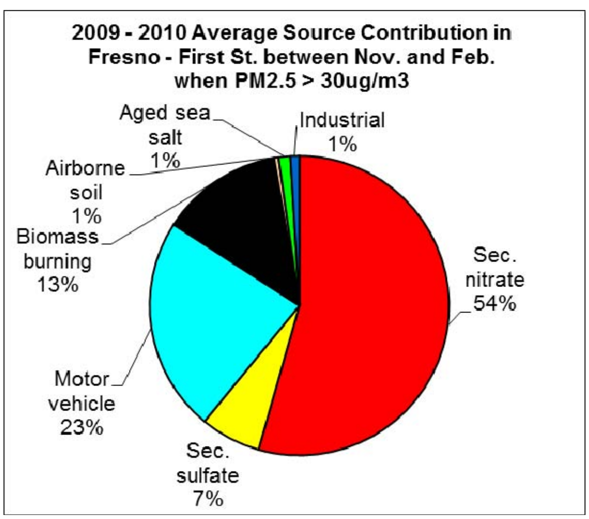


Figure 4. Monthly average source contributions.

The airborne soil factor was identified by its high concentrations of Si, Al, Ca and Fe. It contributed 7% and 10% to the $PM_{2.5}$ mass concentration at Fresno and Bakersfield, respectively. Airborne soil reflects wind-blown dust as well as re-suspended crustal materials by road traffic as indicated by the presence of OC or EC in the source profiles. Airborne soil did not show clear weekday/weekend variation. Both sites exhibited autumn-high seasonal trends. The CPF plots for airborne soil suggested high contributions from SW and S at both sites.

The aged sea salt factor was represented by its high concentrations of NO_3^-, SO_4^{2-}, and Na^+, accounting for 6% the $PM_{2.5}$ mass concentration at Fresno and 4% at Bakersfield. Aged sea salt reflects particles in which Cl^- in the fresh sea salt is partially displaced by acidic gases during the transport and collected along with NO_3^- and SO_4^{2-} (Song and Carmichael, 1999). Aged sea salt did not show weekday/weekend variation at either site. Aged sea salt had high contributions in summer at the Fresno site. Interestingly, it had a high contribution in winter at the Bakersfield site. The CPF plot for aged sea salt at Fresno site pointed towards NE. The CPF plot for aged sea salt at Bakersfield site suggested high contributions from NE and S.

A possible industrial source such as metal processing that was characterized by OC, EC, Fe, and Zn was identified at both sites. This source accounted for 2% of the $PM_{2.5}$ mass concentrations at both sites. It showed weak weekday-high variations at the Bakersfield site. The industrial source showed winter-high variations at the Fresno site. The CPF plot suggested high contributions from NE and SW at both sites.



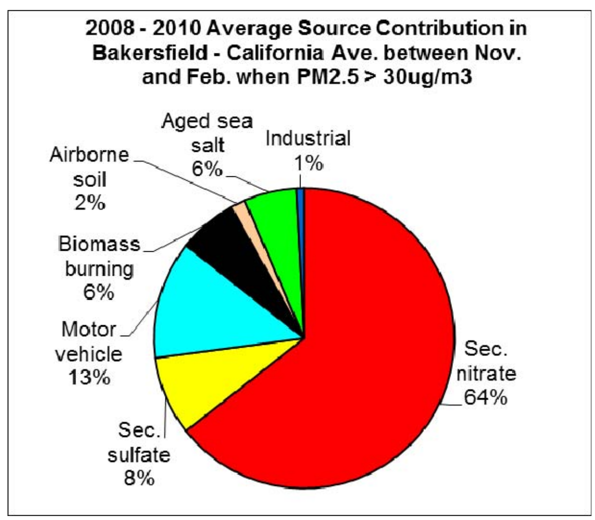


Figure 5. Average source contributions in Fresno – First St. and Bakersfield – California Ave. when $PM_{2.5}$ concentrations were higher than 30 µg/m^3 in the high $PM_{2.5}$ season (Nov. - Feb.).

Higher $PM_{2.5}$ Day Contributions

The average source contributions when $PM_{2.5}$ concentrations were higher than 30 µg/m^3 in the high $PM_{2.5}$ season (Nov. - Feb.) are shown in Figure 5 for percentiles and in Table A4 for mass concentrations. The contributions from secondary nitrate and motor vehicle were increased from 35% up to 54% and from 12% up to 23%, respectively, at the Fresno site. The biomass burning contributions also increased slightly from 11% up to 13% at Fresno site. At the Bakersfield site, the contributions from secondary nitrate increased from 41% up to 64% and aged sea salt from 4% up to 6%.

Conclusions

$PM_{2.5}$ speciation and related meteorological data collected at the Fresno-First St. and Bakersfield-California Ave. CSN monitoring sites between 2008 and 2010 were analyzed by PMF2. Seven major $PM_{2.5}$ sources were identified at both monitoring sites: secondary nitrate, secondary sulfate, motor vehicle, biomass smoke, airborne soil, aged sea salt, and industrial. Annual average and high day source contributions showed that secondary nitrate, secondary sulfate, motor vehicles, and biomass burning were the largest contributors to $PM_{2.5}$ concentrations.

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APPENDIX

Table A1. Summary of $PM_{2.5}$ species mass concentrations at Fresno.

Species	Arithmetic mean (µg/m^3)	Geometric mean (µg/m^3)	Minimum (µg/m^3)	Maximum (µg/m^3)	Number of below MDL values (%)
$PM_{2.5}$	14.5649	11.2762	0.3000	66.6000	0.6
OC	2.7861	1.9428	0.1600	17.4240	0.0
EC	0.7934	0.5764	0.0769	5.0400	0.6
SO4	1.2507	1.1155	0.2440	5.3900	0.6
NO^{3-}	3.6499	1.9445	0.0445	29.1000	0
NH_4^+	1.3964	0.8936	0.1380	9.3500	0.6
Al	0.0646	0.0418	0.0013	0.6330	25.3
Br	0.0042	0.0032	0.0001	0.0338	15.5
Ca	0.0420	0.0310	0.0027	0.2860	4.0
Cl	0.0563	0.0156	0.0001	0.5130	40.2
Cr	0.0026	0.0018	0.0000	0.0387	75.3
Cu	0.0044	0.0032	0.0001	0.0163	28.7
Fe	0.1007	0.0843	0.0129	0.6890	0
K^+	0.1072	0.0770	0.0169	0.6460	32.8
Mg	0.0200	0.0138	0.0002	0.1140	68.4
Mn	0.0019	0.0015	0.0000	0.0126	62.1
Na^+	0.1373	0.0972	0.0176	0.8720	3.4
Ni	0.0074	0.0017	0.0000	0.1850	65.5
Si	0.1682	0.1100	0.0006	1.6400	1.7
Ti	0.0057	0.0043	0.0001	0.0448	61.5
Zn	0.0067	0.0045	0.0004	0.0296	25.3

Table A2. Summary of $PM_{2.5}$ species mass concentrations at Bakersfield.

Species	Arithmetic mean (µg/m³)	Geometric mean (µg/m³)	Minimum (µg/m³)	Maximum (µg/m³)	Number of below MDL values (%)
$PM_{2.5}$	20.9253	17.1631	2.9000	73.3000	0
OC	2.4981	1.7591	0.0400	18.2200	1.3
EC	1.1390	0.9764	0.2160	3.0900	0
SO4	1.6927	1.4718	0.1200	8.0600	0
NO^{3-}	6.4908	3.2626	0.3520	35.7000	0
NH_4^+	2.5874	1.5187	0.3160	14.8000	0.7
Al	0.1276	0.0818	0.0013	1.0800	12.7
As	0.0015	0.0013	0.0001	0.0056	73.3
Br	0.0058	0.0048	0.0001	0.0299	4.7
Ca	0.1096	0.0791	0.0065	0.6770	1.3
Cl	0.0436	0.0192	0.0002	0.3270	26.0
Co	0.0013	0.0010	0.0000	0.0047	76.0
Cr	0.0021	0.0016	0.0001	0.0156	80.0
Cu	0.0089	0.0064	0.0002	0.0570	10.0
Fe	0.1923	0.1555	0.0020	1.0900	0
K^+	0.1091	0.0931	0.0183	0.5280	16.0
Mg	0.0238	0.0160	0.0002	0.2310	60.7
Mn	0.0034	0.0025	0.0003	0.0276	32.7
Na^+	0.1556	0.1229	0.0168	0.6980	1.3
Ni	0.0010	0.0009	0.0000	0.0042	84.7
Si	0.3586	0.2322	0.0217	3.4300	0.7
Sr	0.0019	0.0017	0.0001	0.0120	84.0
Ti	0.0103	0.0068	0.0001	0.0818	46.7
Zn	0.0127	0.0084	0.0006	0.1300	8.7

Table A3. Average source contributions (µg/m^3) to $PM_{2.5}$ mass concentration.

Sources	Average source contribution (± 95 % distribution)	
	Fresno	Bakersfield
Secondary nitrate	4.89 (1.09)	8.07 (1.85)
Secondary sulfate	1.72 (0.16)	2.60 (0.39)
Motor vehicle	3.70 (0.44)	4.01 (0.39)
Biomass smoke	1.47 (0.28)	2.02 (0.28)
Airborne soil	0.83 (0.14)	1.97 (0.37)
Aged sea salt	1.04 (0.16)	0.79 (0.22)
Industrial	0.22 (0.03)	0.40 (0.11)
Estimated $PM_{2.5}$ (µg/m^3)	13.86 (1.57)	19.85 (2.27)
Measured $PM_{2.5}$ (µg/m^3)	14.56 (1.74)	20.48 (2.33)

Table A4. Average source contributions (µg/m^3) to $PM_{2.5}$ mass concentration at Fresno-First St. and Bakersfield-California Ave. when $PM_{2.5}$ mass concentrations were higher than 30 µg/m^3 between Nov. and Feb.

Sources	Average source contribution (Nov. – Feb.)	
	Fresno	Bakersfield
Secondary nitrate	20.14	28.83
Secondary sulfate	2.42	3.80
Motor vehicle	8.58	5.69
Biomass smoke	4.87	2.83
Airborne soil	0.18	0.71
Aged sea salt	0.47	2.52
Industrial	0.35	0.38
No. of days	21	25

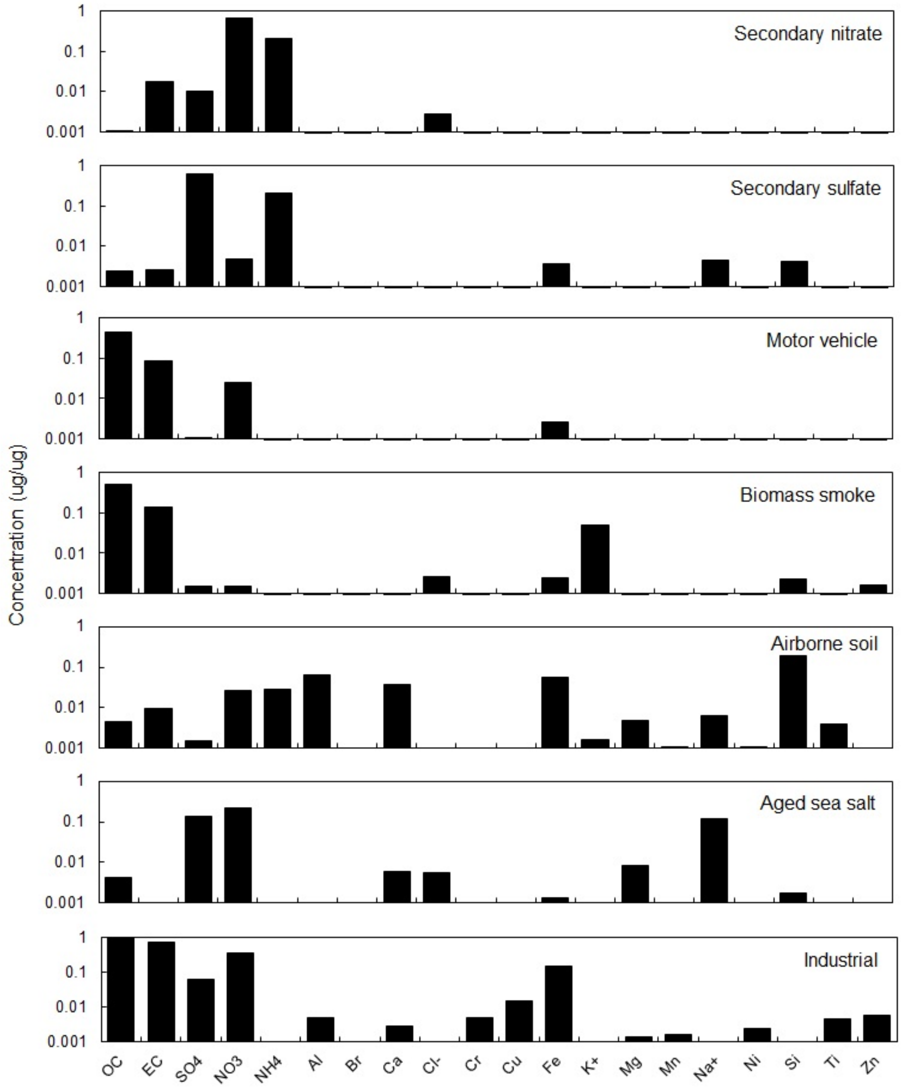

Figure A1. Source profiles deduced from $PM_{2.5}$ samples measured at Fresno-First St. (prediction ± standard deviation).

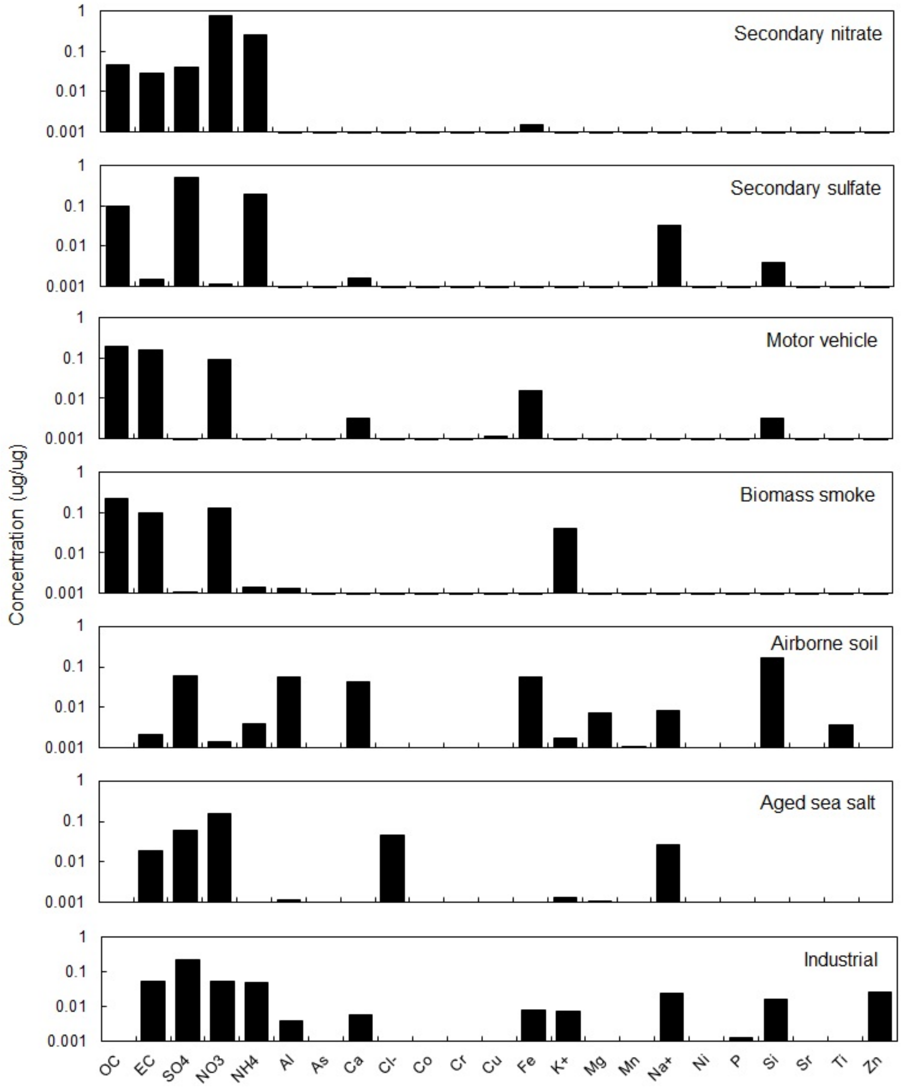

Figure A2. Source profiles deduced from $PM_{2.5}$ samples measured at Bakersfield-California Ave. (prediction ± standard deviation).

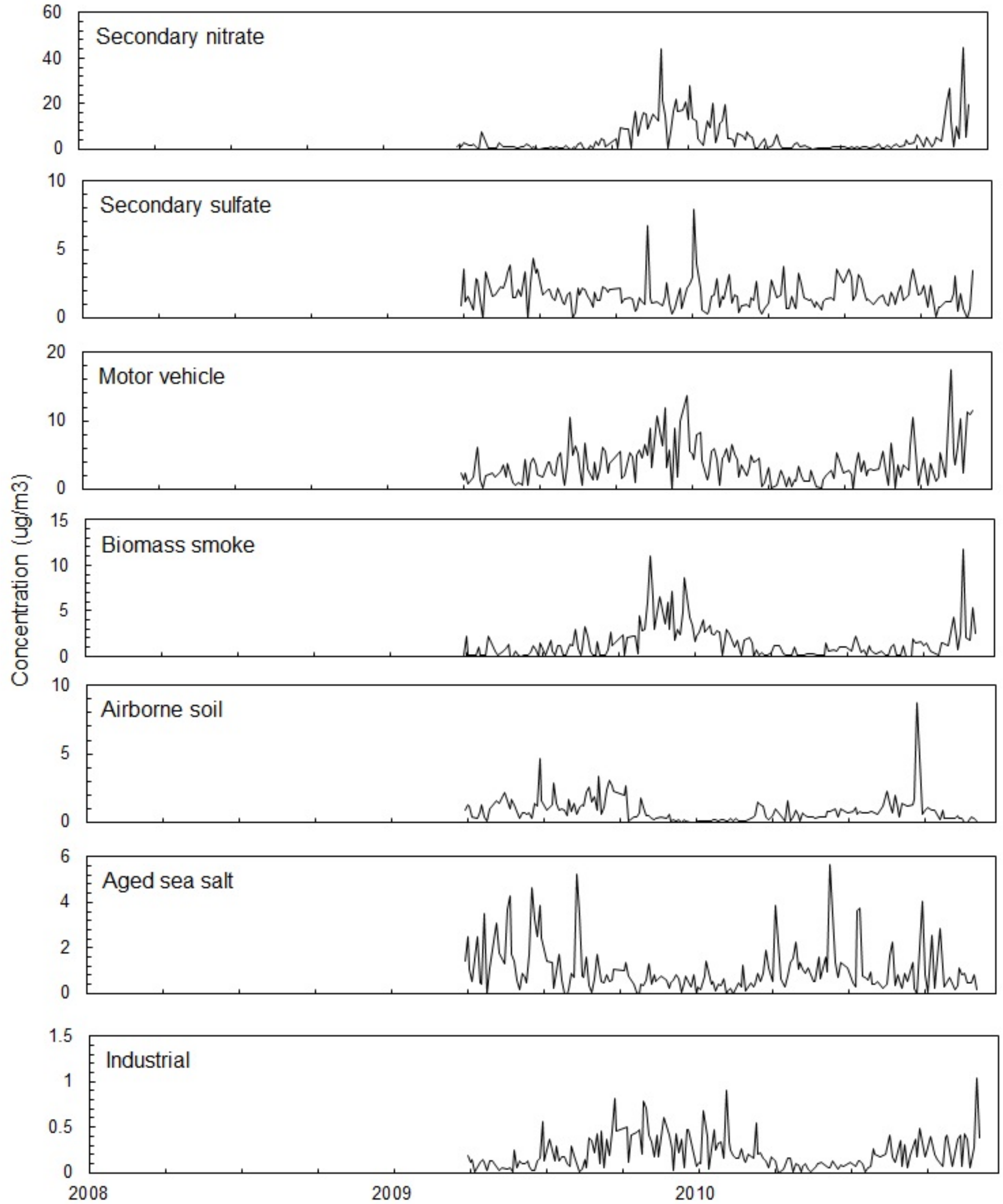

Figure A3. Source contributions deduced from $PM_{2.5}$ samples measured at Fresno-First St.

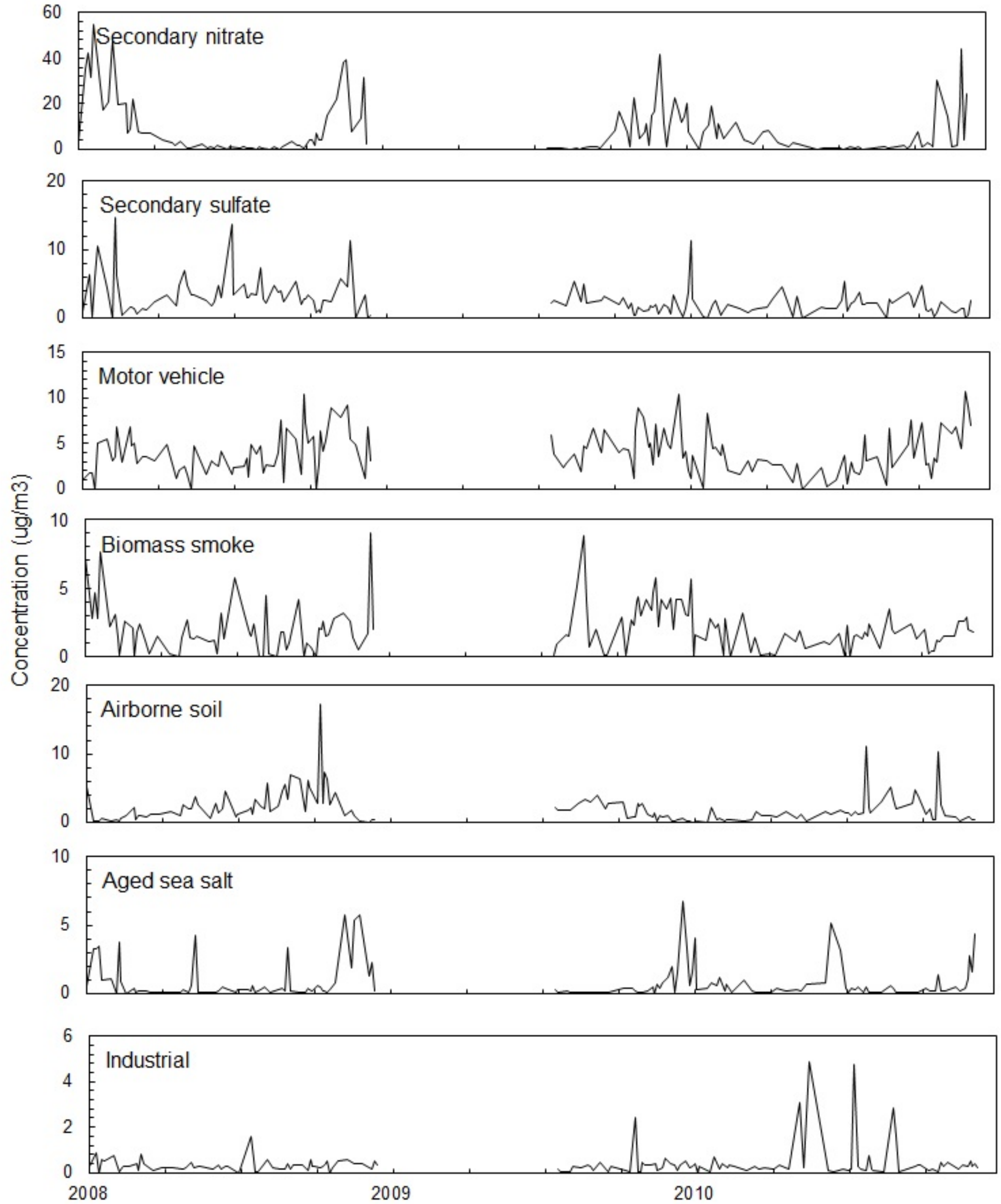

Figure A4. Source contributions deduced from $PM_{2.5}$ samples measured at Bakersfield-California Ave. (missing data: Jan. - Jun. 2009)

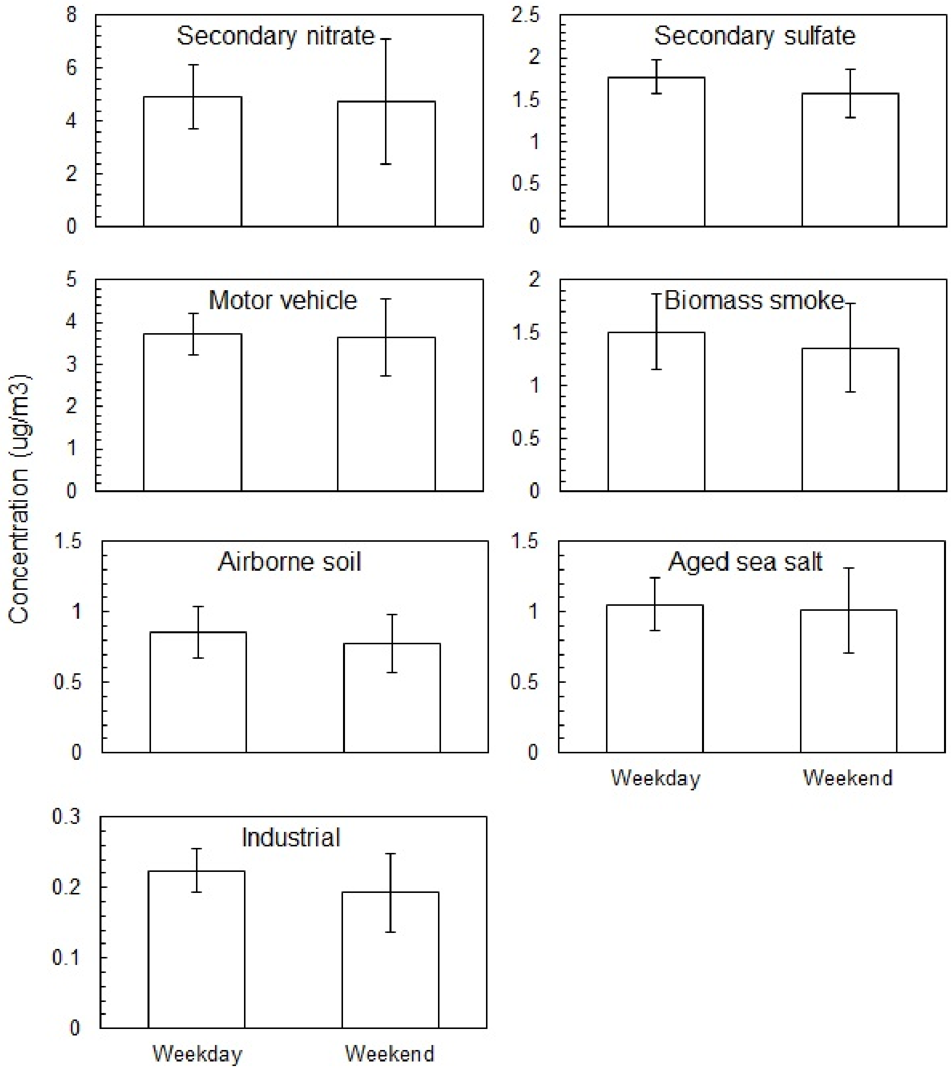

Figure A5. Weekday/weekend variations at Fresno-First St. (mean ± 95 % distribution).

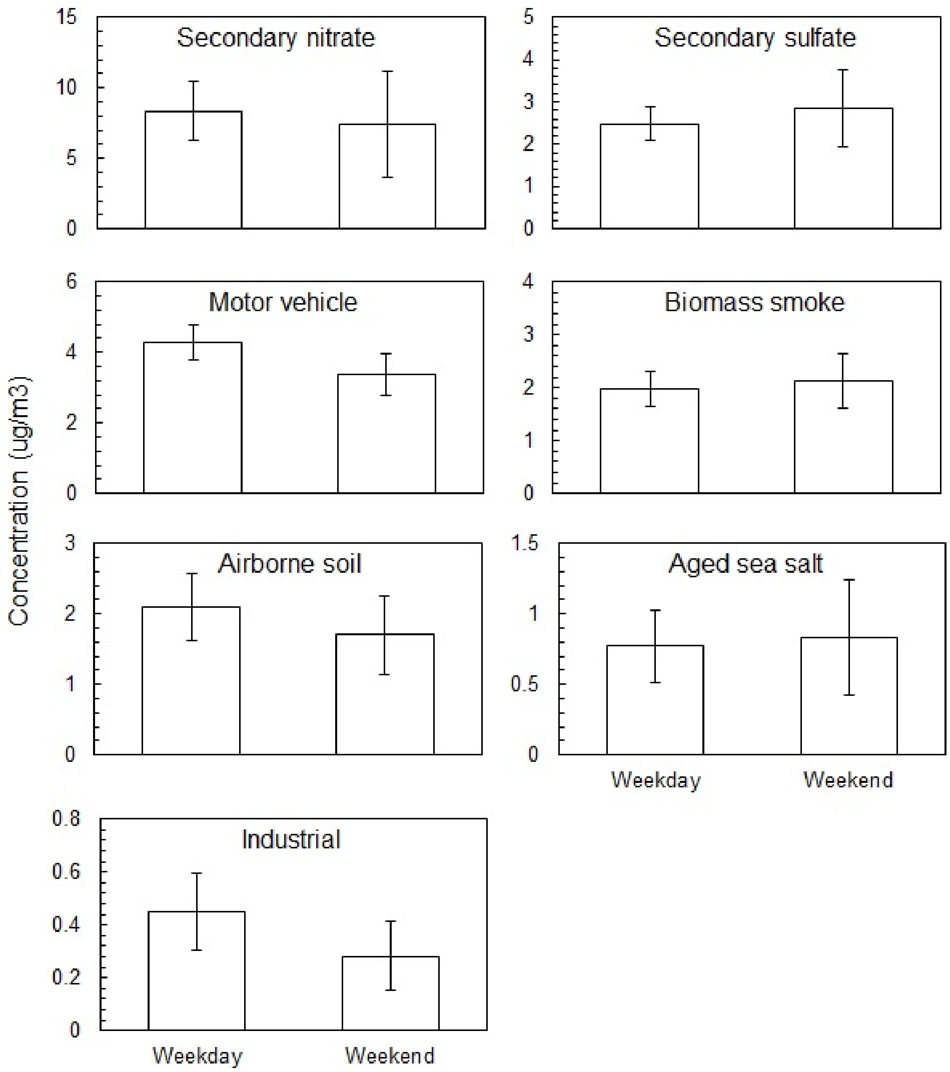

Figure A6. Weekday/weekend variations at Bakersfield-California Ave. (mean ± 95 % distribution).

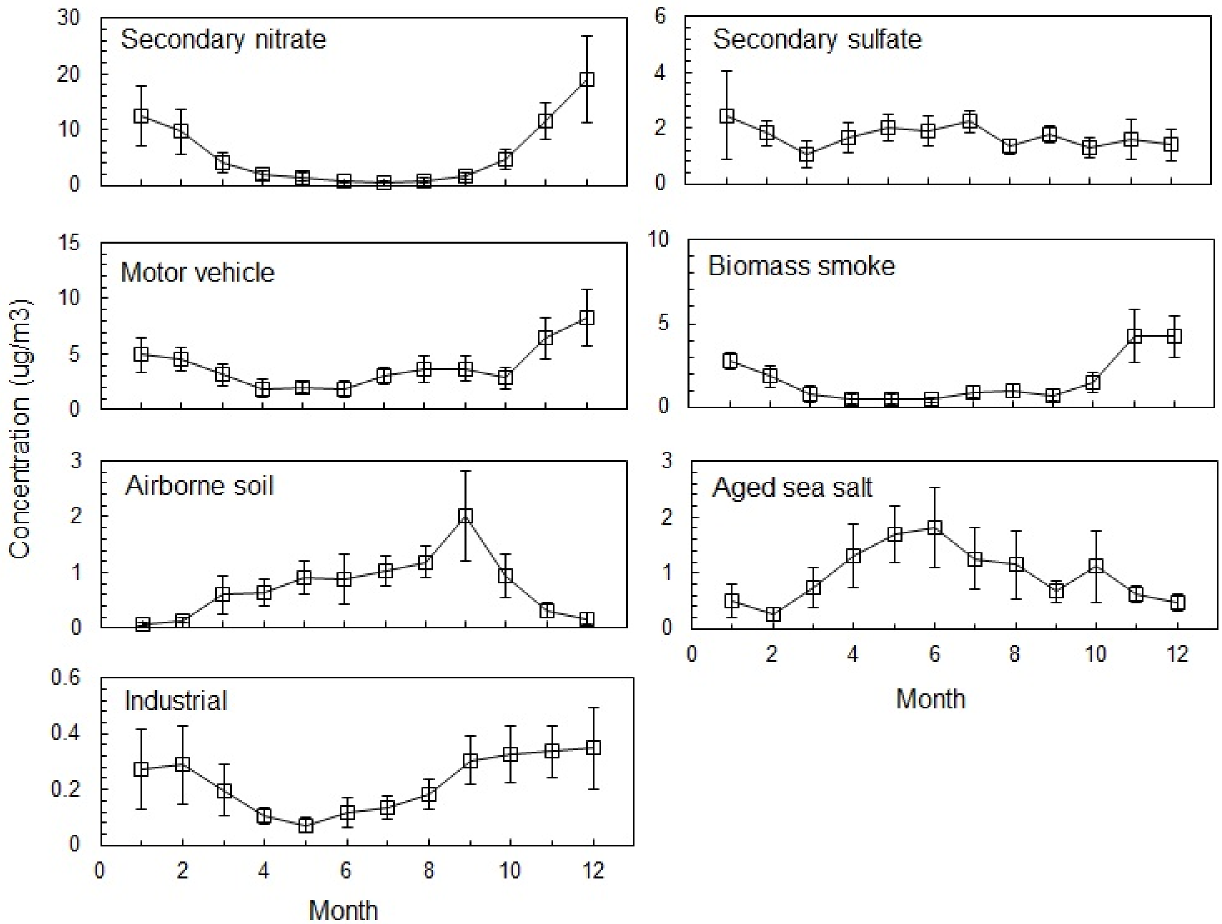

Figure A7. The monthly variations of source contributions to $PM_{2.5}$ mass concentration at Fresno-First St. (mean ± 95 % distribution).

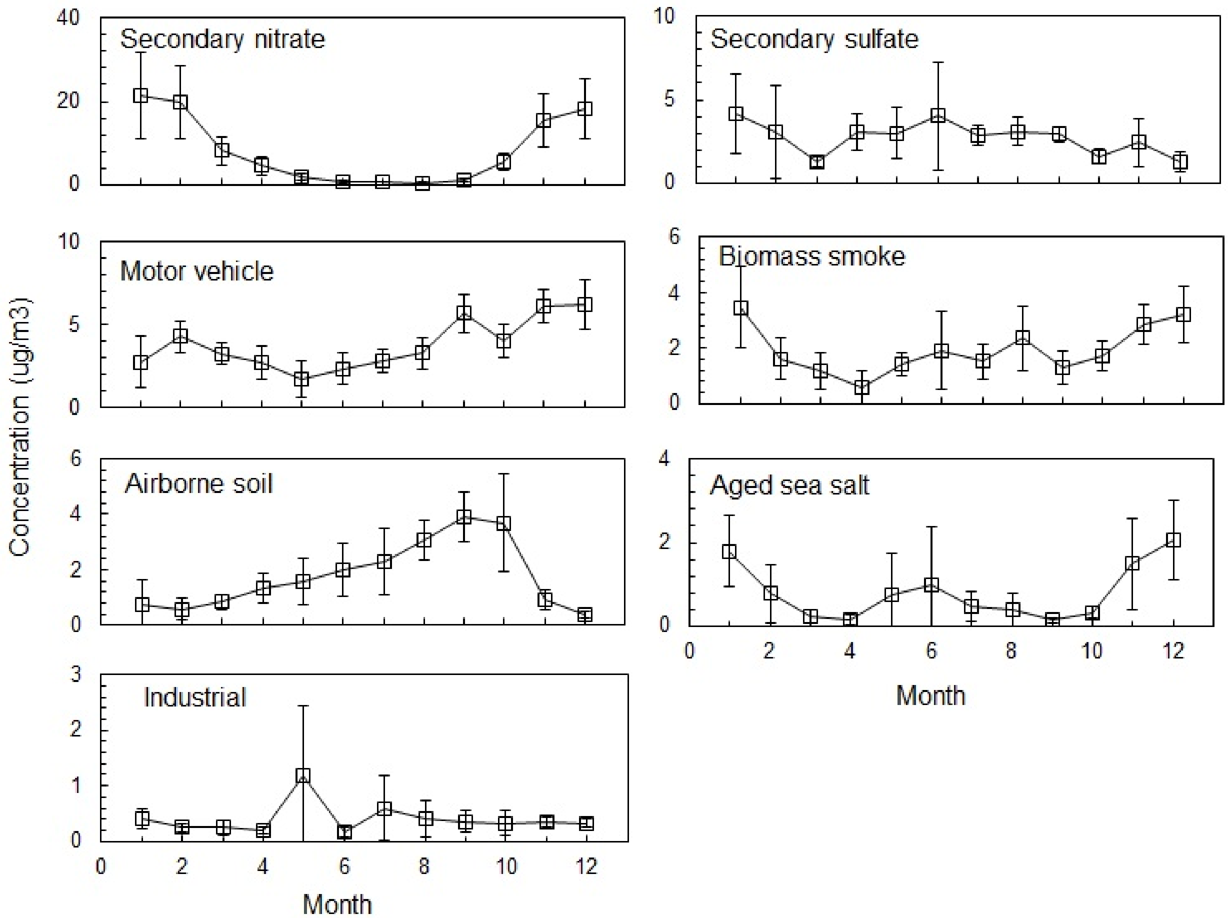

Figure A8. The monthly variations of source contributions to $PM_{2.5}$ mass concentration at Bakersfield-California Ave. (mean ± 95 % distribution).

Secondary nitrate

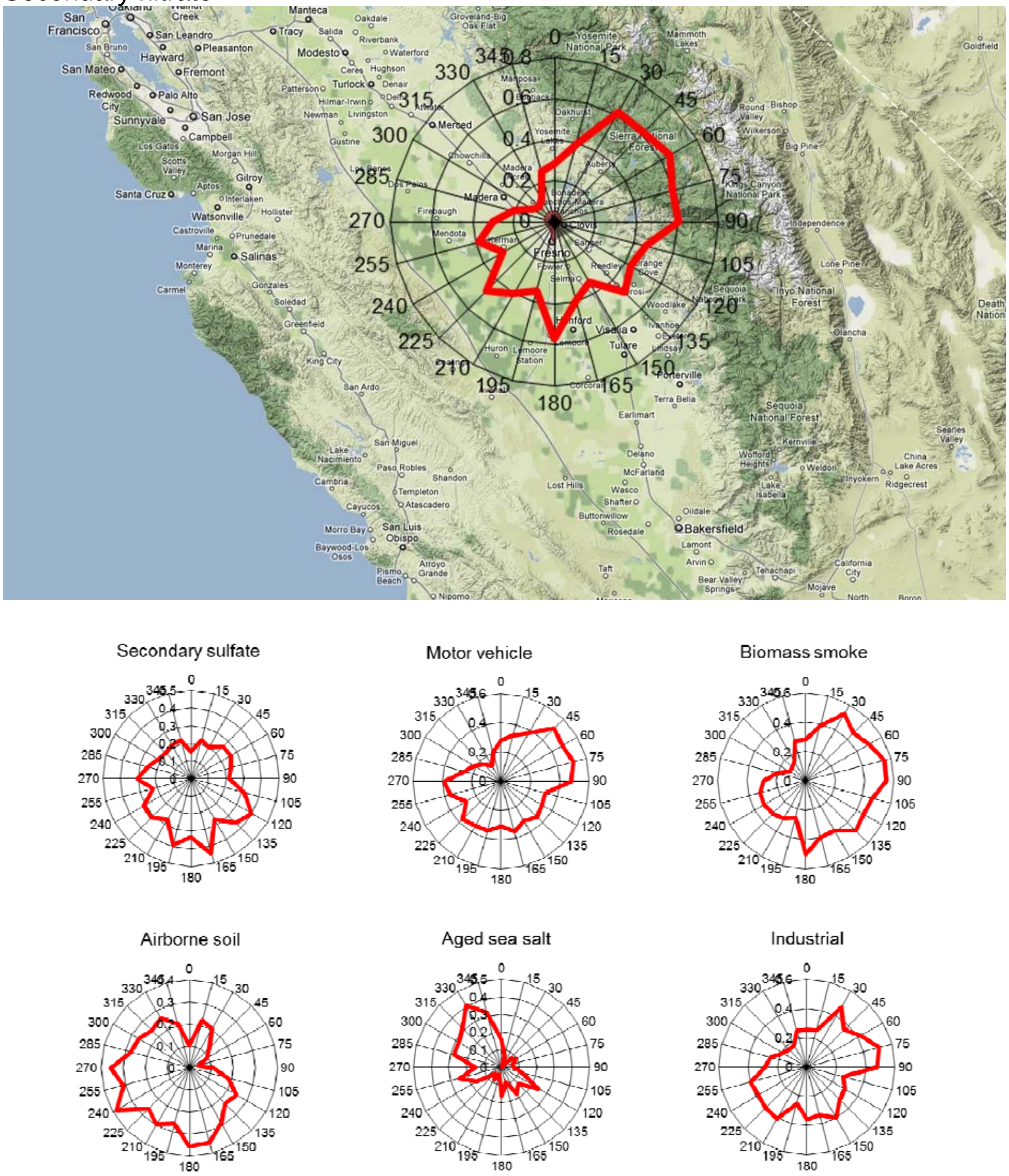

Figure A9. Conditional probability function plots for the highest 25% of the mass contributions at Fresno-First St.

Secondary nitrate

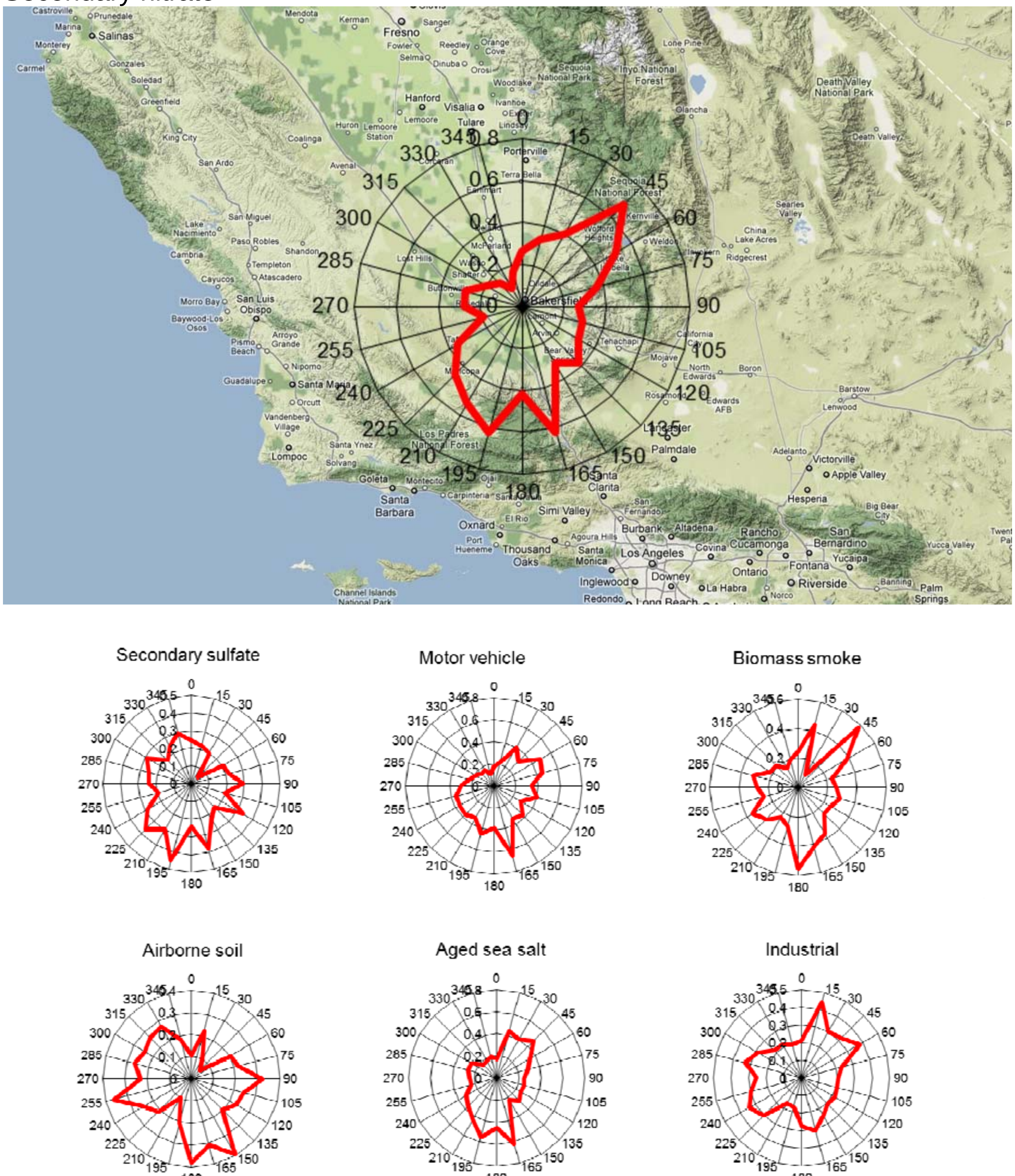

Figure A10. Conditional probability function plots for the highest 25% of the mass contributions at Bakersfield-California Ave.

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San Joaquin Valley PM2.5 Weight of Evidence Analysis

Appendix 4

Methodology for Meteorological Adjustment of PM2.5 Trend Statistics

Introduction

Air quality trends can help reveal the effects of emission control strategies and regulations on ambient air pollution levels. However, meteorological conditions also affect pollutant levels and can obscure the effects of changing emissions on ambient air pollution levels over time. If the met-effects can be identified, quantified, and removed, the met-adjusted trends may reveal the emissions-induced trends with greater clarity.

For the San Joaquin Valley PM2.5 SIP, met-adjusted trends were prepared for annual average PM2.5 and for PM2.5 exceedance days. This Technical Appendix presents the methodology used to construct the met-adjusted trends.

1. Data Acquisition and Preparation

PM2.5 mass concentrations from the air quality monitoring sites in two major urban centers of the SJV (Bakersfield and Fresno) were collected. Meteorological data for factors that may impact the PM2.5 concentrations were also acquired from various meteorological monitoring networks. Monitors at ground level provided temperature, relatively humidity, pressure, wind speed, wind direction, precipitation, and solar radiation data. For various reasons, surface pressure, wind direction, precipitation, and solar radiation were not used in the final analysis. Routine rawinsondes (weather balloons) at Oakland provided data for 500 millibar heights and 850 millibar temperatures. These surface and upper air factors are consistent with studies of meteorological conditions associated with daily PM2.5 levels [Dye et al., 2003].

Table 1 lists the air quality and meteorological monitoring sites that provided data used in this analysis. The PM2.5 and meteorological data presented are daily regional averages of the data collected from the sites in Table 1.

Table 1. Air quality and meteorological monitoring sites

Region	Air Quality Sites	Meteorological Sites
Bakersfield Area	Bakersfield-Golden State Highway, Bakersfield-5558 California Avenue, Bakersfield-410 E Planz Road	Oakland (Upper Air), Mercury/Desert Rock (Upper Air), Vandenberg AFB (Upper Air), Bakersfield-Golden State Highway, Bakersfield-5558 California Avenue, Oildale-3311 Manor Street, Shafter-Walker Street, Arvin-Edison, Belridge
Fresno Area	Fresno-1st Street, Clovis-N Villa Avenue Fresno-Hamilton and Winery	Oakland (Upper Air) Fresno-1st Street Clovis-N Villa Avenue,

A consistent analysis of met-effects on daily PM2.5 will benefit from and may require the presence of all PM2.5 and meteorological data for each daily record used in the analysis. If any values are missing, the entire day might be excluded from further consideration. Therefore, data completeness is very desirable for the analysis to be as meaningful as possible. To minimize instances of missing PM2.5 and meteorological data, imputed values were calculated based on relationships for measured data at sites nearby. The imputed values were used when appropriate. Details concerning the imputation method (called “I-Bot”) are available from the Air Quality and Statistical Studies Section of the ARB.

2. Analytical method: Classification and Regression Trees

Classification and Regression Trees (CART) is a statistical exploratory technique for uncovering structures in the data, which is sometimes called “data mining” [Breiman et al., 1984; Thompson et al., 2001; Slini, et al., 2007]. CART is a non-parametric decision tree learning technique that produces a classification tree if the dependent (target) variable is categorical or a regression tree if the dependent variable is numeric. At each step of the tree building process, CART finds the best possible independent variable (or linear combination of independent variables) to split the values of the target variable into two groups for which the means are as different as possible (subject to certain constraints). Each of the new groups is called a “child” node. The process of node splitting is repeated for each child node and continued recursively until a stopping criterion is satisfied and a set of terminal nodes is reached [Breiman et al., 1984; Xu et al., 2005]. In this way, the nodes of the final CART tree explain the values of the dependent variable in terms of the independent variables used to make splits.

In this analysis of PM2.5 and meteorology, the final CART tree explains daily PM2.5 in terms of the meteorological variables (parameters) used to make the splits. Table 2 lists all the parameters used in this particular analysis. The parameters used are much the same as those listed in U.S. EPA Guidelines for Developing an Air Quality (Ozone and PM2.5) Forecasting Program [Dye et al., 2003].

Table 2. Meteorological parameters used in CART analysis

Target: Average PM2.5 Concentrations	
Predictor	**Type**
Season	Categorical
Weekday / Weekend	Categorical
Holiday or Not	Categorical
Temperature	Surface
Wind Speed	Surface
Relative Humidity	Surface
500 mbar Height	Upper Air
850 mbar Temperature	Upper Air
Difference between Surface and 850 mbar Temperature (Surrogate for Stability)	Derived
Difference of Maximum and Minimum Temperature (Diurnal Variability)	Derived

To prepare a CART tree, we selected the years 2004 – 2006 as base years, assuming that the relevant emissions did not change greatly during these few years. When emissions are reasonably stable, day-to-day differences in PM2.5 concentrations are mostly due to differences in meteorology. We then applied CART analysis to the base years to define a relationship ("tree") between daily PM2.5 and daily meteorological conditions.

First, we forced the tree to be split by season so that an independent sub-tree was generated for each season. Each sub-tree consisted of one or more terminal nodes representing different meteorological classes. The CART system makes the differences in PM2.5 between the met-classes as large as possible and the differences in PM2.5 within the met-classes as small as possible. The PM2.5 concentration representing each met-class (terminal node) is the average concentration of all the days assigned to that met-class in the base years. For each day assigned to a met-class, the average PM2.5 for the met-class serves as a "predicted PM2.5" for that day. Days with high predicted values have met-conditions that are more conducive to PM2.5 formation compared to days with low predicted values.

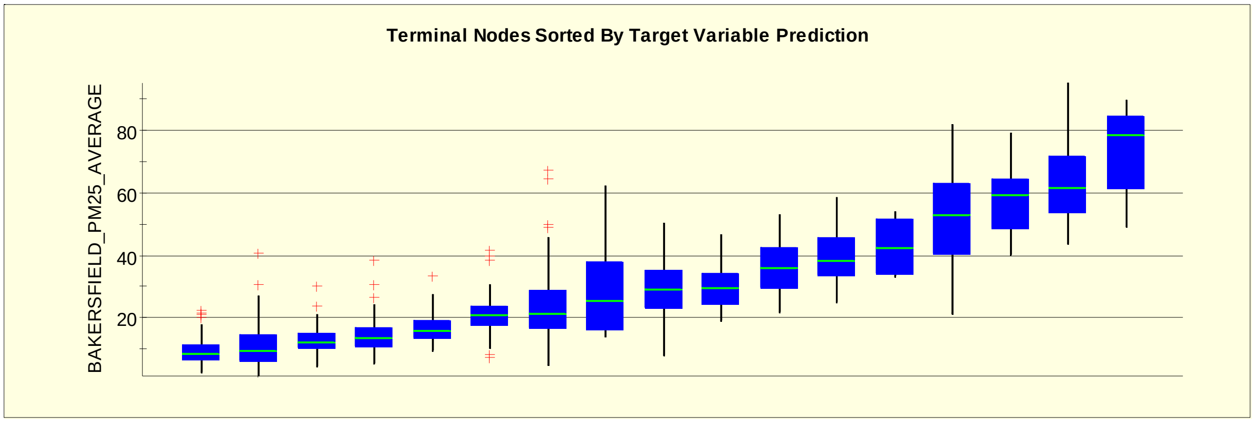
The CART-defined relationships between meteorology and PM2.5 in the base years were then used to assign days in the other years to their appropriate met-classes based on their day-specific meteorological data. The predicted PM2.5 values for all the days are then used to adjust PM2.5 trends up or down to compensate for each year's PM2.5-conduciveness relative to "normal".

3. Results and Discussion

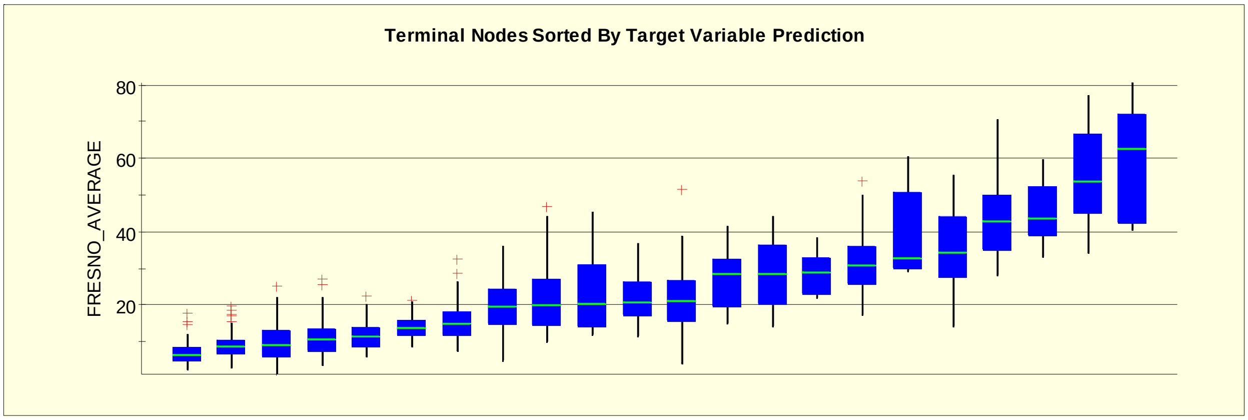
Based on daily air quality and meteorological data in 2004-2006, a CART tree with 17 met-classes (terminal nodes) was constructed for the Bakersfield area (Figure 1a) and a CART tree with 22 met-classes was constructed for the Fresno area (Figure 1b). Figure 2 indicates that ~75 – 80 percent of the variation in daily PM2.5 during the base years is accounted for by each of the CART trees. Table 3 shows that three met-factors – wind speed, stability (difference surface 850mb temperatures), and minimum surface temperature – affected daily PM2.5 concentrations strongly in both Bakersfield and Fresno, while relative humidity (RH) was more important for PM2.5 production in the Bakersfield area than in the Fresno area. In general, high PM2.5 concentrations in the Bakersfield were associated with relatively high stability, low wind speed and high RH. In Fresno, high PM2.5 was generally associated with cold mornings (low minimum surface temperature), high stability, and low wind speed.

It is worth mentioning that this CART model treats each day independently and does not directly characterize met-conditions over a sequence of days that may result in long-term buildup and transport of PM2.5.

A sensitivity analysis was, also, done to explore the impact of the selected base years on the CART results for the Bakersfield area. For this purpose, different sets of base years (2003-2005, 2004-2006, and 2006-2008) were used with CART to develop relationships between meteorology and PM2.5. The met-adjusted annual average PM2.5 concentrations proved to be quite similar regardless of the base years used in the CART analysis.

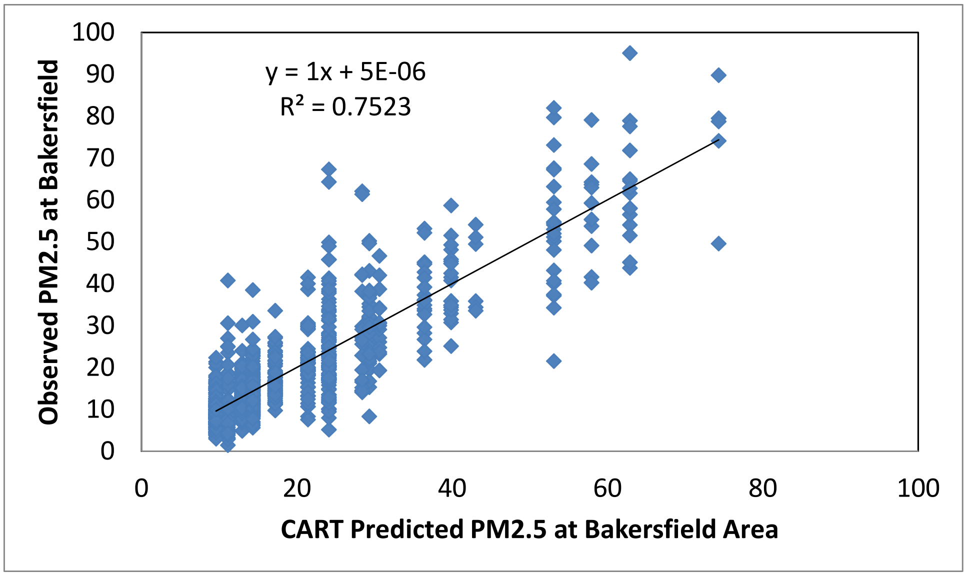


(a)

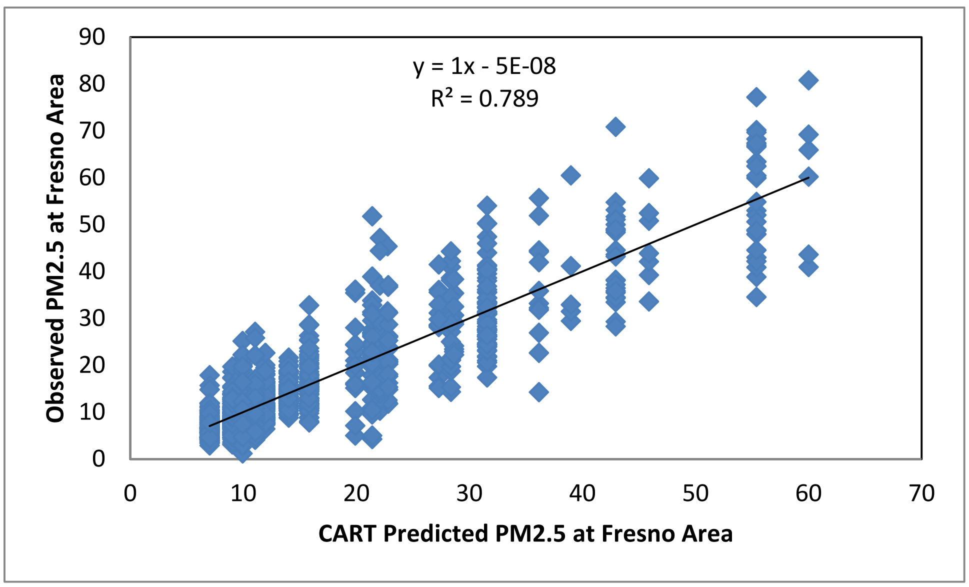


(b)

Figure 1. CART terminal nodes sorted by target variable predictions (PM2.5) in (a) Bakersfield area and (b) Fresno area.



(a)



(b)

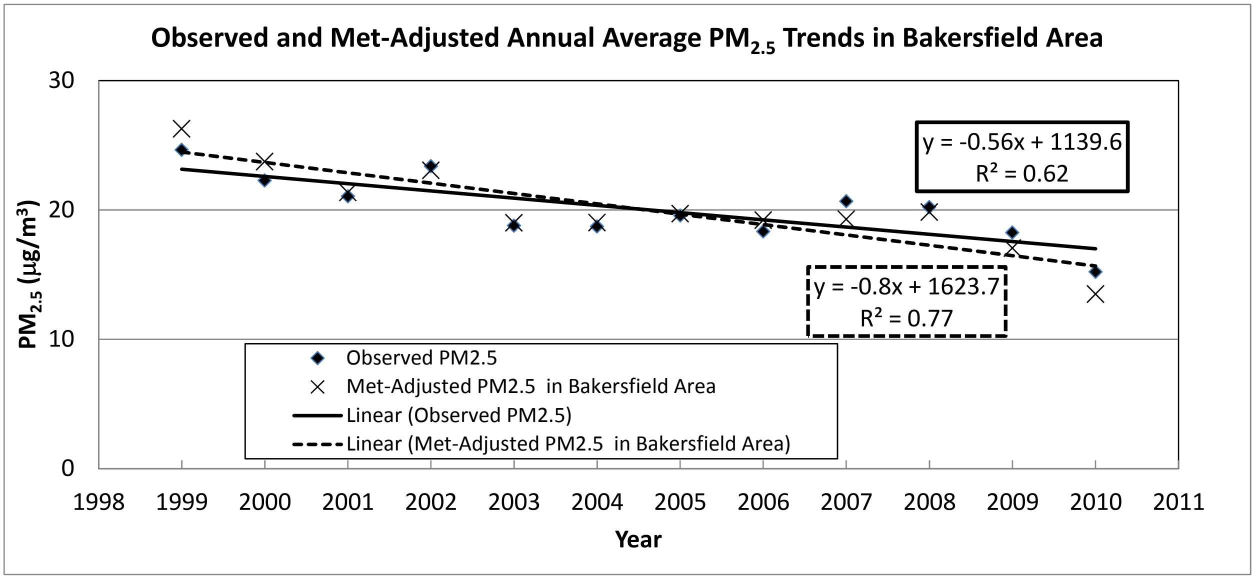
Figure 2. Observations vs. CART predictions during the base years in the (a) Bakersfield and (b) Fresno areas

Table 3. Relative importance of met-factors in forming the CART trees on a 0 to 100 scale.

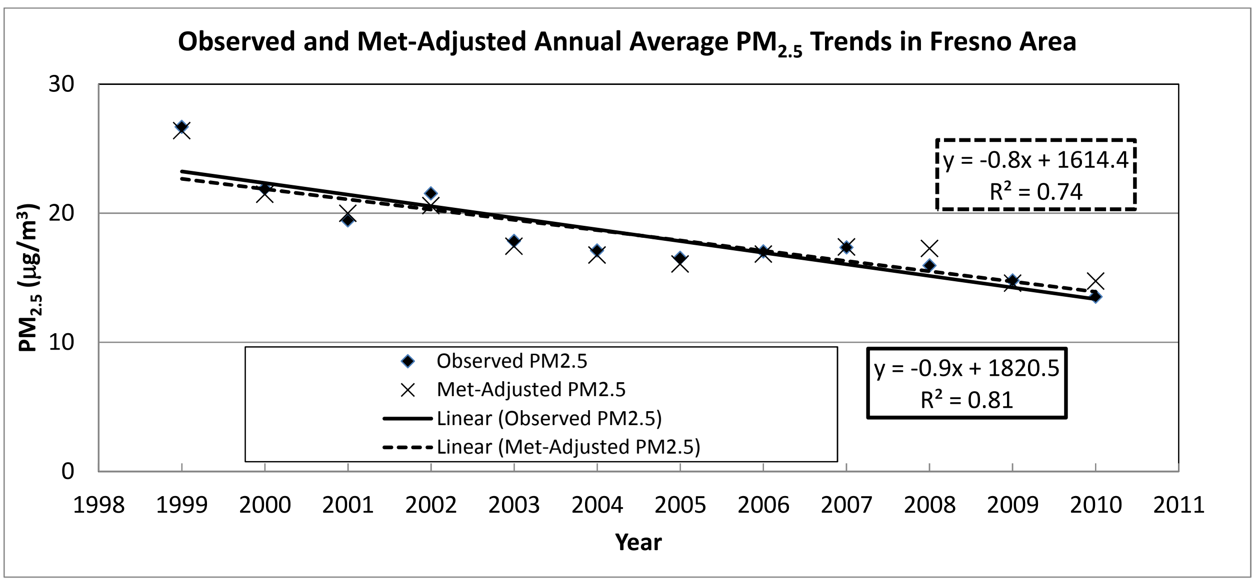
Meteorological Factor	Variable Importance in Bakersfield	Variable Importance in Fresno
Average Wind Speed	100	100
Aveage Surface T - 850 mbar T	69.02	56.24
Minimum Surface Temperature	56.11	60.89
Season	52.52	51.48
Minium Surface T - 850 mbar T	47.74	36.37
Maximum Surface T - 850 mbar T	45.59	96.49
Average Relatively Humidity	40.12	10.11
Average Surface Temperature	39.84	59.65
Maximum Surface Temperature	28.51	37.02
Afternoon 850 mbar Temperature	26.4	6
Average 850 mbar Temperature	20.88	5.89
Average 500 mbar Height	12.42	22.91
Afternoon 500 mbar Height	12.14	7.07
Maximum Relative Humidity	10.45	9.67
Morning 850 mabr Temperature	6.01	5.85
Maximum Surfact T - Minimum Surface T	4.15	3.76
Minimum Relative Humidity	3.54	2.84
Morning 500 mbar Height	0.07	5.43

Annual average PM2.5 trends for observed data and for CART-predicted values (2004-2006 used as base years) were compared in the Bakersfield and Fresno areas. In both areas, observed PM2.5 levels decreased significantly from 1999 to 2003, were relatively flat from 2003 to 2008, then decreased in 2009 and 2010. CART-predicted trends represent meteorological conditions that affect PM2.5 concentrations. For the Bakersfield area, the CART-predicted trend indicates that met-conditions favored lower than normal PM2.5 in 1999 – 2000, normal PM2.5 from 2001 – 2006, and higher than normal PM2.5 from 2007 – 2010. The CART-predicted trend for the Fresno area indicates that met-conditions have been more stable and have had relatively small impacts on the observed PM2.5 trends from 1999 – 2010.

The CART-predicted trend information was merged with the observed trends to produce met-adjusted trends for annual average PM2.5. Figure 3 shows the observed and met-adjusted trends for (a) the Bakersfield area and (b) the Fresno area. Linear trend lines are shown for the observed and the met-adjusted trends in each area. Figure 3 indicates that the met-adjusted trend shows a greater decrease than the observed trend in the Bakersfield area, while the met-adjusted trend is similar to the observed trend in the Fresno area. In both areas, met-adjusted PM2.5 decreased by ~ 0.8 $\mu g/m^3$ per year from 1999 – 2010. Overall, the met-adjusted trends indicate that average PM2.5 decreased 40 – 50 percent in the Bakersfield and Fresno areas from 1999 – 2010 as a consequence of ongoing emission reductions.



(a)



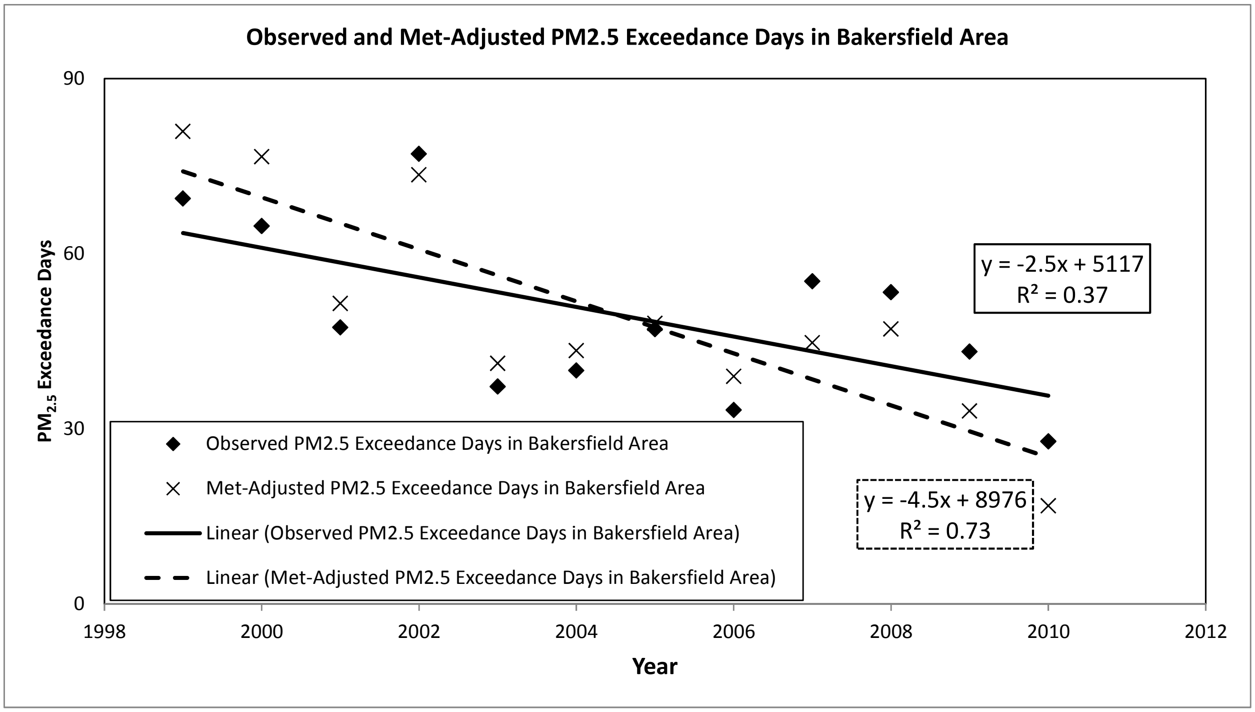
(b)

Figure 3. Trends of observed and meteorologically adjusted PM2.5 concentrations in (a) Bakersfield and (b) Fresno areas of the San Joaquin Valley

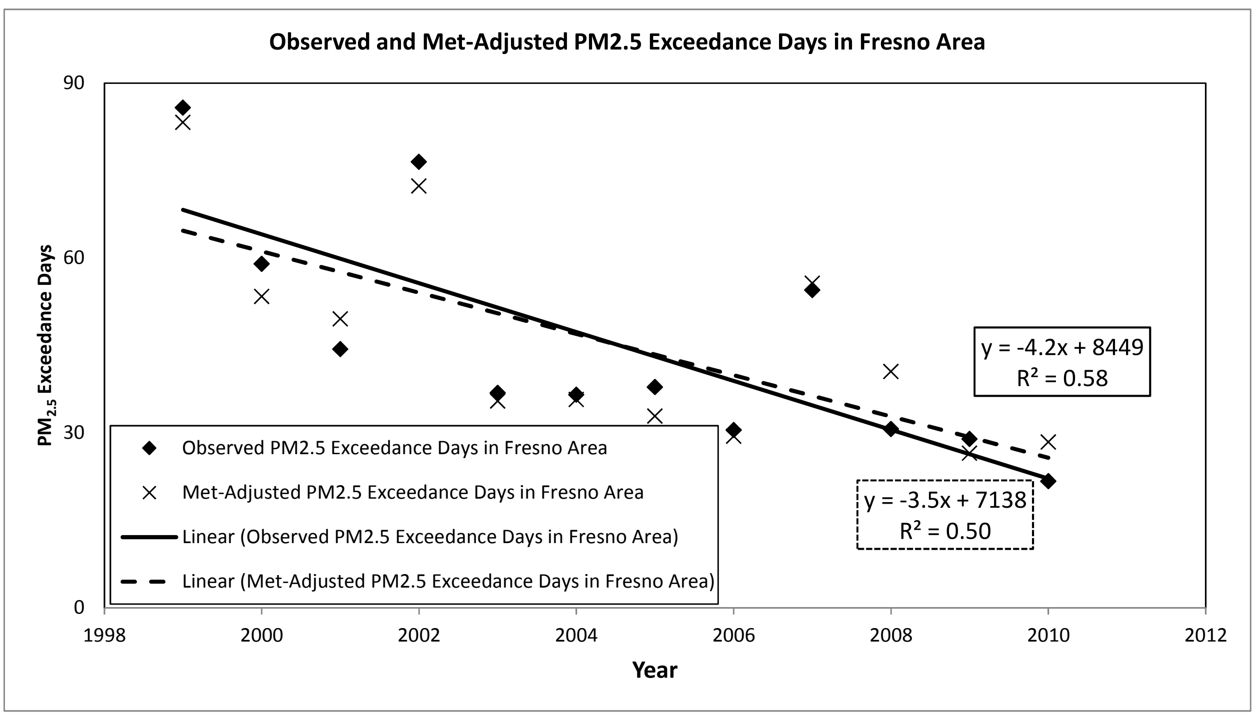
Trends for exceedance days were prepared for the Bakersfield and Fresno sub-regions. For this work, an exceedance day meant that the sub-regional average daily PM2.5 concentration was greater than or equal to 35 ug/m3. Trends for the observed PM2.5 data and for the CART-predicted PM2.5 data (representing meteorological effects) were prepared.

In the Bakersfield area, similar to the annual averages, the CART-predicted exceedance days increased from the earlier years to recent years, indicating an increase in meteorological conduciveness for PM2.5. In the Fresno area, the impact of meteorology on PM2.5 exceedance days was relatively small, again similar to the annual averages. In both areas, the observed PM2.5 exceedance days were greater than the CART-predicted PM2.5 exceedance days from 1999 through 2002. The two trends were similar from 2003 through 2008. Finally, for 2009 and 2010, observed PM2.5 exceedance days decreased significantly and dipped below the CART-predicted exceedance days. The implication of these results is that emission reductions played a significant role in decreasing the PM2.5 exceedance days from 1999 – 2010, especially in the Bakersfield area.

The CART-predicted trend information was merged with the observed trends to produce met-adjusted trends for PM2.5 exceedance days. Figure 4 shows that after adjusting for meteorology, PM2.5 exceedance days decreased about 60 – 70 percent from 1999 to 2010, with decreases of ~ 3.5 days per year in the Fresno area and ~ 4.5 days per year in the Bakersfield area.



(a)



(b)

Figure 4. Trends of observed and meteorologically adjusted PM2.5 exceedance days in (a) the Bakersfield area and (b) the Fresno area.

4. Summary

Overall, CART analysis can help us to define the relationship between PM2.5 mass concentrations and meteorological conditions and to calculate meteorologically adjusted trends. Such trends can help reveal the impact of emission changes on air pollutant levels, and promote the development of effective air pollution control strategies and regulations. Of course, as with any statistical analysis, there are uncertainties and limitations in CART analysis. Therefore, caution is needed when interpreting the resulting air quality trends, especially when small differences occur within short time periods.

The annual average PM2.5 concentrations and the number of exceedances of the 24-hour PM2.5 standard followed similar trends in the Bakersfield and Fresno areas from 1999-2010. In the Fresno area, the meteorological conditions seem to have been relatively stable, so met-adjusted trends were similar to the observed trends. In the Bakersfield area, however, meteorological conditions were relatively less PM2.5 conducive in the earlier years (i.e. 1999-2000) and more conducive in recent years (i.e. 2007-2010), with more normal years in between. Accordingly, the met-adjusted trends for the Bakersfield area show a greater decrease in PM2.5 levels compared to the observed trends.

Based on the differences between the predicted PM2.5 levels under the observed meteorological conditions and under "normal" meteorological conditions, the PM2.5 observations are adjusted to derive met-adjusted PM2.5 trends. The analyses indicate that the met-adjusted annual average PM2.5 concentrations decreased at a rate of ~0.8 $\mu g/m^3$ per year between 1999 and 2010 for a total of ~40-50 percent decrease in met-adjusted PM2.5 in the Bakersfield and Fresno areas as a result of emission reductions during this period. Met-adjusted trends for PM2.5 exceedance days indicate ~60-70 percent progress from 1999 – 2010, with decreases of ~ 3.5 days per year in the Fresno area and ~ 4.5 days per year in the Bakersfield area.

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San Joaquin Valley PM2.5 Weight of Evidence Analysis

Appendix 5

Speciated Linear Rollback Modeling as a Corroborative Analysis to the Regional Photochemical Model

Speciated Linear Rollback Modeling as a Corroborative Analysis to the Regional Photochemical Model

Background

To add to the weight-of-evidence analysis to determine that the control strategy adopted as a part of this Plan will be successful, the District conducted a "Speciated Linear Rollback" analysis to corroborate the results of the regional photochemical model. Different from the photochemical model, which simulates the complex interaction between meteorology, chemical mechanisms, and other physical phenomena, speciated linear rollback is an approach where the change in the emissions inventory from the base year to the future year is applied to measured base year concentrations analyzed into major component sources by the Chemical Mass Balance (CMB) [1] model to project an estimated future year concentration. The CMB model accounts for the end products of the atmospheric process without the requirement to simulation the chemical interactions. The linear component of the process assumes that the rate of reduction in the emissions inventory is related linearly to the reduction in ambient concentrations. Through the combination of source identification and relative linear emissions projection, the measured concentrations can be projected in connection to the inventory changes between the base year and projected future year.

Analysis Procedure

To begin this analysis, the District collected PM2.5 speciation data from the Environmental Protection Agency (EPA) Air Quality System (AQS) database for the years 2009-2011 at the sites of Fresno-First and Bakersfield-California. The data was then organized and limited to only days in the 1st and 4th quarters where the total concentration was above 35.4 ug/m3. The data was then formatted into a structure acceptable as an input into the CMB model, which connects observed PM2.5 concentrations to likely pollution sources though the commonality between the speciation of concentrations and source profiles in the area. The CMB model then outputs a source contribution estimate from each pollution source (in $\mu g/m^3$) for each selected PM2.5 sample.

To improve the quality of the CMB results dataset, specific criteria were used to filter out any poor results where the source profiles did not adequately explain the mass from the speciation sample. In order for a CMB result to be kept, the R^2 value had to be greater than 0.8, the chi- square value had to be less than 4, and the percent of mass explained had to be at least 80%. From here, the final daily results were then averaged

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[1] The Environmental Protection Agency's (EPA) Chemical Mass Balance (CMB) model is available at http://www.epa.gov/scram001/receptor_cmb.htm

for each site to create a generalized source contribution profile for both Fresno and Bakersfield. The source profiles used for the CMB analysis consisted of ammonium nitrate, ammonium sulfate, fugitive dust, mobile exhaust, marine influence, organic carbon, tire/brake wear, and vegetative burning. Contributions from other sources are not excluded, but rather are not separable from the identified major components either due to chemical similarity or lack of a characteristic signature to isolate the emissions from other groupings.

Connecting CMB Results to the Emissions Inventory

Next, with the average CMB results in hand, an assignment was made between the emissions sources identified through CMB and appropriate subsets of the emissions inventory developed for this plan, e.g. ammonium nitrate from CMB was connected to NOx from the emissions inventory, ammonium sulfate was connected to SOx, fugitive dust was connected to direct PM2.5 from sources than generate dust, etc. Since the selected base year in the air quality modeling for this plan was 2007, and with the future year being 2019, the change in the emissions inventory from 2007 to 2019 was analyzed. The specific change in the emissions inventory subsets assigned to the CMB sources were calculated in detail, and these changes were applied directly to the mass from each source specific subset in the average PM2.5 concentration as estimated by CMB. Through this procedure, each source specific subset of the total PM2.5 mass of the average sample value were rolled back at the same rate of their respective representative emissions inventory subsets, assuming a linear relationship between the current and future emissions levels in connection to the particulate matter that the emissions will produce . For example: the ammonium nitrate particulate mass was reduced at the same relative rate that NOx in the inventory is projected to change, the fugitive dust portion of the total mass in the design value was reduced at the same rate of reduction of direct PM2.5 in the emissions inventory, and so forth for all of the categories.

It should be noted that in this analysis all PM2.5 mass sources were reduced linearly at the same rate that their respective emissions inventory subsets were being reduced toward 2019. No adjustments were made for non-linearity among any of the trends. In addition, specific background levels of PM2.5 were assumed for each source category. These background amounts were not reduced at the same rate of their respective emissions inventory subsets, but were rather reduced at the rate of reduction in the California statewide emissions inventory. This approach was taken to account for emissions reductions happening in other parts of the State that would effectively reduce any background/transport emissions coming into the San Joaquin Valley.

Analysis Results

Based on the average CMB results, the ratio of the source specific subsets to the total PM2.5 mass value were applied to the 2007 24-hour design value to create a CMB breakdown of the design value itself. Next, the speciated linear rollback produced percentage concentration change from 2007 to 2019 in each of these emissions inventory subsets were applied to the source specific subsets of the 2007 design value, therefore driving down the concentration from each of these categories. Note that the small contribution from tire and brake wear that is projected to increase slightly with the growth in vehicle travel is reflected in the projection as well as an unchanged contribution from natural sea salt particulate (marine). When these projected reduction calculations were complete, the source specific subsets of the design value were added back together to provide an estimated future year 2019 design value. The results of this analysis for the Fresno and Bakersfield areas are summarized in Table 1 below.

Table 1. Summary of Results of Speciated Linear Rollback Analysis (in µg/m^3)

Region	2007 24-hr PM2.5 Design Value	Projected 2019 24-hr PM2.5 Design Value
Fresno	63	31.8
Bakersfield	66	35.2

As the summary in Table 1 indicates, the speciated linear rollback analysis estimates that both the Fresno and Bakersfield areas are projected to attain the 24-hour PM2.5 standard of 35.4 ug/m3 by 2019. Therefore the application of the reduction in the emissions inventory (from 2007 to 2019) to the respective source specific subsets of the 2007 design value concentration drive the total mass below the attainment target by the deadline.

To compare these results against those of the regional photochemical modeling analysis, Table 2 below shows both the speciated linear rollback and regional model final figures for Fresno and Bakersfield.

Table 2. Comparison of Results between Speciated Linear Rollback Analysis and Regional Photochemical Model (in µg/m^3)

Region	Speciated Linear Rollback Projected 2019 24-hr PM2.5 Design Value	Regional Model Projected 2019 24-hr PM2.5 Design Value
Fresno	31.8	30.5
Bakersfield	35.2	35.4

As can be observed, the results of the speciated linear rollback analysis drive the 2019 design value down to a value comparable to the projected design value from the regional model. Since these two approaches arrive at a similar conclusion, this builds confidence into the control strategy and technical analysis developed for this plan. In summary, the speciated linear rollback analysis provides a corroborative piece to the regional model, and adds to the weight-of-evidence that the District's current control strategy and the further reductions committed to in this plan will be successful in attaining the current federal 24-hour PM2.5 standard by 2019.

San Joaquin Valley PM2.5 Weight of Evidence Analysis

Appendix 6

Unmonitored Areas Analysis

Unmonitored Area Analyses for the 2012 24-Hour $PM_{2.5}$ State Implementation Plan for the San Joaquin Valley

1. Introduction:

The U.S. EPA guidance for $PM_{2.5}$ modeling (U.S. EPA, 2007) recommends an analysis known as the “Unmonitored Area Analysis” that requires testing all grid cells in the modeling domain for their potential to violate the NAAQS. The guidance (U.S. EPA, 2007) also provides a procedure for this analysis and recommends using a software package known as the Model Attainment Test Software (MATS) (Abt Associates, Inc., 2010). However, in 2011 U.S. EPA issued an addendum to the modeling guidance which changed the procedure for the 24-hour $PM_{2.5}$ attainment test (U.S. EPA, 2011). This addendum did not contain guidance on a modified Unmonitored Area Analysis that matched the new attainment test. Therefore, the staff of the Air Resources Board has constructed the following Unmonitored Area Analysis approach. In brief, this analysis has following steps.

- For each of the three years and for the first and fourth quarters that are used for the attainment test, identify the top 8 days with high $PM_{2.5}$ measured with the Federal Reference Method (FRM) anywhere in the San Joaquin Valley (SJV). This results in a total of 48 days over three years.
- Interpolate speciated FRM values for each of these top 48 days using inverse distance weights.
- For each day, multiply nitrate, sulfate, organic carbon, elemental carbon, salt, and geologic fractions in each grid cell by the corresponding simulated Relative Response Factor (RRF) for that chemical component. Obtain the ammonium ion field by ion balancing nitrate and sulfate. Then, calculate particle bound water explicitly.
- Add the chemical components for each day for each grid cell.
- For each year and each grid cell, sort the 16 days for that year and select the 3rd highest value. This is the 98th percentile for that year for that grid cell.
- Average the 98th percentile value for each grid cell for each of the three years to obtain a relative design value for that grid cell.
- Examine the relative design value field to determine if there are peak values higher than those at the monitors that could cause violations of the NAAQS.

More details on each step are provided in the subsequent sections.

2. Methodology and Discussion:

2.1. Identification of the Top 8 Days per Quarter:

We have taken all available FRM measurements for the years 2005 through 2007 and selected those days that fall on a regular one-in-three-day schedule. While some monitors collect data more frequently, this allowed us to select the days for which nearly all stations had data. This was important for subsequent interpolations. The days selected for each year and quarter are shown in Table 1.

Table 1: The top 8 days selected for each year and quarter.

Year	Quarter	ID	Sampling Day	SJV Max	Bakersfield – 410 E Planz	Bakersfield – 5558 California	Corcoran-Patterson	Visalia-N Church	Fresno-Hamilton and Winery	Fresno-1st Street	Clovis-N Villa Avenue	Merced-2334 M	Modesto-14th	Stockton – Hazelton
2005	1	1	3/11	**53**	51.6	50.8	48.1	50	45.7	53	12.1	34	23	19
2005	1	2	2/3	**53**	26	31.1	41	29	36	36	27.5	48.6	53	44
2005	1	3	2/6	**50.5**	41.8	50.5	34.5	46	41.3	40	41.3	19	9	7
2005	1	4	2/12	**47.3**	40.2	47.3	24.3		23.7	23	26.2	18.3	31	22
2005	1	5	1/16	**47**	26.6	43.4	35		47	39	37.8	31.5	42	27
2005	1	6	2/9	**38.7**	33.4	38.7	31.4	36	30.1	27	23.6	29.4	21	16
2005	1	7	1/25	**37.9**	27.3		32.2	32	33.9	35	32.1	37.9	30	32
2005	1	8	3/8	**34.9**	13.3	34.9	33.4	30	18.2	18	15.8	24.8	29	23
2005	4	13	12/12	**92.5**			92.5	84	79	86	77		80	63
2005	4	14	11/24	**85.7**		85.7	77.8	79	74.1	71	67.1	48.3	37	31
2005	4	15	12/15	**80.1**	77.5	80.1	74.5	54	71.2	62	47.2	38.3	45	43
2005	4	16	11/21	**71.7**	71.7		64.6	47	43.9	51	37.6	46	61	46
2005	4	17	12/6	**67**	47.6	54.1	50.7	54	57	67	56.9	46.8	55	37
2005	4	18	12/9	**66**			57.7	65	61	66	63	53.9	39	28
2005	4	19	11/15	**56**	41.3	39.7	36.7	49	49	56	49.8	44	13	11
2005	4	20	10/22	**55.5**		55.5	43.2	34	33.9	32		22	17	12
2006	1	26	2/13	**71**		62.5	32.1	65	65	71	65.8	34.7	27	22
2006	1	27	2/10	**63.8**	33	60.5	63.8	49	52.7	56	41.8	43.8	52	42
2006	1	28	2/7	**45.7**	43.8	45.7	30.4	32	27.3	26	19.9	28.5	22	22
2006	1	29	1/23	**43**	32.5	32.8	23.3	34	35.5	43	37.2	28.5	21	17
2006	1	30	2/25	**42**			38.7	29	28.2	28	22.6	23.9	42	35

Year	Quarter	ID	Sampling Day	SJV Max	Bakersfield – 410 E Planz	Bakersfield – 5558 California	Corcoran-Patterson	Visalia-N Church	Fresno-Hamilton and Winery	Fresno-1st Street	Clovis-N Villa Avenue	Merced-2334 M	Modesto-14th	Stockton – Hazelton
2006	1	31	2/1	**41**	17.3	15.6	23.9	31	36.7	41	33.3	17.6	21	17
2006	1	32	1/11	**38**	36.3	35.1	29.2	31	30.1	32	28.7	27.5	38	38
2006	1	33	1/5	**37**		29.8	24.4	29	26.1	30	20.3	26.5	37	30
2006	4	40	12/7	**87**	78.6	77.7	74.2		87		60.5	55.8	71	47
2006	4	41	12/25	**71.2**		71.2	33.3	42	46.2	58	22	42.5	39	36
2006	4	42	11/19	**64.7**	64.7		22.5	27	30.3	31	28.6	27.1	23	22
2006	4	43	12/31	**57**		49.6	44	45	53.5	57	51.3	52.5	54	47
2006	4	44	11/22	**57**	50.2	53.1	42	57	40.6	49	39.6	32.8	22	21
2006	4	45	12/4	**55**		47.5	45.7	28	55		40.5	43	45	36
2006	4	46	11/7	**53**		53	50.1	47	33	35		19	19	14
2006	4	47	12/19	**51**	18.7	23.6	30.6	30	36.7	51	34.6	32.2	44	36
2007	1	57	2/5	**90.7**	90.7	85.8	75	71	52.5	51	34.8	52.7	64	50
2007	1	58	1/9	**69.8**	67	69.8	56.1	56		62	47.9	46.7	50	48
2007	1	59	1/21	**65.1**		27	44	33	65.1	46	61.2	53	17	14
2007	1	60	1/3	**60**		45.5	53.9	52	55.3	60	42.2	42.2	44	32
2007	1	61	1/24	**59.5**		51.1	59.5	51	48.7	48	40.4	50.7	56	52
2007	1	62	2/2	**55.2**	55.2	49.3	34.5	39	32.9	35	31.7	36.8	37	41
2007	1	63	1/15	**55**	23	28.7	30.7	35	54.2	55		41.8	42	34
2007	1	64	2/8	**53**		39.8	33.2	53	43.5	44	36.4	36.8	49	42
2007	4	74	11/29	**81.6**	43.8	42	45.5	59.7	57.9	64.4	64.7	81.6	59.7	47.5
2007	4	75	11/2	**72.2**	72.2	71.5	53.3	58.4	35.3	40.8	30.5	29.3	23.4	24.5
2007	4	76	12/14	**70.7**	66	70.7	57.7	60.4	55.2	66.5	60.9	49.7	53.9	45.5
2007	4	77	12/11	**59.7**	40.2	42	54	39.8	57.4	59.7	58.2	35.7		6.8
2007	4	78	11/8	**57.9**	53.1	56.2	57.9		53.3	55.3	50	34.2	25.7	22.3
2007	4	79	11/26	**57.4**	48.7	52.1	40	49	47.2	50.5		46.6	57.4	43
2007	4	80	12/23	**54.6**		52.5	37.3	43.8	44.8	54.6	52.5	44.5	26.2	19.8
2007	4	81	11/14	**52.7**	43.4	48.7	52.7	42.9	32.8	35.5	32.1	26.5	21.3	12.8

2.2. The Interpolation of Speciated FRM Measurements:

Table 1 shows 10 monitoring stations with either direct or inferred chemical speciation information. First, FRM measurements for each day were speciated with the speciation profiles appropriate for the quarter that day was in. Those speciated fractions were then interpolated using an inverse distance weight.

The speciation fractions we used during the interpolation are shown in Tables 2 and 3. These speciation fractions were derived following the Sulfate, Adjusted Nitrate, Derived Water, Inferred Carbonaceous Material Balance Approach (SANDWICH) described in the peer-reviewed literature (Frank, 2006) and in the guidance (U.S. EPA, 2007).

Table 2: Speciation fractions used for the first quarter of each year. The monitors in the header are located from south to north in the San Joaquin Valley and their long names are listed in the header of Table 1 from left to right.

	BEP	BAK	COP	VCS	FSH	FSF	CLO	MRM	M14	SOH
NH4	0.1293	0.1293	0.1424	0.1390	0.1198	0.1198	0.1384	0.1306	0.1307	0.1306
NO3	0.3992	0.3992	0.4456	0.4010	0.3704	0.3704	0.4509	0.3883	0.4232	0.4186
SO4	0.0358	0.0358	0.0692	0.0602	0.0328	0.0328	0.0399	0.0476	0.0418	0.0485
OC	0.2849	0.2849	0.2312	0.2912	0.3454	0.3454	0.2211	0.3122	0.2898	0.2586
EC	0.0361	0.0361	0.0086	0.0099	0.0416	0.0416	0.0400	0.0169	0.0136	0.0172
Salt	0.0063	0.0063	0.0051	0.0043	0.0056	0.0056	0.0046	0.0070	0.0049	0.0071
Geologic	0.0317	0.0317	0.0189	0.0154	0.0130	0.0130	0.0192	0.0217	0.0152	0.0392
PBWater	0.0768	0.0768	0.0790	0.0790	0.0713	0.0713	0.0859	0.0756	0.0807	0.0803
Total	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Table 3: Speciation fractions used for the fourth quarter of each year. The monitors in the header are located from south to north in the San Joaquin Valley and their long names are listed in the header of Table 1 from left to right.

	BEP	BAK	COP	VCS	FSH	FSF	CLO	MRM	M14	SOH
NH4	0.1482	0.1482	0.1485	0.1388	0.1106	0.1106	0.1290	0.1110	0.1152	0.1146
NO3	0.4546	0.4546	0.4901	0.4410	0.3494	0.3494	0.4253	0.3516	0.3833	0.3790
SO4	0.0431	0.0431	0.0331	0.0288	0.0244	0.0244	0.0297	0.0238	0.0209	0.0242
OC	0.2106	0.2106	0.1818	0.2546	0.3809	0.3809	0.2634	0.3870	0.3631	0.3371
EC	0.0318	0.0318	0.0172	0.0199	0.0473	0.0473	0.0454	0.0350	0.0281	0.0356
Salt	0.0037	0.0037	0.0051	0.0043	0.0062	0.0062	0.0051	0.0078	0.0055	0.0079
Geologic	0.0204	0.0204	0.0348	0.0283	0.0144	0.0144	0.0212	0.0165	0.0116	0.0298
PB Water	0.0876	0.0876	0.0893	0.0842	0.0668	0.0668	0.0807	0.0672	0.0724	0.0718
Total	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

However, the positioning of the FRM monitoring stations in the San Joaquin Valley poses a special challenge during the interpolation. They are nearly lined up on a northwest to southeast diagonal of the modeling domain. When the FRM specie fractions are interpolated, they form bands perpendicular to that diagonal. These bands extend from the coastal mountains to the Sierras and register high $PM_{2.5}$ values outside of the nonattainment area. To reduce the effect of this geometrical artifact on the current analysis, during the interpolation we have applied a mild decay function in the form of $(1/\text{distance})^a$, where a=0.25.

Also note in Table 1 that not all monitors have FRM measurements for all days. Thus, we had to use only the available measured values for the interpolation for a given day. This has the effect of mixing measured and interpolated values at a given monitor for a given quarter.

2.3. Application of RRF to Interpolated Speciated FRM Fields:

The speciated FRM fields for each day were then multiplied by the simulated quarterly RRF fields appropriate for that day to obtain the 2019 concentrations.

The simulation of $PM_{2.5}$ loadings and chemical component specific RRFs are described in detail in the modeling protocol document (ARB, 2012) in this package. In short, we have simulated the first and fourth quarters of 2007 as the base case. We used the Mesoscale Meteorological Model version 5 (MM5; Grell et al., 1994) to simulate gridded hourly meteorological fields for 2007, which were in turn used to drive the Community Multi-scale Air Quality (CMAQ) Model v4.7.1 (Byun and Schere, 2006;

Foley et al., 2010), with the SAPRC99 chemical mechanism (Carter, 2000) and the aero5 aerosol module.

Simulations were conducted at a 12-km resolution for the entire state and nested down to 4-km for the SJV. Chemical boundary conditions for the 12-km domain were provided by downscaled MOZART global chemistry model (Emmons et al., 2010) output for the year 2007 (http://www.acd.ucar.edu/wrf-chem/mozart.shtml).

The simulated future year is 2019. We have used the same inputs for that simulation except for the anthropogenic emissions that were projected to 2019. The top 10% of the simulated chemical specie concentrations were averaged for each quarter for both 2007 and 2019. RRFs were calculated for each chemical species as the ratio between 2019 and 2007 for each grid cell for each quarter.

The 2019 species concentrations for each grid cell for each day were summed to obtain the total $PM_{2.5}$.

2.4. Determination of the 98th Percentile and the relative design value for each Grid Cell:

As mentioned previously, the data in Table 1 were selected on a one-in-three-day schedule so that nearly all stations would have measured data. This makes the 98th percentile the third highest value. Therefore, we sorted the total $PM_{2.5}$ concentration for each grid cell for a given year (16 days) and selected the third highest value as the 98th percentile for that grid cell for that year. The average of the 98th percentile value for a given grid cell over three years was the relative design value for that grid cell. This relative design value is used only on a relative basis for the identification of unmonitored peaks that may violate the NAAQS.

2.5. Identification of Unmonitored Peaks:

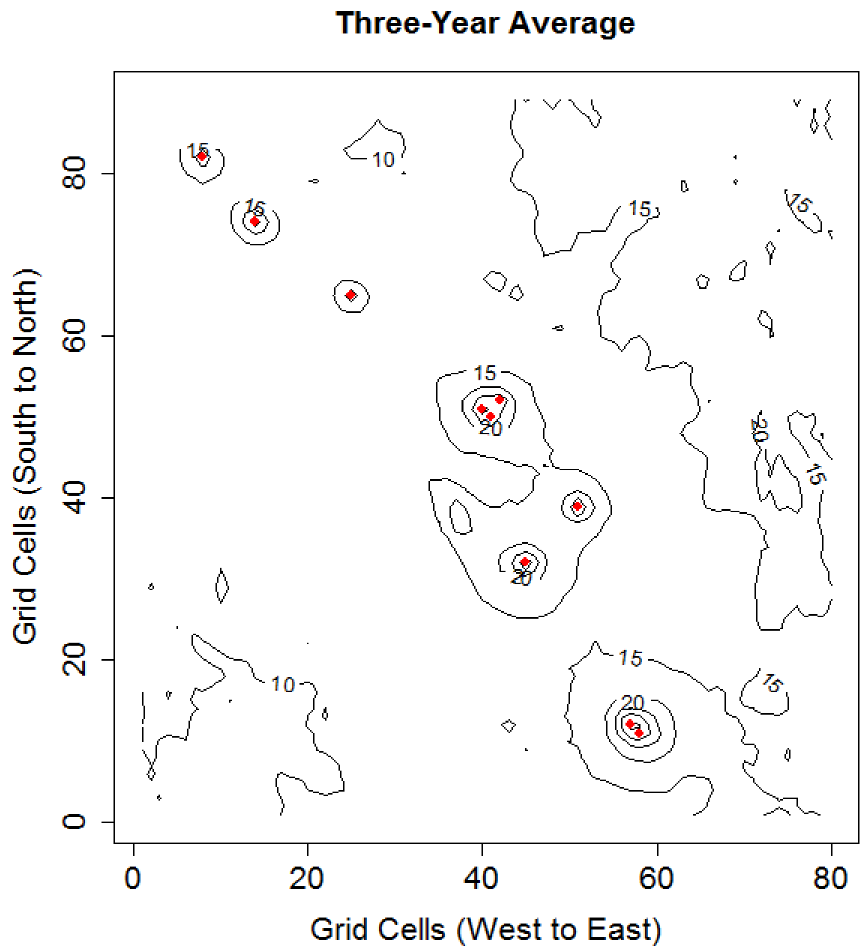

Figure 1: The 3-year average of the 98th percentile values for 2017-2019. The red dots are the FRM monitoring stations from south to north in the order listed in Table 1 from left to right.

Figure 1 shows the final result of this analysis. The highest value occurs at grid cell (57,12) which is the location of the Bakersfield - California Street FRM station. Therefore, there is no higher peak value in an unmonitored area in the domain.

3. Conclusions:

There is no guidance on how to perform the unmonitored area analysis for the 24-hour $PM_{2.5}$ standard within the framework of the new attainment test (U.S. EPA, 2011). Therefore, we have designed a test to do so. We included a mild decay function that remedies a geometric artifact due to the near-linear positioning of the FRM stations in the San Joaquin Valley.

The highest three-year average value calculated with this method occurs at the Bakersfield – California Street FRM monitor. This monitor is projected to be in attainment of the 24-hour $PM_{2.5}$ NAAQS pursuant to the current plan. Therefore, this analysis projects that there will not be an unmonitored peak anywhere in the modeling domain that would violate the 24-hour $PM_{2.5}$ NAAQS.

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Appendix H

Emission Reduction Credits

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Appendix H: Emission Reduction Credits

H.1 INTRODUCTION

The District requires most new and modified stationary sources that increase emissions in amounts in excess of specific emission offset thresholds to obtain emission reduction credits (ERCs) to offset the growth in emissions. District Rule 2201 (New and Modified Stationary Source Review, or NSR, Rule) contains the offset requirements. Offsets represent either on-site reductions or the use of banked ERCs. The District expects that some pre-baseline credits (pre-2007 for the modeling used in this PM 2.5 Plan) will be used to mitigate growth from permitted stationary sources during the period of this plan. This Appendix discusses the use of such ERCs in the SJVAB.

H.2 PRE-BASELINE EMISSION REDUCTION CREDITS

The General Preamble to the Federal Clean Air Act (57 FR 13498) states that the pre-baseline ERCs must be reflected as growth and included in the attainment demonstration "*to the extent that the State expects that such credits will be used as offsets or netting prior to attainment of the ambient standards.*" The August 26, 1994 memorandum from John Seitz, EPA's Director of Office of Air Quality Planning and Standards, to David Howekamp of EPA Region IX, provides two ways for inclusion of these ERCs as growth by stating that "*A state may choose to show that the magnitude of the pre-1990* (pre-baseline) *ERCs (in absolute tonnage) was included in the growth factor, or the state may choose to show that it was not included in the growth factor, but in addition to anticipated general growth.*"

By including the pre-baseline ERCs in the growth factor, the District has selected the first methodology provided in Seitz's memorandum. However, in either case, the purpose is to show that this plan, by including pre-baseline ERCs as a part of expected growth, will result in a projected inventory adequate to attain the NAAQS and achieve any applicable rate of progress:

projected inventory = baseline inventory + growth + ERCs(pre-baseline) – offsets – reductions

where: growth = non-permitted growth + permitted growth

offsets = ERCs(post-baseline) + ERCs(pre-baseline)

reductions = reductions required by the measures in the Plan

<u>Growth Estimates</u>: The emissions trends and growth estimates in this plan were generated using the reports from the California Emissions Projection Analysis Model (CEPAM). The emissions inventory and associated emissions projections are based on ARB's latest PM 2.5 SIP Planning Projections (Norcal 2012 PM2.5 SIP Version 1.03). CEPAM's computer tools were used to develop projections and emission estimates based on the most current available growth and control data available at the time of the forecast runs. CEPAM was first developed in the 1990s (called CEFS at the time) to

assist in developing air quality plans, determining how and where air pollution can be reduced, tracking progress towards meeting plans goals and mandates, and constructing emission trends, and has been updated regularly since then.

A key component of CEPAM is the growth data. The growth estimates generated by CEPAM include growth in emissions requiring offsets under the New Source Review Rule as well as that which can be accommodated without triggering offsets. Tables H-1 through H-4 show total projected growth from stationary sources of 0.835 tons/day of directly emitted PM 2.5, and, for PM 2.5 precursors, growth of 1.08 tons/day of NOx, 0.264 tons/day of SOx, and 14.8 tons/day of VOC, for the period of 2007 through 2019. The CEPAM inventory shows negative growth for some segments of the economy, representing a shrinking emissions inventory even before considering reductions required by District plans. However, for the purposes of this ERC-use analysis, the District did not include these negative growth numbers (by setting negative growth to zero), as only positive growth requires offsetting with ERCs.

The CEPAM projected inventory for 2019 shown in the table does incorporate the projected growth (both positive and negative) as well as the expected controls from the measures contained in prior plans. Notwithstanding slight rounding errors, the projected 2019 inventory equals the baseline inventory plus the projected growth minus the expected reductions from the controls contained in previously adopted plans. Reductions due to this PM 2.5 plan are not incorporated in these projections, and do not affect the amount of offsets estimated to mitigate the projected growth.

<u>Emissions Offset Requirements:</u> Under District's New Source Review Rule 2201, new sources with emissions exceeding the following level must offset their emissions:

NOx ………………………………..	20,000 lbs/year
VOC………………………………..	20,000 lbs/year
PM10……………………………….	29,200 lbs/year
SOx…………………………………	54,750 lbs/year

Additionally, for existing facilities with emissions meeting or exceeding the above levels, any increase in emissions must be offset.

Also, PM2.5 offsets would be required for any new major PM2.5 source (exceeding 100 tons per year of direct PM2.5 emissions), or for major modifications at existing major PM2.5 sources (emissions increases of 20,000 lbs PM2.5 per year at an existing major PM2.5 source).

<u>Use of Interpollutant Offsets:</u> Under the District's New Source Review Rule 2201, offsetting emissions increases with reductions in precursor pollutants is allowed, within some specified limitations. Interpollutant offsets between PM2.5 and PM2.5 precursors are specifically allowed by Rule 2201 at specific ratios "*as established by US EPA, or as approved into the State Implementation Plan by the US EPA*." Upon approval of this

attainment plan into the State Implementation Plan by EPA, the following interpollutant trading ratios will be approved for use within the San Joaquin Valley Air District:

NOx:PM2.5 ……………………. 5.3 to 1
SOx:PM2.5 ……………………. 4.1 to 1

In the past, the District has determined interpollutant relationships for PM2.5 and PM10 using a method called "speciated linear rollback" in which a pollutant's precursor emissions are reduced at the same rate of reduction of the applicable portions of the emissions inventory. However, EPA rejected this method in their 2011 TSD for the District's Revised 2008 PM2.5 SIP.

The new interpollutant offsetting ratios presented here were developed using EPA's suggested method of photochemical modeling. The District has enlisted the assistance of the ARB to develop interpollutant relationships based on the same photochemical modeling processes used to develop the PM2.5 attainment approach in this plan. ARB proposed, and then performed the analysis of, an examination of the effect of domain-wide (District-wide) pollutant-by-pollutant emissions reductions on local ambient concentrations for each of the counties in the SJVAB, using that photochemical model. It was determined that the results of this analysis are the best available representation of local effects of emissions reductions generated throughout the Valley, and the District is therefore proposing to use the valley-wide average of those specific site-based interpollutant relationships. See Attachment 1 to this Appendix for ARB's technical analysis of this approach.

Two other approaches were examined before choosing to go with the Valley-wide approach:

- First, the District examined whether there were significant differences in the results when analyzing the effect of local (county-wide) reductions (rather than domain-wide reductions) on local ambient concentrations, but using the same photochemical modeling discussed above (see Attachment 1). The results were somewhat lower (5.2:1 for NOx and 2.9:1 for SOx), but the use of these ratios would need to be accompanied by an as yet undetermined distance ratio, since the analysis only examined local reductions while the NSR rule allows the use of reductions from anywhere in the San Joaquin Valley to offset local emissions increases. For instance, if a distance ratio of 1.5 was found to be appropriate, the SOx:PM2.5 ratio using this approach would be 2.9 x 1.5 = 4.3. Since the resulting offset ratios were similar to the domain-wide analysis, and the domain wide-analysis doesn't require the further justification of a distance ratio, it was decided to use ARB's domain-wide analysis.

- Second the District re-examined the speciated linear rollback approach. As seen in Attachment 1 the results of the new speciated linear-rollback modeling effort remain similar to those determined in past District analyses. Specifically, the linear rollback results in a valley average (between Fresno and Bakersfield)

NOx:PM2.5 ratio of about 2.3:1, and a SOx:PM2.5 ratio of 1:1. These ratios would also require a distance ratio for use as NSR offsets. These results are presented here in the interests of full disclosure and to demonstrate that EPA's preferred method is indeed more conservative and will require more precursor reductions to offset a given PM2.5 increase.

It should be noted that no interpollutant ratio has been developed for VOC reductions to mitigate PM2.5 increases, and therefore no interpollutant trading between VOC and PM2.5 will be allowed by District Rule 2201.

Pre-Baseline Offset Usage Estimate: The amount of offsets expected to be consumed during this plan's period was estimated by establishing the percentage of permitting actions for each source category that would be subject to offset requirements under Rule 2201. For each source category, this percentage was established based on past permitting history, the fraction of sources in the category with emissions at or above the offset trigger levels, and any expected changes in permitting activity for the source category. The following factors were used in estimating the potential need for offsets:

- All increases from modifications to existing sources with potential emissions at or above the above offset thresholds would require offsets (District Rule 2201).
- New sources with emissions exceeding the above offset thresholds would require offsets (District Rule 2201).
- The percentage of sources that meet any of the above criteria was estimated by examining past permitting history and by projecting future permitting based on the estimated growth. For instance, the majority of permitting actions with increases in emissions from oil production facilities come from sources with potential emissions in excess of the above offset thresholds. Therefore, for that source category, it was assumed that 80-100% of increases in overall emissions would require offsets.

The quantity of required offsets was then established by multiplying the expected growth in emissions for each source category (from CEPAM) by this percentage and the expected offset ratio. District Rule 2201 establishes offset ratios ranging from 1.0:1 to 1.5:1 based on the distance from the source of ERCs to the source with increase in emissions. An offset ratio of 1.5:1 applies to all transactions where the distance is greater than 15 miles, and to all off-site VOC and NOx offsetting. For calendar years 2007 and 2012, the average offset ratio for all permitting actions varied from 1.32:1 for NOx, to 1.36:1 for SOx and PM10, to 1.37:1 for VOC. The District has therefore used a distance ratio of 1.37 for all pollutants for this analysis. Tables H-1 through H-4 contain the expected growth, percentage of activities subject to offset requirements, and the expected quantity of offsets for each pollutant.

Although some offsets are expected to come from post-baseline reductions, this plan conservatively assumes that all offsets will be pre-baseline. See Table H-5 for a current list of District-issued ERCs, as of November 2012. These ERCs and future ERCs (and any ERCs generated from them) are available to be used in the District's NSR program. The expected ERC usage after 2007 and through 2019, as shown in Tables H-1 through H-4, has been estimated in this plan as follows:

	Expected ERC Use (tpd)	ERC Use (PM2.5 Equivalents) (tpd)	Growth (tpd)	Growth (PM2.5 Equivalents) (tpd)
PM 2.5	0.64	0.64	0.835	0.084
NOx	0.99	0.19	1.08	0.20
SOx	0.17	0.04	0.264	0.06
VOC	7.50	NA	14.8	NA
Total		**0.87**		**1.10**

As shown above, the quantity of pre-baseline offsets (conservatively considering all ERCs used to be pre-baseline ERCs) that are expected to be used between 2007 and 2019 ("Expected ERC Use" column) is less than the plan's estimated growth in emissions for each pollutant ("Growth" column). As can also be seen, the same conclusion is reached after converting the expected ERC use and growth to PM2.5-equivalents. Specifically, total ERC usage, after converting to PM2.5 equivalents using the interpollutant ratios specified above, is less than the total growth after converting growth to PM2.5 equivalents.

Therefore, if growth in new and modified sources occurs at the rate estimated in this plan, the use of offsets as required in Rule 2201 will ensure that permitted increases in emissions will not interfere with progress toward attainment of federal PM 2.5 standards. As discussed in Chapter 9, the District also satisfies the requirement for reasonable further progress with the above-mentioned projected inventories and without taking credit for the ERCs required of and provided by new and modified stationary sources permitted during this period.

<u>Safeguards to assure plan integrity despite the use of pre-baseline credits:</u> In order to assure that the use of pre-baseline ERCs does not interfere with attainment effort and the applicable rate of progress, this plan incorporates the following safeguards:

- The District will place a cap on the amount of PM2.5-equivalent pre-baseline credits that can be used. Although the District has relied on a number of conservative assumptions in estimating the usage quantity of pre-baseline credits, some degree of uncertainty exists. For instance, unexpected growth or irregular permitting activity may occur for one or more source categories. The cap on the use of pre-baseline ERCs will be enforced by tracking the use of such credits and disallowing the use of pre-baseline credits in permitting actions when the above-specified PM2.5-equivalent growth level is reached. The second column of the table above lists expected ERC use for stationary source growth, for each pollutant. The cap on pre-baseline ERC usage is the total PM2.5-equivalent ERCs, in the amount of 0.87 tons per day, with NOx and SOx usage calculated at the appropriate interpollutant offset ratio specified above. Since there is no interpollutant ratio established for VOC, VOC ERC use will be capped at the expected use of 7.5 tons/day. The appropriate proportion of PM10 credits used as PM 2.5 credits for offsetting purposes will be included in the PM 2.5 cap. These ERC usage caps replace any caps established in prior plans.

- These caps apply to the use of NOx and SOx ERCs in their application as offsets for direct emissions as well as in their use as PM 2.5 precursor interpollutant offsets. Thus, to the extent that precursor ERCs are used to offset direct increases of these respective precursors, these same ERCs will no longer be available to offset PM 2.5 increases. While no VOC:PM2.5 interpollutant ratio has yet been developed by the District or ARB for NSR offsetting purposes, interpollutant trading ratios for NOx:PM2.5 and SOx:PM2.5 have been developed, as discussed in this Appendix above, and approval of this plan will allow NOx and SOx emissions reductions to be used at the approved ratios to offset PM 2.5 increases.

- Although some ERCs will come from post-baseline reductions, this plan conservatively assumes that all offsets will come from pre-baseline reductions. As discussed earlier, federal law only requires the pre-baseline ERCs to be included in the growth and the attainment demonstration. This plan assumes that all ERCs used to offset emission increases will be pre-baseline ERCs and, therefore, includes them all within the projected inventory as growth. Using this higher projected inventory leads to conservative conclusions relating to the attainment and rate of progress demonstrations.

- Although permissible, this plan does not take credit for reductions and mitigations required under the District's New and Modified Stationary Source Review Rule. In particular, this plan does not reduce the future years' emissions by taking credit for the amount of ERCs provided through permitting actions. This conservative approach further assures that the attainment demonstration is not affected by the use of pre-baseline ERCs.

Table H-1
Estimated PM2.5 Growth, Control, and Estimated Offset Use

SUMMARY CATEGORY NAME	2007 Emissions Tons/day	Growth Factor (%)	Estimated Growth (tons/day)	Control Factor (%)	Reductions (tons/day)	2019 Emissions Tons/day	Percent Requiring Offsets	Estimated Offsets* (tons/day)
FUEL COMBUSTION								
ELECTRIC UTILITIES	1.415	-4.81%	0.000	0.00%	0.000	1.347	100	0.000
COGENERATION	0.784	24.62%	0.193	0.00%	0.000	0.977	80	0.154
OIL AND GAS PRODUCTION (COMBUSTION)	1.935	-24.34%	0.000	0.05%	0.001	1.464	80	0.000
PETROLEUM REFINING (COMBUSTION)	0.172	0.00%	0.000	0.00%	0.000	0.172	80	0.000
MANUFACTURING AND INDUSTRIAL	0.205	-5.37%	0.000	0.00%	0.000	0.194	25	0.000
FOOD AND AGRICULTURAL PROCESSING	0.75	-5.46%	0.000	-43.33%	-0.325	0.385	20	0.000
SERVICE AND COMMERCIAL	0.367	5.18%	0.019	0.00%	0.000	0.386	25	0.005
OTHER (FUEL COMBUSTION)	0.015	0.00%	0.000	-33.33%	-0.005	0.01	25	0.000
TOTAL PM2.5: FUEL COMBUSTION	**5.641**		**0.212**		**-0.329**	**4.935**		**0.159**
WASTE DISPOSAL								
SEWAGE TREATMENT	0.003	33.33%	0.001	0.00%	0.000	0.004	25	0.000
LANDFILLS	0.075	26.67%	0.020	0.00%	0.000	0.095	50	0.010
INCINERATORS	0.016	25.00%	0.004	0.00%	0.000	0.02	25	0.001
SOIL REMEDIATION	0.002	0.00%	0.000	0.00%	0.000	0.002	25	0.000
OTHER (WASTE DISPOSAL)	0.002	0.00%	0.000	0.00%	0.000	0.002	25	0.000
TOTAL PM2.5: WASTE DISPOSAL	**0.097**		**0.025**		**0.000**	**0.123**		**0.011**
CLEANING AND SURFACE COATINGS								
LAUNDERING	0	0.00%	0.000	0.00%	0.000	0	25	0.000
DEGREASING	0.017	23.53%	0.004	0.00%	0.000	0.021	50	0.002
COATINGS AND RELATED PROCESS SOLVENTS	0.068	47.06%	0.032	0.00%	0.000	0.1	25	0.008
PRINTING	0	0.00%	0.000	0.00%	0.000	0	10	0.000
ADHESIVES AND SEALANTS	0	0.00%	0.000	0.00%	0.000	0.001	10	0.000
OTHER (CLEANING/SURFACE CTNGS)	0	0.00%	0.000	0.00%	0.000	0	50	0.000

Table H-1
Estimated PM2.5 Growth, Control, and Estimated Offset Use

SUMMARY CATEGORY NAME	2007 Emissions Tons/day	Growth Factor (%)	Estimated Growth (tons/day)	Control Factor (%)	Reductions (tons/day)	2019 Emissions Tons/day	Percent Requiring Offsets	Estimated Offsets* (tons/day)
TOTAL PM2.5: CLEANING AND SURFACE COATINGS	**0.085**		**0.036**		**0.000**	**0.122**		**0.010**
PETROLEUM PRODUCTION AND MARKETING								
OIL AND GAS PRODUCTION	0.017	-23.53%	0.000	0.00%	0.000	0.013	80	0.000
PETROLEUM REFINING	0.123	0.81%	0.001	0.00%	0.000	0.124	80	0.001
PETROLEUM MARKETING	0.005	40.00%	0.002	0.00%	0.000	0.007	80	0.002
OTHER (PETROLEUM PRODUCTION AND MARKETING)	0	0.00%	0.000	0.00%	0.000	0	80	0.000
TOTAL PM2.5: PETROLEUM PRODUCTION AND MARKETING	**0.146**		**0.003**		**0.000**	**0.144**		**0.002**
INDUSTRIAL PROCESSES								
CHEMICAL	0.233	-12.45%	0.000	0.00%	0.000	0.204	25	0.000
FOOD AND AGRICULTURE	0.714	25.77%	0.184	-10.50%	-0.075	0.805	50	0.092
MINERAL PROCESSES	1.476	22.15%	0.327	0.00%	0.000	1.803	50	0.164
METAL PROCESSES	0.071	40.85%	0.029	0.00%	0.000	0.1	80	0.023
WOOD AND PAPER	0.213	-7.98%	0.000	0.00%	0.000	0.196	50	0.000
GLASS AND RELATED PRODUCTS	0.601	-6.82%	0.000	-8.99%	-0.054	0.511	100	0.000
ELECTRONICS	0.002	50.00%	0.001	0.00%	0.000	0.003	25	0.000
OTHER (INDUSTRIAL PROCESSES)	0.085	21.18%	0.018	0.00%	0.000	0.103	25	0.005
TOTAL PM2.5: INDUSTRIAL PROCESSES	**3.394**		**0.559**		**-0.129**	**3.725**		**0.283**
TOTAL PM2.5: STATIONARY SOURCES	**9.364**		**0.835**		**-0.458**	**9.049**		**0.639***

Table H-2
Estimated NOx Growth, Control, and Estimated Offset Use

SUMMARY CATEGORY NAME	2007 Emissions Tons/day	Growth Factor (%)	Estimated Growth (tons/day)	Control Factor (%)	Reductions (tons/day)	2019 Emissions Tons/day	Percent Requiring Offsets	Estimated Offsets* (tons/day)
FUEL COMBUSTION								
ELECTRIC UTILITIES	7.092	2.33%	0.165	-27.74%	-1.967	5.746	100	0.165
COGENERATION	2.983	16.02%	0.478	-46.26%	-1.380	2.026	90	0.430
OIL AND GAS PRODUCTION (COMBUSTION)	3.488	-24.34%	0.000	-46.42%	-1.619	1.413	80	0.000
PETROLEUM REFINING (COMBUSTION)	0.709	0.00%	0.000	-30.89%	-0.219	0.49	100	0.000
MANUFACTURING AND INDUSTRIAL	5.103	-2.23%	0.000	-4.61%	-0.235	4.747	30	0.000
FOOD AND AGRICULTURAL PROCESSING	12.73	-1.62%	0.000	-74.01%	-9.422	3.21	30	0.000
SERVICE AND COMMERCIAL	3.97	7.03%	0.279	-12.41%	-0.493	3.636	30	0.084
OTHER (FUEL COMBUSTION)	0.575	7.13%	0.041	-24.17%	-0.139	0.437	25	0.010
TOTAL NOx: FUEL COMBUSTION	**36.65**		**0.963**		**-15.474**	**21.705**		**0.689**
WASTE DISPOSAL								
SEWAGE TREATMENT	0.033	30.30%	0.010	0.00%	0.000	0.043		0.000
LANDFILLS	0.122	27.87%	0.034	0.00%	0.000	0.156		0.000
INCINERATORS	0.083	21.69%	0.018	0.00%	0.000	0.101	100	0.018
SOIL REMEDIATION	0.021	28.57%	0.006	0.00%	0.000	0.027		0.000
OTHER (WASTE DISPOSAL)	0.001	0.00%	0.000	0.00%	0.000	0.001		0.000
TOTAL NOx: WASTE DISPOSAL	**0.26**		**0.068**		**0.000**	**0.327**		**0.018**
CLEANING AND SURFACE COATINGS								
LAUNDERING	0	0.00%	0.000	0.00%	0.000	0		0.000
DEGREASING	0	0.00%	0.000	0.00%	0.000	0		0.000
COATINGS AND RELATED PROCESS SOLVENTS	0	0.00%	0.000	0.00%	0.000	0		0.000
PRINTING	0	0.00%	0.000	0.00%	0.000	0		0.000
ADHESIVES AND SEALANTS	0	0.00%	0.000	0.00%	0.000	0		0.000
OTHER (CLEANING AND SURFACE COATINGS)	0	0.00%	0.000	0.00%	0.000	0		0.000

Table H-2
Estimated NOx Growth, Control, and Estimated Offset Use

SUMMARY CATEGORY NAME	2007 Emissions Tons/day	Growth Factor (%)	Estimated Growth (tons/day)	Control Factor (%)	Reductions (tons/day)	2019 Emissions Tons/day	Percent Requiring Offsets	Estimated Offsets* (tons/day)
TOTAL NOx: CLEANING AND SURFACE COATINGS	**0**		**0.000**		**0.000**	**0**		**0.000**
PETROLEUM PRODUCTION AND MARKETING								
OIL AND GAS PRODUCTION	0.19	-24.21%	0.000	0.00%	0.000	0.144	100	0.000
PETROLEUM REFINING	0.064	0.00%	0.000	0.00%	0.000	0.064	80	0.000
PETROLEUM MARKETING	0.03	36.67%	0.011	0.00%	0.000	0.041	80	0.009
OTHER (PETROLEUM PRODUCTION AND MARKETING)	0.002	0.00%	0.000	0.00%	0.000	0.002	80	0.000
TOTAL NOx: PETROLEUM PRODUCTION AND MARKETING	**0.285**		**0.011**		**0.000**	**0.251**		**0.009**
INDUSTRIAL PROCESSES								
CHEMICAL	0.516	-12.21%	0.000	0.00%	0.000	0.453	25	0.000
FOOD AND AGRICULTURE	0.002	0.00%	0.000	0.00%	0.000	0.002	10	0.000
MINERAL PROCESSES	0.167	21.11%	0.035	-15.25%	-0.025	0.172	25	0.009
METAL PROCESSES	0.002	0.00%	0.000	0.00%	0.000	0.002	10	0.000
WOOD AND PAPER	0	0.00%	0.000	0.00%	0.000	0		0.000
GLASS AND RELATED PRODUCTS	7.751	-8.09%	0.000	-38.89%	-3.014	4.387	100	0.000
ELECTRONICS	0	0.00%	0.000	0.00%	0.000	0		0.000
OTHER (INDUSTRIAL PROCESSES)	0.011	27.27%	0.003	-18.18%	-0.002	0.012	25	0.001
TOTAL NOx: INDUSTRIAL PROCESSES	**8.448**		**0.038**		**-3.041**	**5.028**		**0.010**
TOTAL NOx: STATIONARY SOURCES	**45.643**		**1.080**		**-18.515**	**27.311**		**0.994***

Table H-3
Estimated SOx Growth, Control, and Estimated Offset Use

SUMMARY CATEGORY NAME	2007 Emissions Tons/day	Growth Factor (%)	Estimated Growth (tons/day)	Control Factor (%)	Reductions (tons/day)	2019 Emissions Tons/day	Percent Requiring Offsets	Estimated Offsets* (tons/day)
FUEL COMBUSTION								
ELECTRIC UTILITIES	1.437	-0.97%	0.000	-3.41%	-0.049	1.357	100	0.000
COGENERATION	0.112	88.39%	0.099	0.00%	0.000	0.211	80	0.079
OIL AND GAS PRODUCTION (COMBUSTION)	1.999	-24.36%	0.000	-73.34%	-1.466	0.403	80	0.000
PETROLEUM REFINING (COMBUSTION)	0.296	0.00%	0.000	-73.31%	-0.217	0.079	100	0.000
MANUFACTURING AND INDUSTRIAL	1.099	-2.18%	0.000	-7.79%	-0.086	0.994	25	0.000
FOOD AND AGRICULTURAL PROCESSING	0.255	-26.98%	0.000	-52.16%	-0.133	0.066	10	0.000
SERVICE AND COMMERCIAL	0.369	2.44%	0.009	-12.10%	-0.045	0.332	25	0.002
OTHER (FUEL COMBUSTION)	0.005	0.00%	0.000	0.00%	0.000	0.005		0.000
TOTAL SOx: FUEL COMBUSTION	**5.571**		**0.108**		**-1.995**	**3.447**		**0.081**
WASTE DISPOSAL								
SEWAGE TREATMENT	0.047	31.91%	0.015	0.00%	0.000	0.062		0.000
LANDFILLS	0.054	25.93%	0.014	0.00%	0.000	0.068		0.000
INCINERATORS	0.009	22.22%	0.002	0.00%	0.000	0.011	25	0.001
SOIL REMEDIATION	0.001	0.00%	0.000	0.00%	0.000	0.001		0.000
OTHER (WASTE DISPOSAL)	0	0.00%	0.000	0.00%	0.000	0		0.000
TOTAL SOx: WASTE DISPOSAL	**0.111**		**0.031**		**0.000**	**0.143**		**0.001**
CLEANING AND SURFACE COATINGS								
LAUNDERING	0	0.00%	0.000	0.00%	0.000	0		0.000
DEGREASING	0	0.00%	0.000	0.00%	0.000	0		0.000
COATINGS AND RELATED PROCESS SOLVENTS	0	0.00%	0.000	0.00%	0.000	0		0.000
PRINTING	0	0.00%	0.000	0.00%	0.000	0		0.000
ADHESIVES AND SEALANTS	0	0.00%	0.000	0.00%	0.000	0		0.000
OTHER (CLEANING AND SURFACE COATINGS)	0	0.00%	0.000	0.00%	0.000	0		0.000
TOTAL SOx: CLEANING AND SURFACE COATINGS	**0**		**0.000**		**0.000**	**0**		**0.000**
PETROLEUM PRODUCTION AND MARKETING								
OIL AND GAS PRODUCTION	0.028	-25.00%	0.000	0.00%	0.000	0.021	90	0.000

Table H-3
Estimated SOx Growth, Control, and Estimated Offset Use

SUMMARY CATEGORY NAME	2007 Emissions Tons/day	Growth Factor (%)	Estimated Growth (tons/day)	Control Factor (%)	Reductions (tons/day)	2019 Emissions Tons/day	Percent Requiring Offsets	Estimated Offsets* (tons/day)
PETROLEUM REFINING	0.112	0.89%	0.001	0.00%	0.000	0.113	100	0.001
PETROLEUM MARKETING	0.001	0.00%	0.000	0.00%	0.000	0.001		0.000
OTHER (PETROLEUM PRODUCTION AND MARKETING)	0	0.00%	0.000	0.00%	0.000	0	80	0.000
TOTAL SOx: PETROLEUM PRODUCTION AND MARKETING	**0.14**		**0.001**		**0.000**	**0.135**		**0.001**
INDUSTRIAL PROCESSES								
CHEMICAL	0.977	-12.28%	0.000	0.00%	0.000	0.857	25	0.000
FOOD AND AGRICULTURE	0.222	22.97%	0.051	0.00%	0.000	0.273	50	0.026
MINERAL PROCESSES	0.29	21.38%	0.062	0.00%	0.000	0.352	25	0.016
METAL PROCESSES	0.014	35.71%	0.005	0.00%	0.000	0.019	25	0.001
WOOD AND PAPER	0.003	0.00%	0.000	0.00%	0.000	0.003		0.000
GLASS AND RELATED PRODUCTS	3.036	-5.47%	0.000	-35.24%	-1.070	1.885	100	0.000
ELECTRONICS	0	0.00%	0.000	0.00%	0.000	0		0.000
OTHER (INDUSTRIAL PROCESSES)	0.028	0.214286	0.006	0.00%	0.000	0.034	25	0.002
TOTAL SOx: INDUSTRIAL PROCESSES	**4.57**		**0.124**		**-1.070**	**3.422**		**0.044**
TOTAL SOx: STATIONARY SOURCES	**10.392**		**0.264**		**-3.065**	**7.147**		**0.174***

Table H-4
Estimated VOC Growth, Control, and Estimated Offset Use

SUMMARY CATEGORY NAME	2007 Emissions Tons/day	Growth Factor (%)	Estimated Growth (tons/day)	Control Factor (%)	Reductions (tons/day)	2019 Emissions Tons/day	Percent Requiring Offsets	Estimated Offsets* (tons/day)
FUEL COMBUSTION								
ELECTRIC UTILITIES	0.233	-13.73%	0	0.00%	0	0.201	100	0.000
COGENERATION	0.155	19.35%	0.03	0.65%	0.001	0.185	90	0.027
OIL AND GAS PRODUCTION (COMBUSTION)	1.461	-24.37%	0.000	0.07%	0.001	1.105	95	0.000
PETROLEUM REFINING (COMBUSTION)	0.112	0.00%	0.000	0.00%	0.000	0.112	100	0.000
MANUFACTURING AND INDUSTRIAL	0.249	-5.22%	0.000	0.00%	0.000	0.236	25	0.000
FOOD AND AGRICULTURAL PROCESSING	1.164	-4.31%	0.000	-61.27%	-0.713	0.403	10	0.000
SERVICE AND COMMERCIAL	0.552	3.80%	0.021	0.00%	0.000	0.573	25	0.005
OTHER (FUEL COMBUSTION)	0.07	5.71%	0.004	-18.57%	-0.013	0.057	10	0.000
TOTAL VOC: FUEL COMBUSTION	**3.995**		**0.055**		**-0.724**	**2.871**		**0.033**
WASTE DISPOSAL								
SEWAGE TREATMENT	0.033	24.24%	0.008	0.00%	0.000	0.041	25	0.002
LANDFILLS	1.282	19.11%	0.245	0.00%	0.000	1.527	50	0.123
INCINERATORS	0.01	20.00%	0.002	0.00%	0.000	0.012		0.000
SOIL REMEDIATION	0.182	23.63%	0.043	0.00%	0.000	0.225	10	0.004
OTHER (WASTE DISPOSAL)	23.103	23.31%	5.385	-25.01%	-5.778	21.361	25	1.346
TOTAL VOC: WASTE DISPOSAL	**24.61**		**5.683**		**-5.778**	**23.165**		**1.475**
CLEANING AND SURFACE COATINGS								
LAUNDERING	0.081	18.52%	0.015	0.00%	0.000	0.096	0	0.000
DEGREASING	1.461	9.65%	0.141	-0.07%	-0.001	1.602	10	0.014
COATINGS AND RELATED PROCESS SOLVENTS	7.337	31.06%	2.279	-7.16%	-0.525	9.066	50	1.140
PRINTING	4.446	25.53%	1.135	0.00%	0.000	5.581	25	0.284
ADHESIVES AND SEALANTS	0.652	-14.57%	0.000	-0.15%	-0.001	0.557	25	0.000
OTHER (CLEANING AND SURFACE COATINGS)	3.647	34.71%	1.266	-0.03%	-0.001	4.913	50	0.633

Table H-4
Estimated VOC Growth, Control, and Estimated Offset Use

SUMMARY CATEGORY NAME	2007 Emissions Tons/day	Growth Factor (%)	Estimated Growth (tons/day)	Control Factor (%)	Reductions (tons/day)	2019 Emissions Tons/day	Percent Requiring Offsets	Estimated Offsets* (tons/day)
TOTAL VOC: CLEANING AND SURFACE COATINGS	**17.623**		**4.836**		**-0.528**	**21.814**		**2.070**
PETROLEUM PRODUCTION AND MARKETING								
OIL AND GAS PRODUCTION	28.482	-24.36%	0.000	0.04%	0.012	21.544	80	0.000
PETROLEUM REFINING	1.097	0.82%	0.009	0.00%	0.000	1.106	90	0.008
PETROLEUM MARKETING	6.653	24.52%	1.631	0.02%	0.001	8.284	40	0.652
OTHER (PETROLEUM PRODUCTION AND MARKETING)	0.021	19.05%	0.004	0.00%	0.000	0.025	80	0.003
TOTAL VOC: PETROLEUM PRODUCTION AND MARKETING	**36.253**		**1.644**		**0.013**	**30.957**		**0.664**
INDUSTRIAL PROCESSES								
CHEMICAL	3.436	-12.28%	0.000	0.03%	0.001	3.014	25	0.000
FOOD AND AGRICULTURE	9.461	25.29%	2.393	-0.01%	-0.001	11.854	50	1.197
MINERAL PROCESSES	0.312	21.47%	0.067	0.00%	0.000	0.379	25	0.017
METAL PROCESSES	0.168	7.14%	0.012	0.00%	0.000	0.18	25	0.003
WOOD AND PAPER	0.005	0.00%	0.000	0.00%	0.000	0.005	25	0.000
GLASS AND RELATED PRODUCTS	0.048	-10.42%	0.000	0.00%	0.000	0.043	100	0.000
ELECTRONICS	0	0.00%	0.000	0.00%	0.000	0		0.000
OTHER (INDUSTRIAL PROCESSES)	0.314	21.97%	0.069	0.00%	0.000	0.383	25	0.017
TOTAL VOC: INDUSTRIAL PROCESSES	**13.744**		**2.541**		**0.000**	**15.858**		**1.234**
TOTAL VOC: STATIONARY SOURCES	**96.226**		**14.759**		**-7.017**	**94.665**		**7.501***

*Offset distance ratio of 1.37:1 used for all pollutants, calculated only on the “Total (Pollutant)” lines.

Emissions Inventory used: CEPAM Norcal 2012 PM2.5 SIP Ver 1.03

Table H-5 – List of Emission Reduction Credits
PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
SWANSON HULLING	N	10	4	PM10	0	0	2984	0
WESTERN STONE PRODUCTS, INC.	N	17	4	PM10	513	513	558	558
H. J. HEINZ COMPANY, L.P.	N	21	4	PM10	0	60	180	60
CAMPBELL SOUP SUPPLY CO.	N	31	4	PM10	0	434	1064	0
AERA ENERGY LLC	S	32	4	PM10	0	0	69	120
HOGAN MANUFACTURING, INC	N	34	4	PM10	1972	4031	2344	2712
CALMAT OF FRESNO	C	40	4	PM10	75	359	165	553
SALIDA HULLING ASSOCIATION	N	44	4	PM10	0	0	12246	0
BROWN SAND INC	N	46	4	PM10	1107	1474	840	1099
CLEAN HARBORS BUTTONWILLOW, LLC	S	49	4	PM10	567	573	580	580
CALMAT CO.	C	50	4	PM10	15	16	23	24
WEST ISLAND COTTON GROWERS INC	C	55	4	PM10	0	0	0	4365
DEL MONTE CORPORATION/PLANT #1	N	58	4	PM10	0	0	8410	0
H. J. HEINZ COMPANY	N	60	4	PM10	0	42	226	4
AMERICAN MOULDING & MILLWORK	N	63	4	PM10	1106	701	809	471
CRAYCROFT BRICK COMPANY	C	71	4	PM10	50	40	39	40
CHEVRON USA INC	S	77	4	PM10	3067	2768	2607	3422
CALAVERAS MATERIALS INC	C	89	4	PM10	45	41	47	38
J G BOSWELL COMPANY OIL MILL	C	92	4	PM10	670	460	648	916
J G BOSWELL COMPANY OIL MILL	C	93	4	PM10	2810	2418	2082	4097
THE NESTLE COMPANY INC	N	93	4	PM10	5602	5688	4414	7118
H & H COTTON GINNING COMPANY	C	105	4	PM10	0	0	0	9954
SC JOHNSON HOME STORAGE INC	C	107	4	PM10	326	315	281	269

Table H-5 – List of Emission Reduction Credits
PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
CASTLE AIRPORT AVIATION & DEVELOP CENTER	N	109	4	PM10	6262	6332	6402	6402
LOS BANOS GRAVEL GROUP, ASPHLT	N	125	4	PM10	85	162	376	168
P-R FARMS, INC.	C	126	4	PM10	0	0	357	180
CAMPBELL SOUP COMPANY	N	127	4	PM10	416	289	261	308
ECKERT FROZEN FOODS	N	133	4	PM10	5	20	72	14
CHEVRON USA PRODUCTION INC	S	147	4	PM10	50	57	46	46
R M WADE & COMPANY	C	152	4	PM10	14	17	17	16
BRITZ INCORPORATED	C	159	4	PM10	0	0	0	715
GALLO GLASS COMPANY	N	161	4	PM10	23150	22909	24274	22565
AERA ENERGY LLC	S	202	4	PM10	123	100	70	88
PARAMOUNT FARMS	N	206	4	PM10	0	0	65	52685
CALPINE CORPORATION	N	208	4	PM10	715	8177	6581	715
POHL ALMOND HULLING	N	212	4	PM10	0	0	4279	8511
AERA ENERGY LLC	S	215	4	PM10	403	362	361	406
CALAVERAS MATERIALS INC.	C	233	4	PM10	243	652	759	479
RIO BRAVO FRESNO	C	244	4	PM10	1000	0	0	0
AERA ENERGY LLC	S	254	4	PM10	1093	1174	0	913
AERA ENERGY LLC	S	255	4	PM10	4184	1519	0	1074
AERA ENERGY LLC	S	256	4	PM10	10145	5624	0	0
AERA ENERGY LLC	S	259	4	PM10	1483	1747	0	705
AERA ENERGY LLC	S	260	4	PM10	1858	1946	286	633
AERA ENERGY LLC	S	272	4	PM10	806	760	721	693
PARAMOUNT FARMS, INC	N	284	4	PM10	312	1881	275	275

Table H-5 – List of Emission Reduction Credits
PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
PARAMOUNT FARMS, INC.	C	288	4	PM10	1000	1000	36000	12000
CALPINE CORPORATION	N	297	4	PM10	0	0	101	66394
DEL MONTE CORPORATION	N	316	4	PM10	221	189	388	83
AERA ENERGY LLC	S	319	4	PM10	449	650	497	499
NAS LEMOORE	C	330	4	PM10	17	17	17	17
CHEVRON USA INC	C	331	4	PM10	3766	3767	3767	3767
CHEVRON USA INC	C	339	4	PM10	11300	11300	11301	11301
WESTSIDE FARMERS COOP. GIN	C	352	4	PM10	0	0	0	33444
CHEVRON U S A INC	S	357	4	PM10	137	116	114	153
LIDESTRI FOODS, INC	N	391	4	PM10	0	0	1056	0
J D HEISKELL & COMPANY	S	415	4	PM10	643	322	356	1039
MONTEREY RESOURCES, INC.	S	432	4	PM10	906	918	753	837
TURLOCK IRRIGATION DISTRICT	N	433	4	PM10	0	0	0	4720
CALPINE CORPORATION	C	448	4	PM10	1067	1067	1067	1067
CALPINE CORPORATION	C	449	4	PM10	82	28	373	674
LAWRENCE LIVERMORE NATL. LAB	N	464	4	PM10	8	3	0	6
BRITZ GIN PARTNERSHIP	S	475	4	PM10	0	0	0	4259
CALIFORNIA DAIRIES	N	498	4	PM10	273	313	128	186
PARAMOUNT FARMS, INC.	C	499	4	PM10	78	249	393	346
LA PALOMA GENERATING COMPANY	N	500	4	PM10	11695	16203	9929	8254
CANDLEWICK YARNS	C	507	4	PM10	11	9	7	7
TURLOCK IRRIGATION DISTRICT	C	510	4	PM10	0	0	0	6430
OWENS-BROCKWAY GLASS CONTAINER	N	517	4	PM10	0	0	0	490

Table H-5 – List of Emission Reduction Credits
PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
DOLE PACKAGED FOODS LLC	N	520	4	PM10	5	20	72	14
HURON GINNING CO	C	521	4	PM10	8	373	186	631
GENERAL CABLE INDUSTRIES, LLC	C	524	4	PM10	2	1	2	1
BRITZ AG FINANCE CO., INC.	C	558	4	PM10	0	0	0	5780
BRITZ AG FINANCE CO., INC.	C	559	4	PM10	0	0	0	35897
CORCORAN IRRIGATION DISTRICT	C	560	4	PM10	75	77	74	44
SAINT-GOBAIN CONTAINERS, INC	C	572	4	PM10	18	18	18	18
PACIFIC PIPELINE SYSTEM, LLC	S	575	4	PM10	0	0	108	0
PACIFIC PIPELINE SYSTEM, LLC	S	576	4	PM10	0	203	181	0
PACIFIC PIPELINE SYSTEM, LLC	S	577	4	PM10	710	860	899	899
BRITZ INCORPORATED	C	586	4	PM10	0	0	0	19720
MODESTO TALLOW CO INC	N	599	4	PM10	254	228	279	271
OAKWOOD LAKE RESORT	N	601	4	PM10	0	9	15	0
GENERAL MILLS OPERATIONS, INC	N	608	4	PM10	178	0	385	298
OLDUVAI GORGE, LLC	N	611	4	PM10	0	0	3830	1915
OLDUVAI GORGE, LLC	N	619	4	PM10	1138	1137	1084	1053
WESTERN MILLING, LLC	C	621	4	PM10	152	152	152	152
CHEVRON U S A INC	S	629	4	PM10	24	21	21	21
KRAFT FOODS, INC	S	630	4	PM10	8	70	112	71
DIAMOND FOODS INCORPORATED	N	645	4	PM10	49	0	4	0
KINGS RIVER CONSERVATION DISTRICT	C	649	4	PM10	0	0	0	138
UNITED STATES GYPSUM COMPANY	N	659	4	PM10	0	0	0	23209
UNITED STATES GYPSUM COMPANY	N	660	4	PM10	0	0	0	23515

Table H-5 – List of Emission Reduction Credits
PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
WESTERN MILLING, LLC	C	670	4	PM10	0	0	0	10844
CONAGRA CONSUMER FROZEN FOODS	N	672	4	PM10	135	48	91	137
OLDUVAI GORGE, LLC	N	676	4	PM10	51	40	67	47
OLDUVAI GORGE, LLC	N	677	4	PM10	700	928	1057	930
CE2 ENVIRONMENTAL OPPORTUNITIES I LP	N	684	4	PM10	3855	3652	2906	3860
H. J. HEINZ COMPANY	N	694	4	PM10	0	0	1372	0
CE2 ENVIRONMENTAL OPPORTUNITIES I LP	N	695	4	PM10	0	4710	4761	4191
CE2 ENVIRONMENTAL MARKETS LP	N	696	4	PM10	5973	10000	10000	14027
CANANDAIGUA WINE COMPANY INC	C	702	4	PM10	423	422	449	411
CHEVRON USA INC	S	702	4	PM10	1861	1881	1902	1902
AVENAL POWER CENTER, LLC	N	721	4	PM10	0	0	3215	0
AVENAL POWER CENTER, LLC	N	723	4	PM10	0	0	985	0
ANDERSON CLAYTON CORPORATION	N	737	4	PM10	979	0	0	19767
STOCKTON EAST WATER DISTRICT	N	763	4	PM10	214	299	301	271
OLDUVAI GORGE, LLC	N	769	4	PM10	165	153	158	136
BERRY SEED & FEED COMPANY	N	773	4	PM10	17630	15335	16869	18974
OLDUVAI GORGE, LLC	C	789	4	PM10	0	0	0	40000
AERA ENERGY LLC	S	790	4	PM10	153	102	117	167
CE2 ENVIRONMENTAL OPPORTUNITIES I LP	N	795	4	PM10	165	308	333	5030
OLDUVAI GORGE, LLC	C	796	4	PM10	0	0	0	6382
BAR VP DAIRY	C	797	4	PM10	0	0	0	2180
BAR VP DAIRY	C	798	4	PM10	0	0	0	3204

Table H-5 – List of Emission Reduction Credits
PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
BAR VP DAIRY	C	799	4	PM10	0	0	0	4111
THE DOW CHEMICAL COMPANY	N	799	4	PM10	73	82	83	72
AERA ENERGY LLC	S	802	4	PM10	734	1218	47	623
OLDUVAI GORGE, LLC	C	809	4	PM10	0	0	0	3785
OLDUVAI GORGE, LLC	C	814	4	PM10	0	0	0	5468
CERTAINTEED CORPORATION	C	816	4	PM10	600	600	600	600
RANCHERS COTTON OIL	C	817	4	PM10	1327	1325	1323	1323
UNITED STATES GYPSUM COMPANY	C	818	4	PM10	0	0	0	18935
RIVERSIDE DAIRY	C	819	4	PM10	1225	409	0	3469
RIVERSIDE DAIRY	C	820	4	PM10	4335	0	0	6111
OCCIDENTAL OF ELK HILLS INC	S	826	4	PM10	71	67	60	68
UNITED STATES GYPSUM COMPANY	C	827	4	PM10	0	0	0	4000
UNITED STATES GYPSUM COMPANY	C	828	4	PM10	0	0	0	2848
OCCIDENTAL OF ELK HILLS INC	S	829	4	PM10	68	72	85	69
UNITED STATES GYPSUM COMPANY	C	829	4	PM10	0	0	0	1649
UNITED STATES GYPSUM COMPANY	C	830	4	PM10	0	0	0	5824
UNITED STATES GYPSUM COMPANY	C	831	4	PM10	0	0	0	5395
UNITED STATES GYPSUM COMPANY	C	832	4	PM10	0	0	0	5112
UNITED STATES GYPSUM COMPANY	C	833	4	PM10	1006	44	0	943
UNITED STATES GYPSUM COMPANY	C	834	4	PM10	0	0	0	6788
UNITED STATES GYPSUM COMPANY	C	835	4	PM10	0	0	0	5357
UNITED STATES GYPSUM COMPANY	C	836	4	PM10	0	0	0	6688
BIG WEST OF CA, LLC	N	837	4	PM10	0	0	1322	0

Table H-5 – List of Emission Reduction Credits
PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
UNITED STATES GYPSUM COMPANY	C	837	4	PM10	0	0	0	18959
BIG WEST OF CA, LLC	N	838	4	PM10	0	0	320	0
UNITED STATES GYPSUM COMPANY	C	838	4	PM10	0	0	0	5098
UNITED STATES GYPSUM COMPANY	C	839	4	PM10	0	0	0	5476
UNITED STATES GYPSUM COMPANY	C	840	4	PM10	0	0	0	3470
UNITED STATES GYPSUM COMPANY	C	841	4	PM10	0	0	0	2642
UNITED STATES GYPSUM COMPANY	C	842	4	PM10	0	0	0	3471
UNITED STATES GYPSUM COMPANY	C	843	4	PM10	0	0	0	7953
UNITED STATES GYPSUM COMPANY	C	845	4	PM10	0	0	0	10655
UNITED STATES GYPSUM COMPANY	C	846	4	PM10	0	0	0	11928
EAGLE VALLEY GINNING LLC	N	847	4	PM10	0	0	0	29098
UNITED STATES GYPSUM COMPANY	C	847	4	PM10	0	0	0	26284
BRIAN R. ANDERSON INC.	C	854	4	PM10	0	0	0	20729
KODA FARMS	C	856	4	PM10	0	0	0	1396
AERA ENERGY LLC	S	862	4	PM10	1257	1129	1090	1193
AERA ENERGY LLC	S	863	4	PM10	5	5	10	9
BRITZ GIN PARTNERSHIP II	C	871	4	PM10	0	0	0	10903
PLAINS EXPLORATION & PRODUCTION CO	N	873	4	PM10	0	0	0	510
OLDUVAI GORGE, LLC	C	885	4	PM10	126	325	476	502
OLDUVAI GORGE, LLC	C	886	4	PM10	23	69	108	96
OLDUVAI GORGE, LLC	C	887	4	PM10	0	0	0	29243
FRITO-LAY INC	N	888	4	PM10	0	0	2339	0
FRITO-LAY INC	N	890	4	PM10	61	0	0	0

Table H-5 – List of Emission Reduction Credits
PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
VAN GRONINGEN ORCHARDS	N	894	4	PM10	0	0	2306	1327
AVENAL POWER CENTER, LLC	C	896	4	PM10	80	80	80	80
VARCO PRUDEN BUILDINGS, INC.	N	898	4	PM10	3827	4258	7700	6665
CE2 ENVIRONMENTAL MARKETS LP	C	900	4	PM10	0	0	0	4231
AERA ENERGY LLC	S	913	4	PM10	846	548	530	785
OLAM	N	919	4	PM10	500	1387	1737	15
OLDUVAI GORGE, LLC	N	922	4	PM10	1630	1648	1667	1467
EVOLUTION MARKETS INC.	C	941	4	PM10	0	0	0	41215
CALPINE CORPORATION	C	942	4	PM10	50845	67976	8408	841
ANDERSEN RACK SYSTEMS, INC	N	950	4	PM10	300	303	306	306
PLAINS EXPLORATION & PRODUCTION CO	C	950	4	PM10	127	0	396	350
HERSHEY CHOCOLATE & CONF. CORP	N	952	4	PM10	254	230	240	228
ANDERSON CLAYTON CORP/IDRIA #1	C	959	4	PM10	0	0	0	26896
BERRY PETROLEUM COMPANY	N	961	4	PM10	329	553	326	213
BERRY PETROLEUM COMPANY	N	962	4	PM10	0	8185	13499	5136
BERRY PETROLEUM COMPANY	N	963	4	PM10	0	2870	0	0
CE2 ENVIRONMENTAL MARKETS LP	C	963	4	PM10	0	0	0	5583
CE2 ENVIRONMENTAL MARKETS LP	C	964	4	PM10	1130	1039	1076	1135
CHEVRON USA INC	C	966	4	PM10	144	144	144	144
AERA ENERGY LLC	S	983	4	PM10	503	106	151	756
COUNTY LINE GIN	C	997	4	PM10	0	0	0	8549
KERMAN CO-OP GIN & WAREHOUSE 1	C	1002	4	PM10	0	0	0	8893
AERA ENERGY LLC	S	1006	4	PM10	991	1085	445	696

Table H-5 – List of Emission Reduction Credits
PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
AERA ENERGY LLC	S	1008	4	PM10	80	100	30	21
AERA ENERGY LLC	S	1010	4	PM10	1975	2028	0	2074
CALPINE ENERGY SERVICES, L.P.	C	1010	4	PM10	1029	0	0	13916
AERA ENERGY LLC	S	1012	4	PM10	350	748	479	91
AERA ENERGY LLC	S	1013	4	PM10	269	2280	694	170
THE ENVIRONMENTAL RESOURCES TRUST, INC	C	1013	4	PM10	418	418	418	418
TKV CONTAINERS, INC.	C	1015	4	PM10	0	349	349	0
SAINT-GOBAIN CONTAINERS, INC	N	1017	4	PM10	0	0	0	167
WEST ISLAND COTTON GROWERS INC	C	1017	4	PM10	607	0	1193	1800
LOS GATOS TOMATO PRODUCTS	C	1021	4	PM10	0	24	0	0
AERA ENERGY LLC	S	1026	4	PM10	278	579	252	201
WESTSIDE FARMERS COOP #2 & #3	C	1038	4	PM10	3311	0	0	37809
J R SIMPLOT COMPANY	C	1039	4	PM10	988	1900	877	1470
AERA ENERGY LLC	S	1040	4	PM10	0	961	467	0
KODA FARMS, INC.	N	1042	4	PM10	0	0	0	5180
VALLEY GRAIN/AZTECA MILLING	C	1042	4	PM10	0	0	0	2847
CE2 ENVIRONMENTAL MARKETS LP	N	1043	4	PM10	0	0	0	8300
NAS LEMOORE	C	1050	4	PM10	7799	3198	5638	1626
MARTIN ANDERSON	C	1051	4	PM10	32	48	28	2
LA PALOMA GENERATING CO, LLC	C	1055	4	PM10	0	0	0	360
AERA ENERGY LLC	S	1057	4	PM10	72	81	66	65
FARMERS FIREBAUGH GINNING CO.	C	1061	4	PM10	6374	0	0	9215
GRANITE CONSTRUCTION COMPANY	C	1065	4	PM10	0	0	0	2

Table H-5 – List of Emission Reduction Credits
PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
FRITO-LAY, INC.	C	1068	4	PM10	69	70	67	63
FRITO-LAY, INC.	C	1069	4	PM10	286	280	268	259
AERA ENERGY LLC	S	1091	4	PM10	97	119	120	121
SPRECKELS SUGAR COMPANY	C	1112	4	PM10	0	6074	7699	3185
FRITO-LAY, INC.	C	1136	4	PM10	0	0	0	699
PLAINS EXPLORATION & PRODUCTION CO	C	1151	4	PM10	0	0	0	2
HANFORD L P	C	1164	4	PM10	3365	3665	3359	3120
BERRY PETROLEUM COMPANY	C	1166	4	PM10	0	0	0	2586
CE2 ENVIRONMENTAL OPPORTUNITIES I LP	C	1168	4	PM10	0	0	0	4130
CE2 ENVIRONMENTAL MARKETS LP	C	1170	4	PM10	0	0	0	9298
SC JOHNSON HOME STORAGE INC	C	1173	4	PM10	271	360	355	366
F & T FARMS	C	1177	4	PM10	0	0	0	17034
SAN JOAQUIN FACILITIES MGMT	S	1253	4	PM10	27	30	32	30
PARAMOUNT FARMS	S	1267	4	PM10	350	353	508	387
PARAMOUNT FARMS	S	1349	4	PM10	0	0	0	6679
PARAMOUNT FARMS	S	1350	4	PM10	0	0	0	37321
AERA ENERGY LLC	S	1424	4	PM10	787	1901	1476	380
PARAMOUNT FARMS	S	1446	4	PM10	0	0	1088	18586
AERA ENERGY LLC	S	1476	4	PM10	262	0	0	74
AERA ENERGY LLC	S	1477	4	PM10	455	0	0	128
CHEVRON USA INC	S	1485	4	PM10	1890	1911	1932	1932
SAN JOAQUIN FACILITIES MGMT	S	1509	4	PM10	7	9	9	9

Table H-5 – List of Emission Reduction Credits PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
CALPINE CORPORATION	S	1577	4	PM10	489	0	0	23085
CALPINE CORPORATION	S	1683	4	PM10	0	0	0	1462
CALPINE CORPORATION	S	1689	4	PM10	0	0	0	2604
CALPINE CORPORATION	S	1693	4	PM10	1091	1103	1115	1115
SAN JOAQUIN FACILITIES MGMT	S	1735	4	PM10	23	20	15	12
AERA ENERGY LLC	S	1927	4	PM10	1854	2703	2734	2332
AERA ENERGY LLC	S	2025	4	PM10	1028	714	726	684
CHEVRON USA INC	S	2035	4	PM10	477	1092	1464	1431
CALIFORNIA DAIRIES, INC.	S	2152	4	PM10	0	0	0	99
CRIMSON RESOURCE MANAGEMENT	S	2161	4	PM10	20	17	12	24
CALIFORNIA DAIRIES, INC.	S	2204	4	PM10	0	0	0	405
COUNTY OF SAN JOAQUIN SOLID WASTE DIV	S	2264	4	PM10	0	0	0	471
COUNTY OF SAN JOAQUIN SOLID WASTE DIV	S	2266	4	PM10	0	0	0	1000
COUNTY OF SAN JOAQUIN SOLID WASTE DIV	S	2267	4	PM10	0	0	0	8813
CHEVRON USA INC (REFINERY)	S	2275	4	PM10	490	1911	1932	532
WESTERN MILLING LLC	S	2276	4	PM10	0	0	0	4033
FOSTER FARMS, PORTERVILLE PLANT	S	2337	4	PM10	40	40	40	40
AERA ENERGY LLC	S	2361	4	PM10	4	1	0	2
VANDERHAM WEST	S	2410	4	PM10	0	0	0	5765
VANDERHAM WEST	S	2411	4	PM10	0	0	0	7592
VANDERHAM WEST	S	2412	4	PM10	0	0	7	3945
VANDERHAM WEST	S	2413	4	PM10	9	0	0	4701

Table H-5 – List of Emission Reduction Credits
PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
OLDUVAI GORGE, LLC	S	2461	4	PM10	831	0	415	73
BERRY PETROLEUM COMPANY	S	2480	4	PM10	0	0	0	6000
OLDUVAI GORGE, LLC	S	2482	4	PM10	0	0	0	7471
M CARATAN INC	S	2516	4	PM10	0	0	14	3
UNITED STATES GYPSUM COMPANY	S	2543	4	PM10	0	0	0	8032
AERA ENERGY LLC	S	2575	4	PM10	2301	1770	0	548
UNITED STATES GYPSUM COMPANY	S	2576	4	PM10	0	0	0	5078
UNITED STATES GYPSUM COMPANY	S	2577	4	PM10	0	0	350	17130
UNITED STATES GYPSUM COMPANY	S	2578	4	PM10	0	0	0	14051
UNITED STATES GYPSUM COMPANY	S	2580	4	PM10	1340	0	0	0
UNITED STATES GYPSUM COMPANY	S	2581	4	PM10	2953	0	0	8168
UNITED STATES GYPSUM COMPANY	S	2582	4	PM10	0	0	0	2736
UNITED STATES GYPSUM COMPANY	S	2583	4	PM10	87	0	721	10072
UNITED STATES GYPSUM COMPANY	S	2584	4	PM10	0	0	0	6407
CE2 ENVIRONMENTAL OPPORTUNITIES I LP	S	2591	4	PM10	0	0	0	18971
OLDUVAI GORGE, LLC	S	2603	4	PM10	0	0	0	14789
WESTERN MILLING LLC	S	2634	4	PM10	0	0	0	579
KERN OIL & REFINING CO.	S	2649	4	PM10	3313	3812	3561	5082
OLDUVAI GORGE, LLC	S	2669	4	PM10	1969	1969	1969	1969
TAFT PRODUCTION COMPANY	S	2670	4	PM10	1914	1959	2000	2000
SAINT-GOBAIN CONTAINERS, INC	S	2705	4	PM10	0	0	0	118
E&B NATURAL RESOURCES MGMT	S	2773	4	PM10	90	133	58	96
AERA ENERGY LLC	S	2774	4	PM10	443	368	369	489

Table H-5 – List of Emission Reduction Credits
PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
AERA ENERGY LLC	S	2782	4	PM10	61	60	58	63
EVOLUTION MARKETS INC.	S	2876	4	PM10	0	0	0	46954
CALPINE CORPORATION	S	2877	4	PM10	421	0	176	0
EVOLUTION MARKETS INC.	S	2878	4	PM10	0	0	0	11831
PILKINGTON NORTH AMERICA, INC	S	2912	4	PM10	0	0	0	12000
TULE RIVER CO-OP GIN INC	S	2913	4	PM10	0	0	0	484
BUTTONWILLOW GINNING CO	S	2937	4	PM10	0	0	0	28460
PACTIV, LLC	S	2965	4	PM10	33	29	7	15
CE2 ENVIRONMENTAL OPPORTUNITIES I LP	S	2967	4	PM10	0	0	0	3789
BAKERSFIELD CITY WOOD SITE	S	2969	4	PM10	18	24	26	22
KERN DELTA-WEEDPATCH COTTON GINNING CO	S	2971	4	PM10	4439	67	0	1328
CE2 ENVIRONMENTAL OPPORTUNITIES I LP	S	2974	4	PM10	0	0	0	1956
VINTAGE PRODUCTION CALIFORNIA LLC	S	3036	4	PM10	29	29	29	29
VINTAGE PRODUCTION CALIFORNIA LLC	S	3061	4	PM10	102	52	74	78
PLAINS EXPLORATION & PRODUCTION CO	S	3070	4	PM10	0	0	0	8500
ELBOW ENTERPRISES INC	S	3071	4	PM10	0	0	0	19406
SOC RESOURCES INC	S	3089	4	PM10	5	4	4	4
CALPINE ENERGY SERVICES, L.P.	S	3090	4	PM10	751	812	634	694
CALPINE ENERGY SERVICES, L.P.	S	3091	4	PM10	0	0	0	7210
KODA FARMS MILLING, INC.	S	3196	4	PM10	0	0	0	856

Table H-5 – List of Emission Reduction Credits
PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
KODA FARMS MILLING, INC.	S	3197	4	PM10	0	0	0	3144
CALPINE CORPORATION	S	3198	4	PM10	0	0	0	8699
KERN DELTA WEEDPATCH GINNING	S	3199	4	PM10	0	0	0	26563
GENERAL MILLS, INC	S	3218	4	PM10	0	0	0	4525
CHEVRON USA PRODUCTION INC	S	3228	4	PM10	74	85	147	56
AERA ENERGY LLC	S	3265	4	PM10	1591	0	0	0
SHAFTER-WASCO GINNING COMPANY	S	3268	4	PM10	0	0	0	4695
CALPINE CORPORATION	S	3288	4	PM10	0	0	987	8059
CRIMSON RESOURCE MANAGEMENT	S	3392	4	PM10	1745	1292	1258	941
FRITO-LAY, INC.	S	3412	4	PM10	7136	7320	7507	7506
FRITO-LAY, INC.	S	3414	4	PM10	0	0	0	6935
FRITO-LAY, INC.	S	3416	4	PM10	0	8	306	310
FRITO-LAY, INC.	S	3417	4	PM10	0	0	0	2531
FRITO-LAY, INC.	S	3418	4	PM10	5000	5000	5000	5000
FRITO-LAY, INC.	S	3419	4	PM10	132	132	133	134
FRITO-LAY, INC.	S	3437	4	PM10	210	288	195	174
FRITO-LAY, INC.	S	3453	4	PM10	17	68	208	207
ALON BAKERSFIELD REFINING	S	3462	4	PM10	1584	1877	1791	1974
ALON BAKERSFIELD REFINING	S	3463	4	PM10	2445	2476	2506	2506
ALON BAKERSFIELD REFINING	S	3464	4	PM10	2500	2500	2500	2500
CHEVRON USA PRODUCTION INC	S	3533	4	PM10	101	106	124	122
MOLYCORP MINERALS, LLC	S	3539	4	PM10	373	329	313	238
CHEVRON USA INC	S	3544	4	PM10	1086	1185	913	966

Table H-5 – List of Emission Reduction Credits
PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
SOUTH VALLEY GINS INC	S	3554	4	PM10	0	0	0	8671
CHEVRON USA INC	S	3562	4	PM10	3378	3428	3478	3478
CHEVRON USA INC	S	3598	4	PM10	23958	18336	24959	21380
CHEVRON USA INC	S	3604	4	PM10	699	1081	1219	805
BERRY PETROLEUM COMPANY	S	3624	4	PM10	0	0	789	0
LAND O' LAKES, INC.	S	3625	4	PM10	711	455	821	719
VECTOR ENVIRONMENTAL, INC.	S	3630	4	PM10	72	88	82	10
AGRI-CEL INC	S	3631	4	PM10	31	38	35	4
INERGY PROPANE LLC	S	3677	4	PM10	16	48	30	8
CHEVRON USA INC	S	3679	4	PM10	5317	2839	3598	5227
KODA FARMS MILLING, INC.	S	3796	4	PM10	0	0	0	4820
CE2 ENVIRONMENTAL OPPORTUNITIES I LP	S	3797	4	PM10	0	0	0	4466
MID-VALLEY COTTON GROWERS INC	S	3803	4	PM10	0	0	0	2128
SHAFTER HAY & CUBE LLC	S	3804	4	PM10	0	691	1099	154
TEXACO EXPLOR & PROD INC	S	20250361	4	PM10	41	43	37	40
E & J GALLO WINERY	N	2	2	NOx	2587	2434	7175	7642
WESTERN STONE PRODUCTS, INC.	N	17	2	NOx	543	543	619	619
TRIANGLE PACIFIC CORPORATION	N	18	2	NOx	187	54	54	161
H. J. HEINZ COMPANY, L.P.	N	21	2	NOx	0	1026	3112	1060
COTTON ASSOCIATES, INC	S	25	2	NOx	0	0	0	157
CALMAT OF FRESNO	C	40	2	NOx	74	355	163	547
BROWN SAND INC	N	46	2	NOx	90	98	46	83
CALMAT CO.	C	50	2	NOx	104	111	154	159

Table H-5 – List of Emission Reduction Credits
PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
LEPRINO FOODS COMPANY	C	60	2	NOx	7878	7985	7810	7898
CRAYCROFT BRICK COMPANY	C	71	2	NOx	417	336	328	332
CHEVRON USA INC	S	77	2	NOx	2038	1840	1733	2274
EXXON MOBIL CORPORATION	S	84	2	NOx	1648	1666	1685	1685
GROWERS COOP	S	88	2	NOx	0	0	22	406
CALAVERAS MATERIALS INC	C	89	2	NOx	284	257	294	236
THE BEVERAGE SOURCE	N	92	2	NOx	220	800	520	900
LEPRINO FOODS	N	108	2	NOx	2335	2529	2412	2143
CASTLE AIRPORT AVIATION & DEVELOP CENTER	N	109	2	NOx	38954	39386	39819	39819
KRAFT FOODS, INC	S	119	2	NOx	0	0	3425	1107
LOS BANOS GRAVEL GROUP, ASPHLT	N	125	2	NOx	23	113	359	120
CAMPBELL SOUP COMPANY	N	127	2	NOx	1515	454	409	924
KRAFT FOODS, INC	S	131	2	NOx	2070	0	0	94
AERA ENERGY LLC	S	133	2	NOx	3203	0	0	0
ECKERT FROZEN FOODS	N	133	2	NOx	146	545	2047	395
AERA ENERGY LLC	S	135	2	NOx	5032	1152	0	0
J.G. BOSWELL CO. (EL RICO)	C	135	2	NOx	14	4	0	40
AERA ENERGY LLC	S	137	2	NOx	5115	6792	5437	9206
AERA ENERGY LLC	S	139	2	NOx	11686	11816	11946	11946
AERA ENERGY LLC	S	140	2	NOx	36695	46397	47292	36806
KRAFT FOODS INC	C	149	2	NOx	284	284	284	284
R M WADE & COMPANY	C	152	2	NOx	326	373	379	370
AERA ENERGY LLC	S	158	2	NOx	38057	29690	32405	43791

Table H-5 – List of Emission Reduction Credits
PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
AERA ENERGY LLC	S	162	2	NOx	128454	152970	128743	130786
AERA ENERGY LLC	S	163	2	NOx	96698	107197	101158	78678
EXXON MOBIL CORPORATION	S	188	2	NOx	5175	5197	5494	4871
AERA ENERGY LLC	C	219	2	NOx	1738	1923	2100	1931
CHEVRON USA INC	C	221	2	NOx	2311	2557	2792	2567
SUN GARDEN-GANGI CANNING CO LL	N	222	2	NOx	0	0	12886	540
CALAVERAS MATERIALS INC.	C	233	2	NOx	1265	3371	3913	2469
HANSEN BROTHERS	C	249	2	NOx	0	0	0	256
PARAMOUNT FARMS, INC	N	284	2	NOx	3670	3580	3488	3488
SOUTHERN CALIFORNIA GAS CORPORATION	N	299	2	NOx	0	1311	1415	0
EXXON MOBIL CORPORATION	S	301	2	NOx	3010	2818	2052	3565
CITY OF VISALIA	N	317	2	NOx	0	0	7160	0
CHEVRON USA INC	C	331	2	NOx	23739	23739	23740	23740
VINTAGE PETROLEUM	N	346	2	NOx	0	165	1432	14
CHEVRON USA INC	C	364	2	NOx	30130	29673	29217	29217
KRAFT FOODS INC	C	386	2	NOx	9774	9883	9992	9992
KRAFT FOODS INC	C	387	2	NOx	5	5	4	4
LIDESTRI FOODS, INC	N	391	2	NOx	0	0	1527	0
PILKINGTON NORTH AMERICA, INC	N	410	2	NOx	272	4	43	275
MODESTO IRRIGATION DISTRICT	N	430	2	NOx	0	0	273	0
MONTEREY RESOURCES, INC.	S	432	2	NOx	2053	2081	1707	1898
CHEVRON USA INC	S	436	2	NOx	12891	9861	9530	10101
LAWRENCE LIVERMORE NATL. LAB	N	464	2	NOx	83	31	0	61

Table H-5 – List of Emission Reduction Credits
PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
AERA ENERGY LLC	S	470	2	NOx	3478	4930	5390	5212
BAKER COMMODITIES INC	N	482	2	NOx	1194	1194	1196	1194
CONAGRA CONSUMER FROZEN FOODS	N	487	2	NOx	356	163	243	300
CHEVRON USA INC	S	496	2	NOx	5160	233	1734	4212
PARAMOUNT FARMS, INC.	C	497	2	NOx	1000	2000	4000	3000
CANDLEWICK YARNS	C	507	2	NOx	90	77	63	58
THE NESTLE COMPANY INC	N	508	2	NOx	2975	2444	1853	3352
CLARK BROTHERS-DERRICK GIN	C	511	2	NOx	0	0	0	43
LA PALOMA GENERATING COMPANY	N	514	2	NOx	0	9612	22455	0
H. J. HEINZ COMPANY	N	534	2	NOx	0	360	3207	0
BRITZ AG FINANCE CO., INC.	C	557	2	NOx	0	0	0	232
CORCORAN IRRIGATION DISTRICT	C	560	2	NOx	352	356	321	209
DIAMOND FOODS INCORPORATED	N	573	2	NOx	1	1	0	0
PACIFIC PIPELINE SYSTEM, LLC	S	575	2	NOx	0	4693	10418	3569
R F MACDONALD	C	579	2	NOx	0	8	0	0
BRITZ INCORPORATED	C	586	2	NOx	0	0	0	381
MODESTO TALLOW CO INC	N	599	2	NOx	364	328	400	391
OAKWOOD LAKE RESORT	N	601	2	NOx	0	117	188	0
GENERAL MILLS OPERATIONS, INC	N	610	2	NOx	52	3	0	100
CHEVRON U S A INC	S	629	2	NOx	2316	2041	2088	1975
CALIFORNIA DAIRIES, INC.	C	635	2	NOx	22	22	22	22
WESTLAKE FARMS INC	C	645	2	NOx	0	0	0	498
KINGS RIVER CONSERVATION DISTRICT	C	647	2	NOx	0	0	1029	0

Table H-5 – List of Emission Reduction Credits
PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
CALIFORNIA DAIRIES, INC.	C	658	2	NOx	0	0	102	75
AERA ENERGY LLC	S	662	2	NOx	9433	18919	3766	817
UNITED STATES GYPSUM COMPANY	N	662	2	NOx	308	36838	15649	308
CHEVRON USA PRODUCTION INC	S	674	2	NOx	507	781	226	485
DARLING INTERNATIONAL INC.	N	674	2	NOx	0	51	107	0
CALIFORNIA DAIRIES, INC.	C	677	2	NOx	450	126	472	315
AERA ENERGY LLC	C	681	2	NOx	26900	26900	26900	26900
CHEMICAL WASTE MANAGEMENT, INC	N	687	2	NOx	7	7	6	6
DAIRY FARMERS OF AMERICA, INC.	C	689	2	NOx	0	0	253	0
VALLEY AIR CONDITIONING & REPAIR INC	C	693	2	NOx	0	0	108	0
H. J. HEINZ COMPANY	N	694	2	NOx	0	43	2570	0
CANANDAIGUA WINE COMPANY INC	C	702	2	NOx	423	427	449	403
CHEVRON USA INC LOST HILLS GP	S	704	2	NOx	5564	5626	5687	5687
CALIFORNIA DAIRIES, INC.	N	707	2	NOx	0	1270	1363	226
JOHN T HOPPER	C	712	2	NOx	0	55	295	56
PLAINS LPG SERVICES, L.P.	C	717	2	NOx	1024	1024	1023	1023
AVENAL POWER CENTER, LLC	N	720	2	NOx	0	9	1255	437
AVENAL POWER CENTER, LLC	N	722	2	NOx	0	1166	88317	1422
AVENAL POWER CENTER, LLC	N	726	2	NOx	0	0	4728	0
AVENAL POWER CENTER, LLC	N	728	2	NOx	10542	3731	2487	5171
NORTHERN CALIFORNIA POWER AGENCY	N	751	2	NOx	0	0	10015	0
NORTHERN CALIFORNIA POWER AGENCY	N	752	2	NOx	0	791	835	0

Table H-5 – List of Emission Reduction Credits
PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
PACIFIC COAST PRODUCERS	N	753	2	NOx	195	605	3088	312
PASTORIA ENERGY LLC	C	755	2	NOx	2525	1011	0	2038
STOCKTON EAST WATER DISTRICT	N	763	2	NOx	2654	3705	3750	3359
GALLO GLASS COMPANY	N	768	2	NOx	14634	12268	15814	10504
OLDUVAI GORGE, LLC	N	769	2	NOx	2154	2045	2093	1783
EVOLUTION MARKETS INC.	N	776	2	NOx	875	927	771	876
OLDUVAI GORGE, LLC	N	782	2	NOx	1085	1097	1109	1109
OLDUVAI GORGE, LLC	N	783	2	NOx	7792	7878	7965	7965
AERA ENERGY LLC	S	784	2	NOx	7140	3993	228	0
OLDUVAI GORGE, LLC	N	805	2	NOx	14	0	0	296
LOVELACE & SONS FARMING	C	807	2	NOx	0	0	0	257
UNITED STATES GYPSUM COMPANY	C	818	2	NOx	0	0	0	734
OLDUVAI GORGE, LLC	N	824	2	NOx	0	0	0	396
DIAMOND FOODS INCORPORATED	N	826	2	NOx	4443	2607	2618	0
OCCIDENTAL OF ELK HILLS INC	S	826	2	NOx	6684	6259	5625	6369
VINTAGE PRODUCTION CALIFORNIA LLC	N	831	2	NOx	173	0	3	0
SAPUTO CHEESE USA INC.	N	834	2	NOx	1810	1810	1810	1810
CALIFORNIA DAIRIES	N	836	2	NOx	2298	1078	961	841
AERA ENERGY LLC	S	838	2	NOx	442	218	338	338
CALPINE ENERGY SERVICES, L.P.	N	845	2	NOx	4089	4089	4089	3093
CALPINE ENERGY SERVICES, L.P.	N	846	2	NOx	4429	4429	4429	3353
EAGLE VALLEY GINNING LLC	N	847	2	NOx	0	0	0	427
E & J GALLO WINERY	N	849	2	NOx	0	14	111	0

Table H-5 – List of Emission Reduction Credits
PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
CONAGRA CONSUMER FROZEN FOODS	N	856	2	NOx	0	0	1749	0
DARLING INTERNATIONAL INC.	C	859	2	NOx	0	0	0	270
AERA ENERGY LLC	S	865	2	NOx	6713	6788	6863	6863
PACIFIC GAS & ELECTRIC CO.	N	868	2	NOx	556	3428	2975	355
BRITZ GIN PARTNERSHIP II	C	871	2	NOx	0	0	0	585
WELLHEAD POWER PANOCHE, LLC.	C	874	2	NOx	0	3	3	0
KERN OIL & REFINING COMPANY	N	878	2	NOx	24	19	32	24
KERN OIL & REFINING COMPANY	N	879	2	NOx	156	188	224	202
AERA ENERGY LLC	S	883	2	NOx	632	160	2073	2061
AVENAL POWER CENTER, LLC	C	899	2	NOx	2243	2243	2243	2243
GALLO GLASS COMPANY	N	900	2	NOx	63691	64821	66246	61340
AVENAL POWER CENTER, LLC	C	902	2	NOx	13879	6131	1086	8539
CITY OF TULARE	N	902	2	NOx	0	436	436	471
CALPINE ENERGY SERVICES, L.P.	N	903	2	NOx	5833	5834	5834	5833
SENECA RESOURCES	N	906	2	NOx	183	517	517	517
CHEVRON USA INC	S	909	2	NOx	3990	3412	3474	3072
EVOLUTION MARKETS INC.	C	944	2	NOx	0	298	1590	300
EVOLUTION MARKETS INC.	C	945	2	NOx	0	286	1530	289
VINTAGE PRODUCTION CALIFORNIA LLC	N	945	2	NOx	2384	0	0	0
VINTAGE PRODUCTION CALIFORNIA LLC	N	946	2	NOx	4686	0	0	0
VINTAGE PRODUCTION CALIFORNIA LLC	N	947	2	NOx	1825	0	0	0
VINTAGE PRODUCTION CALIFORNIA	N	948	2	NOx	1532	1530	1530	1530

Table H-5 – List of Emission Reduction Credits
PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
LLC								
HERSHEY CHOCOLATE & CONF. CORP	N	952	2	NOx	114	106	125	125
ANDERSON CLAYTON CORP/IDRIA #1	C	959	2	NOx	0	0	0	2122
CHEVRON USA INC	C	966	2	NOx	2	2	2	2
GALLO GLASS COMPANY	N	966	2	NOx	63525	46849	57176	61929
BERRY PETROLEUM COMPANY	N	980	2	NOx	0	0	5529	581
BERRY PETROLEUM COMPANY	N	981	2	NOx	177	172	1273	128
NORTHROP GRUMMAN CORPORATION	N	992	2	NOx	2000	2000	2000	2000
OLDUVAI GORGE, LLC	C	998	2	NOx	0	0	0	815
OLAM WEST COAST, INC	C	1006	2	NOx	1188	1163	1138	1137
E & J GALLO WINERY	N	1010	2	NOx	2500	2500	2500	2500
E & J GALLO WINERY	N	1011	2	NOx	625	625	625	625
E & J GALLO WINERY	N	1012	2	NOx	545	545	545	545
OLDUVAI GORGE, LLC	C	1012	2	NOx	0	0	0	242
CALPINE ENERGY SERVICES, L.P.	C	1014	2	NOx	302	0	0	852
TKV CONTAINERS, INC.	C	1015	2	NOx	0	13	14	0
SOUTHERN CALIF GAS CO	S	1016	2	NOx	283	288	289	289
STRATAS FOODS LLC	C	1020	2	NOx	0	0	0	108
LOS GATOS TOMATO PRODUCTS	C	1021	2	NOx	0	4	0	0
NORTHERN CALIFORNIA POWER AGENCY	N	1028	2	NOx	0	274	790	147
AERA ENERGY LLC	S	1030	2	NOx	93295	83665	32600	77083
PARAMOUNT FARMS, INC.	C	1035	2	NOx	0	0	155	334
PLAINS EXPLORATION & PRODUCTION	N	1035	2	NOx	2379	2379	2379	2379

Table H-5 – List of Emission Reduction Credits
PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
CO								
WESTSIDE FARMERS COOP #2 & #3	C	1038	2	NOx	109	0	0	1122
CALPINE ENERGY SERVICES, L.P.	C	1040	2	NOx	0	0	0	684
BGC ENVIRONMENTAL BROKERAGE SERVICES	N	1045	2	NOx	66981	66981	66981	66981
NAS LEMOORE	C	1048	2	NOx	26	26	25	25
VINTAGE PRODUCTION CALIFORNIA LLC	N	1048	2	NOx	2750	2750	2750	2750
CHEVRON U.S.A. INC.	N	1051	2	NOx	15566	8173	19366	19259
MARTIN ANDERSON	C	1051	2	NOx	52	77	45	3
CHEVRON U.S.A. INC.	N	1052	2	NOx	0	0	8139	0
CHEVRON U.S.A. INC.	N	1053	2	NOx	0	0	9120	180
CHEVRON U.S.A. INC.	N	1054	2	NOx	500	500	500	500
HYDROGEN ENERGY CA LLC	C	1058	2	NOx	10100	10100	10100	10100
G.I.C. FINANCIAL SERVICES, INC.	C	1059	2	NOx	21900	21900	21900	21900
AERA ENERGY LLC	S	1061	2	NOx	8071	8777	10695	9555
E & J GALLO WINERY	N	1061	2	NOx	9980	9980	10939	9979
AERA ENERGY LLC	S	1062	2	NOx	8530	9784	10046	9903
AERA ENERGY LLC	S	1063	2	NOx	9423	10057	12159	9776
AERA ENERGY LLC	S	1064	2	NOx	5126	5705	5881	6709
AERA ENERGY LLC	S	1065	2	NOx	10366	10483	11017	8841
AERA ENERGY LLC	S	1066	2	NOx	5542	7367	5038	6117
AERA ENERGY LLC	S	1067	2	NOx	1255	893	2650	4592
AERA ENERGY LLC	S	1068	2	NOx	7648	9620	6968	8415

Table H-5 – List of Emission Reduction Credits
PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
AERA ENERGY LLC	S	1069	2	NOx	4713	5029	4352	2082
AERA ENERGY LLC	S	1070	2	NOx	495	4228	2744	99
VINTAGE PRODUCTION CALIFORNIA LLC	C	1087	2	NOx	753	0	0	310
AERA ENERGY LLC	S	1092	2	NOx	348	242	246	236
PACIFIC PIPELINE SYSTEM, LLC	S	1099	2	NOx	0	13703	12649	0
CHEVRON USA INC	S	1100	2	NOx	62167	62857	63548	63548
CHEVRON USA INC	S	1102	2	NOx	57160	57795	58430	58430
CHEVRON USA INC	S	1106	2	NOx	11814	11942	12075	12075
MODESTO IRRIGATION DISTRICT	C	1111	2	NOx	0	0	74	5923
SPRECKELS SUGAR COMPANY	C	1112	2	NOx	0	3701	5023	2200
NORTHERN CALIFORNIA POWER AGENCY	C	1129	2	NOx	0	6728	3983	1831
NORTHERN CALIFORNIA POWER AGENCY	C	1132	2	NOx	0	137	122	117
PARAMOUNT FARMS INTERNATIONAL LLC	C	1133	2	NOx	36000	36000	36000	36000
GUARDIAN INDUSTRIES CORP	C	1134	2	NOx	39346	39346	39346	39346
KRAFT FOODS INC	C	1138	2	NOx	0	0	0	1632
E&B NATURAL RESOURCES MANAGEMENT	C	1141	2	NOx	1632	1632	1632	0
CHEVRON USA INC	C	1158	2	NOx	0	0	0	132
CHEVRON USA INC	C	1159	2	NOx	0	0	0	137
CHEVRON USA INC	C	1160	2	NOx	175	0	0	1230
CHEVRON USA INC	C	1161	2	NOx	0	0	0	846

Table H-5 – List of Emission Reduction Credits
PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
PHILLIPS 66 PIPELINE LLC	C	1163	2	NOx	0	0	17	0
BERRY PETROLEUM COMPANY	C	1187	2	NOx	0	342	4623	2234
VINTAGE PRODUCTION CALIFORNIA LLC	C	1190	2	NOx	13750	13750	13750	13750
HANFORD L P	C	1191	2	NOx	3081	4129	2703	716
MACPHERSON OIL COMPANY	C	1195	2	NOx	73	73	73	73
SAN JOAQUIN FACILITIES MGMT	S	1253	2	NOx	459	509	544	481
CHEVRON USA INC	S	1256	2	NOx	45238	45741	46244	46244
AERA ENERGY LLC	S	1270	2	NOx	4586	4637	4688	4688
CHEVRON U S A INC	S	1325	2	NOx	260	118	276	211
CHEVRON USA INC	S	1419	2	NOx	4875	4928	4983	4983
SENECA RESOURCES	S	1427	2	NOx	88	57	76	98
CHEVRON U S A INC	S	1428	2	NOx	1968	1990	2011	2011
AERA ENERGY LLC	S	1437	2	NOx	42372	49588	46800	43954
CHEVRON USA INC	S	1445	2	NOx	17602	20114	20328	15867
CHEVRON USA INC LOST HILLS GP	S	1470	2	NOx	780	789	797	797
AERA ENERGY LLC	S	1476	2	NOx	1242	0	0	350
AERA ENERGY LLC	S	1477	2	NOx	2153	0	0	607
CHEVRON USA INC	S	1487	2	NOx	11663	11793	11923	11923
SAN JOAQUIN FACILITIES MGMT	S	1509	2	NOx	34	45	45	45
PASTORIA ENERGY FACILITY, LLC	S	1543	2	NOx	10354	8381	11018	11467
CHEVRON USA INC	S	1605	2	NOx	5672	7143	7028	6447
ELK HILLS POWER LLC	S	1622	2	NOx	1373	1389	1404	1404
BUILDING MATERIALS MFG. CORP. (DBA	S	1662	2	NOx	5832	5840	5848	5848

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PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
GAF)								
SAN JOAQUIN FACILITIES MGMT	S	1735	2	NOx	9	8	6	4
AERA ENERGY LLC	S	1821	2	NOx	5974	7291	7466	4158
AERA ENERGY LLC	S	1851	2	NOx	914	455	0	1154
AERA ENERGY LLC	S	1935	2	NOx	474	508	543	543
CHEVRON USA INC	S	1967	2	NOx	973	955	855	984
ELK HILLS POWER LLC	S	1994	2	NOx	12485	12624	12762	12762
AERA ENERGY LLC	S	2023	2	NOx	1108	636	737	993
CHEVRON USA INC	S	2031	2	NOx	5694	4723	4406	0
KERN LAKE COOP GIN	S	2074	2	NOx	0	0	0	309
PLAINS EXPLORATION & PRODUCTION CO	S	2092	2	NOx	10010	10691	10155	6716
PLAINS EXPLORATION & PRODUCTION CO	S	2093	2	NOx	13229	10050	6765	15163
CHEVRON USA INC	S	2111	2	NOx	7823	15506	21032	12182
HILMAR CHEESE COMPANY	S	2138	2	NOx	0	0	0	1070
INERGY PROPANE LLC	S	2193	2	NOx	125	125	125	125
CON AGRA FOOD INGREDIENTS, CO	S	2201	2	NOx	6	6	5	5
CRIMSON RESOURCE MANAGEMENT	S	2251	2	NOx	316	272	186	375
MEMORIAL MEDICAL CENTER	S	2268	2	NOx	2550	2550	2550	2550
PACIFIC PIPELINE SYSTEM, LLC	S	2286	2	NOx	1278	2194	2438	2438
CALIFORNIA DAIRIES, INC.	S	2293	2	NOx	32	33	32	32
AMERICAN ENERGY OPERATIONS INC	S	2295	2	NOx	7	9	7	6
AERA ENERGY LLC	S	2361	2	NOx	30	4	0	12

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Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
CHEVRON USA INC	S	2456	2	NOx	32003	32799	31884	32561
M CARATAN INC	S	2516	2	NOx	0	0	189	46
FARMERS COOPERATIVE GIN INC	S	2533	2	NOx	0	0	0	598
ELBOW ENTERPRISES INC	S	2535	2	NOx	0	0	0	1168
SAN JOAQUIN FACILITIES MGMT	S	2537	2	NOx	71	0	0	0
SAN JOAQUIN FACILITIES MGMT	S	2539	2	NOx	597	0	0	307
UNITED STATES GYPSUM COMPANY	S	2543	2	NOx	0	0	0	311
CALNEV PIPE LINE LLC	S	2553	2	NOx	1886	1886	1886	1886
OCCIDENTAL OF ELK HILLS INC	S	2629	2	NOx	1735	1846	2330	1762
DARLING INTERNATIONAL INC.	S	2635	2	NOx	911	860	804	641
KERN OIL & REFINING CO.	S	2653	2	NOx	94	277	91	215
KAWEAH DELTA DISTRICT HOSPITAL	S	2657	2	NOx	100	441	536	667
CALIFORNIA DAIRIES, INC	S	2731	2	NOx	50	0	24	1282
EVOLUTION MARKETS INC.	S	2738	2	NOx	1696	3526	1536	1221
EVOLUTION MARKETS INC.	S	2740	2	NOx	0	27355	0	0
E&B NATURAL RESOURCES MGMT	S	2773	2	NOx	454	689	275	487
AERA ENERGY LLC	S	2774	2	NOx	5817	4899	4757	8181
AERA ENERGY LLC	S	2782	2	NOx	329	323	318	341
OLDUVAI GORGE, LLC	S	2802	2	NOx	3233	0	0	5000
OLDUVAI GORGE, LLC	S	2806	2	NOx	2306	290	2534	2070
AVENAL POWER CENTER, LLC	S	2814	2	NOx	6121	13869	18914	11461
UNITED STATES GYPSUM COMPANY	S	2815	2	NOx	39560	6703	27282	33352
NORTHERN CALIFORNIA POWER AGENCY	S	2854	2	NOx	0	1437	0	0

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Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
NORTHERN CALIFORNIA POWER AGENCY	S	2857	2	NOx	0	0	0	1031
OLDUVAI GORGE, LLC	S	2865	2	NOx	1126	0	0	0
NORTHERN CALIFORNIA POWER AGENCY	S	2895	2	NOx	0	0	0	3406
EVOLUTION MARKETS INC.	S	2896	2	NOx	130	131	132	132
EVOLUTION MARKETS INC.	S	2899	2	NOx	1313	1378	1443	1443
BERRY PETROLEUM COMPANY	S	2903	2	NOx	824	0	0	109
EVOLUTION MARKETS INC.	S	2908	2	NOx	1500	1500	1500	1500
AVENAL POWER CENTER, LLC	S	2955	2	NOx	51000	51000	51000	51000
PACTIV, LLC	S	2965	2	NOx	233	199	51	109
BAKERSFIELD CITY WOOD SITE	S	2969	2	NOx	1564	2135	2265	1857
PILKINGTON NORTH AMERICA, INC	S	2970	2	NOx	1500	1500	1500	1500
GLOBAL AMPERSAND LLC	S	2976	2	NOx	239	239	239	239
LOCKHEED MARTIN	S	2990	2	NOx	3000	3000	3000	3000
OLDUVAI GORGE, LLC	S	3032	2	NOx	0	0	0	296
OLDUVAI GORGE, LLC	S	3034	2	NOx	0	0	0	321
VINTAGE PRODUCTION CALIFORNIA LLC	S	3038	2	NOx	417	345	508	572
VINTAGE PRODUCTION CALIFORNIA LLC	S	3054	2	NOx	22	0	0	0
LOCKHEED MARTIN	S	3079	2	NOx	1160	1840	1500	1500
CALIFORNIA STATE PRISON - CORCORAN	S	3112	2	NOx	135	137	137	138
PASTORIA ENERGY FACILITY, LLC	S	3114	2	NOx	178929	181004	183080	184561

Table H-5 – List of Emission Reduction Credits
PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
CALPINE ENERGY SERVICES, L.P.	S	3138	2	NOx	0	0	0	760
OLDUVAI GORGE, LLC	S	3139	2	NOx	0	0	0	290
CHEVRON USA INC	S	3156	2	NOx	12415	12563	12710	12710
KERN DELTA WEEDPATCH GINNING	S	3199	2	NOx	0	0	0	622
CHEVRON USA INC (REFINERY)	S	3208	2	NOx	28667	29255	29842	29842
GENERAL MILLS, INC	S	3217	2	NOx	0	0	0	30
PLAINS EXPLORATION & PRODUCTION CO	S	3227	2	NOx	4812	4814	4815	4815
CHEVRON USA PRODUCTION INC	S	3228	2	NOx	139	161	275	104
OCCIDENTAL OF ELK HILLS INC	S	3249	2	NOx	89	208	73	157
BERRY PETROLEUM COMPANY	S	3256	2	NOx	239	239	239	239
AERA ENERGY LLC	S	3267	2	NOx	5519	3439	0	2156
SHAFTER-WASCO GINNING COMPANY	S	3268	2	NOx	0	0	0	232
HYDROGEN ENERGY CALIFORNIA, LLC	S	3273	2	NOx	120500	120500	120500	120500
CALPINE ENERGY SERVICES, L.P.	S	3277	2	NOx	6400	0	3870	1876
CALPINE CORPORATION	S	3298	2	NOx	2103	9681	19140	9076
AERA ENERGY LLC	S	3312	2	NOx	2432	4568	1346	162
LAND O' LAKES, INC.	S	3326	2	NOx	214	166	214	214
HOLMES WESTERN OIL CORPORATION	S	3377	2	NOx	1633	1632	1632	1632
CRIMSON RESOURCE MANAGEMENT	S	3388	2	NOx	4704	3393	3449	2696
CRIMSON RESOURCE MANAGEMENT	S	3389	2	NOx	95	299	319	166
CITY OF TULARE	S	3398	2	NOx	501	0	0	0
CRIMSON RESOURCE MANAGEMENT	S	3441	2	NOx	5	4	4	5
ALON BAKERSFIELD REFINING	S	3459	2	NOx	99200	101589	104030	104030

Table H-5 – List of Emission Reduction Credits
PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
ALON BAKERSFIELD REFINING	S	3460	2	NOx	4645	5658	5190	4325
ALON BAKERSFIELD REFINING	S	3461	2	NOx	1425	1689	1612	1776
GWF ERC LLC	S	3529	2	NOx	0	0	3	0
CHEVRON USA PRODUCTION INC	S	3533	2	NOx	181	188	224	219
CALPINE CORPORATION	S	3541	2	NOx	0	242	0	0
CHEVRON USA INC	S	3544	2	NOx	3027	3303	2542	2691
SAN JOAQUIN REFINING COMPANY	S	3549	2	NOx	201	202	202	201
SOUTH VALLEY GINS INC	S	3554	2	NOx	0	0	0	192
VINTAGE PRODUCTION CALIFORNIA LLC	S	3585	2	NOx	0	9294	4654	9859
VINTAGE PRODUCTION CALIFORNIA LLC	S	3586	2	NOx	0	1512	6228	0
VINTAGE PRODUCTION CALIFORNIA LLC	S	3587	2	NOx	758	694	618	1641
VINTAGE PRODUCTION CALIFORNIA LLC	S	3588	2	NOx	1847	0	0	0
VINTAGE PRODUCTION CALIFORNIA LLC	S	3589	2	NOx	1837	0	0	598
VINTAGE PRODUCTION CALIFORNIA LLC	S	3590	2	NOx	0	434	0	0
VINTAGE PRODUCTION CALIFORNIA LLC	S	3591	2	NOx	508	498	408	379
VINTAGE PRODUCTION CALIFORNIA LLC	S	3592	2	NOx	1283	275	1967	1412
CHEVRON USA INC	S	3604	2	NOx	1948	3037	3398	2243
PLAINS EXPLORATION & PRODUCTION CO	S	3613	2	NOx	1411	73	1449	2071

Table H-5 – List of Emission Reduction Credits PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
LAND O' LAKES, INC.	S	3625	2	NOx	618	473	646	602
VECTOR ENVIRONMENTAL, INC.	S	3630	2	NOx	127	156	146	19
AGRI-CEL INC	S	3631	2	NOx	54	67	63	8
BERRY PETROLEUM COMPANY	S	3636	2	NOx	3538	3339	0	3431
BERRY PETROLEUM COMPANY	S	3656	2	NOx	12976	0	0	0
STARWOOD POWER-MIDWAY, LLC	S	3676	2	NOx	283	283	496	354
INERGY PROPANE LLC	S	3677	2	NOx	47	137	86	23
AERA ENERGY LLC	S	3689	2	NOx	76465	88497	87135	83102
TURLOCK IRRIGATION DISTRICT	S	3707	2	NOx	3442	2862	2277	2277
SENECA RESOURCES	S	3718	2	NOx	0	118	0	0
CHEVRON USA INC	S	3735	2	NOx	43881	44422	44964	44964
NORTHERN CALIFORNIA POWER AGENCY	S	3746	2	NOx	0	1432	15919	10487
FRITO-LAY, INC.	S	3763	2	NOx	287	442	182	53
FRITO-LAY, INC.	S	3765	2	NOx	7432	7619	7790	7789
KRAFT FOODS, INC	S	3769	2	NOx	0	0	0	24
KRAFT FOODS, INC	S	3773	2	NOx	0	0	165	0
KRAFT FOODS, INC	S	3776	2	NOx	1227	3443	0	733
CHEVRON USA INC	S	3782	2	NOx	139808	139808	139808	139808
CHEVRON USA INC	S	3784	2	NOx	47002	47880	48758	48758
E&B NATURAL RESOURCES MGMT	S	3785	2	NOx	0	3296	538	2636
E&B NATURAL RESOURCES MGMT	S	3786	2	NOx	0	2971	2714	2156
E&B NATURAL RESOURCES MGMT	S	3787	2	NOx	0	3374	5552	6708
E&B NATURAL RESOURCES MGMT	S	3788	2	NOx	0	0	1064	0

Table H-5 – List of Emission Reduction Credits
PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
E&B NATURAL RESOURCES MGMT	S	3789	2	NOx	7208	0	0	0
E&B NATURAL RESOURCES MGMT	S	3790	2	NOx	2660	227	0	0
CHEVRON USA INC	S	3817	2	NOx	0	0	9568	154
CHEVRON USA INC	S	3818	2	NOx	0	6312	0	5064
CHEVRON USA INC	S	3819	2	NOx	6000	6000	6000	6000
BERRY PETROLEUM COMPANY	S	3820	2	NOx	31140	31140	31140	31140
ELEMENT MARKETS LLC	S	3821	2	NOx	830	830	830	830
OCCIDENTAL OF ELK HILLS INC	S	3825	2	NOx	24912	25457	26004	26005
AERA ENERGY LLC	S	3831	2	NOx	8498	5583	30	1326
BERRY PETROLEUM COMPANY	S	3837	2	NOx	0	0	1804	0
OLDUVAI GORGE, LLC	S	3854	2	NOx	19313	5679	7230	8820
LIBERTY COMPOSTING INC	S	3855	2	NOx	925	925	925	925
BERRY PETROLEUM COMPANY	S	3871	2	NOx	0	0	0	1047
BERRY PETROLEUM COMPANY	S	3873	2	NOx	227	1250	0	0
INERGY WEST COAST LLC	S	3893	2	NOx	14	14	14	14
BERRY PETROLEUM COMPANY	S	3913	2	NOx	416	833	0	417
BERRY PETROLEUM COMPANY	S	3915	2	NOx	1751	0	0	0
BERRY PETROLEUM COMPANY	S	3925	2	NOx	2234	1892	396	0
AERA ENERGY LLC	S	3933	2	NOx	12023	9838	10685	14104
MACPHERSON OIL COMPANY	S	3940	2	NOx	4055	4055	4055	4055
ELEMENT MARKETS LLC	S	3941	2	NOx	3548	3548	3548	3548
OCCIDENTAL OF ELK HILLS INC	S	3949	2	NOx	25773	26509	27248	27246
SIERRA POWER CORPORATION	S	2910001	2	NOx	2115	2138	2162	2162

Table H-5 – List of Emission Reduction Credits
PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
TEXACO EXPLOR & PROD INC	S	20250361	2	NOx	7037	7356	6314	6778
CHEVRON USA INC	S	20410281	2	NOx	3806	3765	3765	3848
CHEVRON USA INC	S	40410441	2	NOx	20385	20612	20838	20838
WESTERN STONE PRODUCTS, INC.	N	17	5	SOx	636	636	725	725
CALIFORNIA OLIVE GROWERS	C	21	5	SOx	10	10	10	10
COTTON ASSOCIATES, INC	S	25	5	SOx	0	0	0	1
CAMPBELL SOUP SUPPLY CO.	N	31	5	SOx	0	52	128	0
DUNCAN ENTERPRISES	C	33	5	SOx	3	3	3	2
CALMAT OF FRESNO	C	40	5	SOx	25	120	55	185
BUILDERS CONCRETE, INC.	C	41	5	SOx	8	8	8	8
BROWN SAND INC	N	46	5	SOx	3	3	2	3
J G BOSWELL CO. (SEED STORAGE)	C	47	5	SOx	2	1	2	2
CALMAT CO.	C	50	5	SOx	39	41	58	59
H. J. HEINZ COMPANY	N	60	5	SOx	0	0	32	0
CRAYCROFT BRICK COMPANY	C	71	5	SOx	2	2	2	2
ANDERSON CLAYTON CORP/KEARNY	C	75	5	SOx	0	0	0	28
ANDERSON CLAYTON CORP/SETTER	C	76	5	SOx	0	0	0	3
ANDERSON CLAYTON CORP/FIVE PTS	C	78	5	SOx	0	0	0	31
ANDERSON CLAYTON CORP/SAN JOAQ	C	79	5	SOx	0	0	0	22
ANDERSON CLAYTON CORP/TRANQLTY	C	80	5	SOx	0	0	0	2
ANDERSON CLAYTON CORP/CORCORAN	C	81	5	SOx	0	0	0	2
GROWERS COOP	S	88	5	SOx	0	0	0	3
THE NESTLE COMPANY INC	N	93	5	SOx	2491	39	48	6273

Table H-5 – List of Emission Reduction Credits
PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
WESTERN COTTON SERVICES	S	98	5	SOx	0	0	0	27
SUN GARDEN-GANGI CANNING CO LL	N	100	5	SOx	0	0	23440	4
CASTLE AIRPORT AVIATION & DEVELOP CENTER	N	109	5	SOx	3179	3214	3249	3249
LOS BANOS GRAVEL GROUP, ASPHLT	N	125	5	SOx	4	22	72	24
CAMPBELL SOUP COMPANY	N	127	5	SOx	18	13	11	13
SAN JOAQUIN VALLEY ENERGY	N	129	5	SOx	391	555	565	244
ECKERT FROZEN FOODS	N	133	5	SOx	1	3	9	8
ANDERSON CLAYTON CORPORATION	N	135	5	SOx	0	0	0	1
J.G. BOSWELL CO. (EL RICO)	C	135	5	SOx	2	1	0	5
SJVEP I, L.P. (CHOW II)	C	137	5	SOx	298	263	274	342
NAS LEMOORE	C	138	5	SOx	16	6	13	4
GENERAL MILLS OPERATIONS, INC	N	139	5	SOx	2	2	2	2
CRANBROOK ASSOCIATES LLC	N	140	5	SOx	24	24	391	31
CHEVRON USA PRODUCTION INC	S	147	5	SOx	3	3	2	3
R M WADE & COMPANY	C	152	5	SOx	2	2	2	2
WESTSIDE FARMERS COOP. GIN	C	164	5	SOx	0	0	0	37
CHEVRON USA INC	S	171	5	SOx	17	17	16	17
ANDERSON CLAYTON CORP.	N	181	5	SOx	0	0	0	1
PG & E ENERGY TRADING POWER LP	N	200	5	SOx	8	999	321	8
FIBREBOARD CORP.	N	209	5	SOx	9	7	4	10
CALAVERAS MATERIALS INC.	C	233	5	SOx	998	2716	3181	1989
ANDERSON CLAYTON CORP/MURRAY	C	234	5	SOx	0	0	0	6
HANSEN BROTHERS	C	249	5	SOx	0	0	0	2

Table H-5 – List of Emission Reduction Credits
PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
ANDERSON CLAYTON CORP/IDRIA #2	C	250	5	SOx	0	0	0	42
AERA ENERGY LLC	S	260	5	SOx	19004	28541	13717	8240
INGREDION INCORPORATED	N	264	5	SOx	39050	39050	39050	39050
AERA ENERGY LLC	S	272	5	SOx	1735	2907	1810	2494
AERA ENERGY LLC	S	284	5	SOx	19831	12103	6514	16106
PARAMOUNT FARMS, INC.	C	291	5	SOx	0	0	8	1
DUNAVANT OF CALIFORNIA	C	297	5	SOx	22	29	19	25
ANDERSON CLAYTON CORP	S	314	5	SOx	0	0	0	2
DEL MONTE CORPORATION	N	316	5	SOx	17	15	43	8
ANDERSON CLAYTON CORP/PLSNT VA	C	326	5	SOx	0	0	0	22
NAS LEMOORE	C	330	5	SOx	1	1	1	1
CHEVRON USA INC	C	331	5	SOx	1576	1577	1577	1577
ANDERSON CLAYTON CORP/DAIRYLAN	C	332	5	SOx	0	0	0	9
ANDERSON CLAYTON CORP/SUNSET	C	333	5	SOx	0	0	0	6
ANDERSON CLAYTON CORP/MURIT #1	C	334	5	SOx	0	0	0	9
ANDERSON CLAYTON CORP/NAPA GIN	C	335	5	SOx	0	0	0	6
ANDERSON CLAYTON CORP/MURIT #2	C	336	5	SOx	0	0	0	9
CHEVRON USA INC	C	339	5	SOx	4730	4730	4731	4731
CHEVRON U S A INC	S	357	5	SOx	6	5	5	7
HERSHEY CHOCOLATE & CONF. CORP	N	373	5	SOx	2	2	2	2
LIDESTRI FOODS, INC	N	391	5	SOx	0	0	84	0
AERA ENERGY LLC	S	395	5	SOx	4836	5200	5928	5651
INTERLAKE MATERIAL HANDLING	N	414	5	SOx	8	8	7	8

Table H-5 – List of Emission Reduction Credits PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
NRG POWER MARKETING INC	C	426	5	SOx	16	13	5	15
SEMI TROPIC COOP GIN	S	426	5	SOx	0	0	0	2
ANDERSON CLAYTON CORP/EL DORAD	C	427	5	SOx	0	0	0	3
ANDERSON CLAYTON CORP/KERMAN	C	428	5	SOx	0	0	0	48
MONTEREY RESOURCES, INC.	S	432	5	SOx	32	32	26	29
CHEVRON USA INC	S	436	5	SOx	79	72	66	66
VALLEY AIR CONDITIONING & REPAIR INC	C	438	5	SOx	41	105	154	162
MINTURN CO-OP GIN	N	441	5	SOx	0	0	0	31
HOLLY SUGAR CORPORATION	N	451	5	SOx	0	2146	1749	1492
ANDERSON CLAYTON CORP/KINGSRIV	C	460	5	SOx	0	0	0	4
LAWRENCE LIVERMORE NATL. LAB	N	464	5	SOx	30	11	0	22
ANDERSON CLAYTON CORP	S	471	5	SOx	0	0	0	1
ANDERSON CLAYTON CORP/DAIRYLND	C	472	5	SOx	0	0	0	21
CONAGRA CONSUMER FROZEN FOODS	N	489	5	SOx	7	4	5	6
ANDERSON CLAYTON CORP.	N	499	5	SOx	0	0	0	24
PARAMOUNT FARMS, INC.	C	501	5	SOx	26	81	126	112
VALLEY AIR CONDITIONING & REPAIR INC	C	502	5	SOx	7	22	36	30
CANDLEWICK YARNS	C	507	5	SOx	5	5	4	4
CLARK BROTHERS-DERRICK GIN	C	511	5	SOx	0	0	0	3
LODI GAS STORAGE LLC	N	515	5	SOx	5	5	5	5
DOLE PACKAGED FOODS LLC	N	520	5	SOx	1	3	9	8
NAVERUS INC	N	526	5	SOx	1	1	1	1

Table H-5 – List of Emission Reduction Credits
PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
COIT RANCH	C	532	5	SOx	0	0	0	4
COALINGA FARMERS CO-OP GIN	C	537	5	SOx	0	0	0	14
AERA ENERGY LLC	S	548	5	SOx	2803	26	0	0
AERA ENERGY LLC	S	556	5	SOx	1379	869	781	989
BRITZ AG FINANCE CO., INC.	C	557	5	SOx	0	0	0	33
CORCORAN IRRIGATION DISTRICT	C	560	5	SOx	4	5	4	3
UNIVERSITY ENERGY SERVICES	S	561	5	SOx	63	54	59	61
PACIFIC PIPELINE SYSTEM, LLC	S	575	5	SOx	1	39	115	24
PACIFIC PIPELINE SYSTEM, LLC	S	576	5	SOx	0	175	161	0
PACIFIC PIPELINE SYSTEM, LLC	S	577	5	SOx	42	57	61	61
BRITZ INCORPORATED	C	586	5	SOx	0	0	0	11
WESTSIDE FARMERS COOP GIN #6	C	592	5	SOx	10	0	0	71
MODESTO IRRIGATION DISTRICT	C	599	5	SOx	2078	1671	0	0
MODESTO TALLOW CO INC	N	599	5	SOx	20	18	22	22
OAKWOOD LAKE RESORT	N	601	5	SOx	0	0	1	0
BAR 20 PARTNERS LTD	N	612	5	SOx	0	0	79	0
BAR 20 PARTNERS LTD	N	617	5	SOx	0	0	304	0
VANDER WOUDE DAIRY	N	620	5	SOx	878	308	202	427
VANDER WOUDE DAIRY	N	621	5	SOx	0	0	13785	0
RON AND ROSALINDA VANDER WEERD	N	629	5	SOx	0	0	19437	0
RON AND ROSALINDA VANDER WEERD	N	630	5	SOx	0	0	20653	0
GRIMMIUS CATTLE COMPANY	N	636	5	SOx	21307	28000	6627	20577
BAR VP DAIRY	N	638	5	SOx	0	0	0	32

Table H-5 – List of Emission Reduction Credits
PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
BAR VP DAIRY	N	639	5	SOx	10	10	0	7
BAR VP DAIRY	N	640	5	SOx	0	0	16147	0
DIAMOND FOODS INCORPORATED	N	645	5	SOx	2699	2294	2340	1357
WESTLAKE FARMS INC	C	645	5	SOx	0	0	0	29
DANELL BROTHERS INC	N	682	5	SOx	10000	10000	10000	10000
H. J. HEINZ COMPANY	N	694	5	SOx	0	0	117	0
ANDERSON CLAYTON-MARICOPA GIN	S	697	5	SOx	0	0	0	3
EVOLUTION MARKETS INC.	N	698	5	SOx	55742	2294	0	0
SUNLAND REFINING CORPORATION	S	698	5	SOx	1293	1123	1211	1241
ANDERSON CLAYTON CORP/BUTTE	C	699	5	SOx	0	0	0	31
EVOLUTION MARKETS INC.	N	700	5	SOx	762	72578	0	0
CANANDAIGUA WINE COMPANY INC	C	702	5	SOx	33	34	35	32
EVOLUTION MARKETS INC.	N	711	5	SOx	0	0	4595	4591
EVOLUTION MARKETS INC.	N	713	5	SOx	19238	23422	0	0
ANDERSON CLAYTON CORPORATION	N	737	5	SOx	0	0	0	3
LATON CO-OP GIN, INC.	C	746	5	SOx	0	0	0	3
CANTUA COOPERATIVE GIN, INC.	C	760	5	SOx	0	0	0	4
AVENAL POWER CENTER, LLC	N	762	5	SOx	21000	21000	21000	21000
STOCKTON EAST WATER DISTRICT	N	763	5	SOx	8	10	11	9
OLDUVAI GORGE, LLC	N	769	5	SOx	13	12	12	12
BAR 20 PARTNERS LTD	N	778	5	SOx	0	0	1	0
PILKINGTON NORTH AMERICA, INC	N	785	5	SOx	90	90	90	90
OLDUVAI GORGE, LLC	N	786	5	SOx	46	46	40	36

Table H-5 – List of Emission Reduction Credits
PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
AERA ENERGY LLC	S	790	5	SOx	2	1	1	2
ANDERSON CLAYTON CORP/BURREL	C	806	5	SOx	3	0	0	7
BAR VP DAIRY	C	810	5	SOx	250	1096	0	682
BAR VP DAIRY	C	811	5	SOx	919	0	117	80
UNITED STATES GYPSUM COMPANY	C	818	5	SOx	0	0	0	5
OCCIDENTAL OF ELK HILLS INC	S	826	5	SOx	5	5	4	5
AERA ENERGY LLC	S	841	5	SOx	26339	26631	26924	26924
CALPINE ENERGY SERVICES, L.P.	N	841	5	SOx	3041	1167	5891	3122
CALPINE CORPORATION	N	844	5	SOx	6925	7045	7164	7164
AERA ENERGY LLC	S	847	5	SOx	153	227	173	72
EAGLE VALLEY GINNING LLC	N	847	5	SOx	0	0	0	3
PANOCHE ENERGY CENTER LLC	N	852	5	SOx	2	302	0	0
AERA ENERGY LLC	S	863	5	SOx	6	7	13	12
ANDERSON CLAYTON CORP/HANFORD	C	863	5	SOx	0	0	0	4
BRITZ GIN PARTNERSHIP II	C	871	5	SOx	0	0	0	4
PLAINS EXPLORATION & PRODUCTION CO	N	871	5	SOx	35	35	33	33
EVOLUTION MARKETS INC.	C	882	5	SOx	0	0	0	23
RON/ROSALINDA VANDER WEERD	C	883	5	SOx	0	3800	3800	0
RON/ROSALINDA VANDER WEERD	C	884	5	SOx	3750	0	66	3751
CHEVRON USA INC	S	891	5	SOx	2712	2742	2773	2773
CALPINE ENERGY SERVICES, L.P.	N	893	5	SOx	0	0	0	52748
PANOCHE GINNING CO	C	904	5	SOx	0	0	0	5
CHEVRON USA INC	S	906	5	SOx	2470	2498	2526	2526

Table H-5 – List of Emission Reduction Credits
PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
CHEVRON USA INC	S	907	5	SOx	1527	1306	1330	1176
OLAM	N	917	5	SOx	7118	18526	23007	910
OCCIDENTAL OF ELK HILLS INC	N	928	5	SOx	7500	7500	7500	7500
MOLYCORP MINERALS, LLC	N	938	5	SOx	8250	8250	8250	8250
MOLYCORP MINERALS, LLC	N	939	5	SOx	21899	23000	0	14704
OCCIDENTAL OF ELK HILLS INC	N	940	5	SOx	2000	2000	2000	2000
MADERA CO-OP GIN, INC.	C	943	5	SOx	0	0	0	2
PLAINS EXPLORATION & PRODUCTION CO	C	948	5	SOx	22	22	22	22
PLAINS EXPLORATION & PRODUCTION CO	C	949	5	SOx	6	0	16	17
VINTAGE PRODUCTION CALIFORNIA LLC	N	949	5	SOx	4000	4000	4000	4000
HERSHEY CHOCOLATE & CONF. CORP	N	952	5	SOx	3	3	3	3
FARMERS FIREBAUGH GINNING CO.	C	956	5	SOx	2	0	0	6
ANDERSON CLAYTON CORP/IDRIA #1	C	959	5	SOx	0	0	0	53
CHEVRON USA INC	C	966	5	SOx	2	2	2	2
CALIFORNIA DAIRIES, INC.	N	986	5	SOx	9000	9000	9000	9000
AERA ENERGY LLC	S	989	5	SOx	0	2808	0	0
MODESTO IRRIGATION DISTRICT	N	989	5	SOx	23945	25082	12500	0
AERA ENERGY LLC	S	998	5	SOx	735	0	0	0
AERA ENERGY LLC	S	1000	5	SOx	138	2811	489	10
AERA ENERGY LLC	S	1001	5	SOx	275	583	0	0
KERMAN CO-OP GIN & WAREHOUSE 1	C	1002	5	SOx	0	0	0	2
BULLARD ENERGY CENTER, LLC	N	1003	5	SOx	5384	0	0	4390

Table H-5 – List of Emission Reduction Credits
PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
DTE STOCKTON, LLC	N	1007	5	SOx	0	0	27720	0
BULLARD ENERGY CENTER, LLC	N	1008	5	SOx	0	0	27306	0
OXY USA, INC	N	1013	5	SOx	0	0	0	936
THE ENVIRONMENTAL RESOURCES TRUST, INC	C	1013	5	SOx	9823	9823	9823	9823
OXY USA, INC	N	1014	5	SOx	0	0	9774	0
OXY USA, INC	N	1015	5	SOx	34014	32292	24951	35007
TKV CONTAINERS, INC.	C	1015	5	SOx	0	0	1	0
LOS GATOS TOMATO PRODUCTS	C	1021	5	SOx	0	1	0	0
NORTHERN CALIFORNIA POWER AGENCY	N	1022	5	SOx	0	0	5751	0
PLAINS EXPLORATION & PRODUCTION CO	N	1031	5	SOx	2472	2472	2472	2472
AERA ENERGY LLC	S	1032	5	SOx	28371	72172	48856	9900
WESTSIDE FARMERS COOP #2 & #3	C	1038	5	SOx	1	0	0	10
ANDERSON CLAYTON CORP	S	1045	5	SOx	0	0	0	3
VINTAGE PRODUCTION CALIFORNIA LLC	N	1049	5	SOx	5000	5000	5000	5000
GREY K FUND LP	N	1050	5	SOx	70590	70467	20344	20344
MARTIN ANDERSON	C	1051	5	SOx	18	27	16	1
AERA ENERGY LLC	S	1057	5	SOx	4	5	4	3
HYDROGEN ENERGY CA LLC	C	1058	5	SOx	24500	24500	24500	24500
G.I.C. FINANCIAL SERVICES, INC.	C	1059	5	SOx	70500	70500	70500	70500
AERA ENERGY LLC	S	1071	5	SOx	10682	10682	10682	10682
AERA ENERGY LLC	S	1072	5	SOx	5	4	4	4

Table H-5 – List of Emission Reduction Credits PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
AERA ENERGY LLC	S	1073	5	SOx	2	2	2	2
AERA ENERGY LLC	S	1075	5	SOx	0	1	0	0
AERA ENERGY LLC	S	1076	5	SOx	12	11	13	11
AERA ENERGY LLC	S	1077	5	SOx	79	176	164	173
AERA ENERGY LLC	S	1091	5	SOx	57	70	71	71
GUARDIAN INDUSTRIES CORP	C	1103	5	SOx	16966	16966	16966	16966
SPRECKELS SUGAR COMPANY	C	1112	5	SOx	0	26875	37739	16268
OXY USA, INC	C	1123	5	SOx	1598	0	0	0
AERA ENERGY LLC	S	1133	5	SOx	436	877	687	281
TAUBER OIL COMPANY	C	1139	5	SOx	3103	3103	3103	3103
TAUBER OIL COMPANY	C	1140	5	SOx	20	20	21	21
PLAINS EXPLORATION & PRODUCTION CO	C	1150	5	SOx	61	55	49	49
ANDERSON CLAYTON CORP	S	1171	5	SOx	0	0	0	3
VINTAGE PRODUCTION CALIFORNIA LLC	C	1190	5	SOx	10250	10250	10250	10250
HANFORD L P	C	1191	5	SOx	11597	13898	11341	13511
ANDERSON CLAYTON CORP	S	1262	5	SOx	0	0	0	2
ANDERSON CLAYTON CORP	S	1263	5	SOx	1	0	0	3
AERA ENERGY LLC	S	1295	5	SOx	1289	2983	696	488
AERA ENERGY LLC	S	1339	5	SOx	102863	63756	0	10468
AERA ENERGY LLC	S	1476	5	SOx	21	0	0	6
AERA ENERGY LLC	S	1477	5	SOx	36	0	0	10
CHEVRON USA INC	S	1485	5	SOx	1890	1911	1931	1931

Table H-5 – List of Emission Reduction Credits
PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
CHEVRON USA INC	S	1542	5	SOx	25189	21032	18790	30130
AERA ENERGY LLC	S	1865	5	SOx	5592	4295	5749	5942
ELK HILLS POWER LLC	S	1950	5	SOx	496	306	118	118
AERA ENERGY LLC	S	2008	5	SOx	85594	40615	57148	91993
AERA ENERGY LLC	S	2010	5	SOx	0	3320	0	0
AERA ENERGY LLC	S	2019	5	SOx	582	589	597	597
KERN DELTA WEEDPATCH GINNING	S	2062	5	SOx	0	0	0	15
KERN LAKE COOP GIN	S	2074	5	SOx	0	0	0	14
CHEVRON U S A INC	S	2080	5	SOx	35848	36301	36756	36756
AMERICAN ENERGY OPERATIONS INC	S	2297	5	SOx	16	20	16	13
AERA ENERGY LLC	S	2361	5	SOx	542	71	2	215
KERN OIL & REFINING CO.	S	2387	5	SOx	7500	7500	7500	7500
CHEVRON USA INC	S	2454	5	SOx	9938	15295	38474	24993
OLDUVAI GORGE, LLC	S	2483	5	SOx	0	0	1600	0
VANDER WOUDE DAIRY	S	2485	5	SOx	3800	0	3800	3800
GRIMMIUS CATTLE COMPANY	S	2504	5	SOx	6693	0	21373	7423
M CARATAN INC	S	2516	5	SOx	0	0	2	0
FARMERS COOPERATIVE GIN INC	S	2533	5	SOx	0	0	0	4
BAR VP DAIRY	S	2534	5	SOx	0	1	49	50
ELBOW ENTERPRISES INC	S	2535	5	SOx	0	0	0	33
UNITED STATES GYPSUM COMPANY	S	2543	5	SOx	0	0	0	9
OLDUVAI GORGE, LLC	S	2604	5	SOx	0	0	0	6
RICHARD OPPEDYK	S	2620	5	SOx	2750	2750	2750	2750

Table H-5 – List of Emission Reduction Credits
PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
EVOLUTION MARKETS INC.	S	2632	5	SOx	11102	11225	11348	11348
SOUTH LAKES DAIRY	S	2638	5	SOx	300	300	300	300
OLDUVAI GORGE, LLC	S	2671	5	SOx	1744	1744	1744	1744
TAFT PRODUCTION COMPANY	S	2672	5	SOx	1695	1733	1771	1771
TULE RIVER CO-OP GIN INC	S	2682	5	SOx	0	0	0	3
MODESTO IRRIGATION DISTRICT	S	2686	5	SOx	25188	2688	78	8578
OLDUVAI GORGE, LLC	S	2692	5	SOx	22146	30918	8240	22190
COVANTA DELANO INC	S	2721	5	SOx	890	916	941	941
EVOLUTION MARKETS INC.	S	2741	5	SOx	0	0	8706	0
EVOLUTION MARKETS INC.	S	2742	5	SOx	5836	1652	9106	19927
EVOLUTION MARKETS INC.	S	2743	5	SOx	0	0	2666	551
PASTORIA ENERGY FACILITY, LLC	S	2744	5	SOx	11324	11450	11576	11576
EVOLUTION MARKETS INC.	S	2750	5	SOx	0	0	0	28
RON/ROSALINDA VANDER WEERD	S	2751	5	SOx	6250	6200	6134	6249
E&B NATURAL RESOURCES MGMT	S	2773	5	SOx	1954	2649	1427	2052
AVENAL POWER CENTER, LLC	S	2788	5	SOx	5	7	3	6
AVENAL POWER CENTER, LLC	S	2789	5	SOx	6	14	12	8
AVENAL POWER CENTER, LLC	S	2790	5	SOx	12862	491	0	8499
AVENAL POWER CENTER, LLC	S	2791	5	SOx	92179	23666	69157	96288
PLAINS EXPLORATION & PRODUCTION CO	S	2800	5	SOx	840	516	192	192
RIVER RANCH FARMS	S	2930	5	SOx	4702	0	0	11853
CHEVRON USA INC	S	2934	5	SOx	11539	16868	23727	33544
BUTTONWILLOW GINNING CO	S	2937	5	SOx	0	0	0	4

Table H-5 – List of Emission Reduction Credits
PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
BAKERSFIELD CITY WOOD SITE	S	2969	5	SOx	3	5	5	4
GLOBAL AMPERSAND LLC	S	2978	5	SOx	29	0	0	0
MID-VALLEY COTTON GROWERS INC	S	2989	5	SOx	0	0	0	4
VINTAGE PRODUCTION CALIFORNIA LLC	S	3035	5	SOx	2	2	4	4
CALIFORNIA DAIRIES, INC	S	3058	5	SOx	1401	1401	1399	1399
OLDUVAI GORGE, LLC	S	3069	5	SOx	2062	2222	2381	2381
CALPINE ENERGY SERVICES, L.P.	S	3075	5	SOx	5080	12043	7319	15177
CHEVRON USA INC	S	3082	5	SOx	15520	13060	10088	5442
SOC RESOURCES INC	S	3089	5	SOx	94	89	87	90
KERN OIL & REFINING CO.	S	3106	5	SOx	78598	78599	51520	78598
R W MARTELLA	S	3108	5	SOx	0	351	351	922
CHEVRON USA INC	S	3154	5	SOx	22988	23243	23499	23499
PLAINS EXPLORATION & PRODUCTION CO	S	3165	5	SOx	779	779	781	781
KERN DELTA WEEDPATCH GINNING	S	3199	5	SOx	0	0	0	4
CHEVRON USA PRODUCTION INC	S	3228	5	SOx	11	13	22	8
VANDERHAM WEST	S	3233	5	SOx	1453	1452	1452	1452
SHAFTER-WASCO GINNING COMPANY	S	3268	5	SOx	0	0	0	19
HYDROGEN ENERGY CALIFORNIA, LLC	S	3275	5	SOx	42000	42000	42000	42000
CALPINE ENERGY SERVICES, L.P.	S	3279	5	SOx	1625	0	0	1339
CALPINE ENERGY SERVICES, L.P.	S	3281	5	SOx	3875	5500	5500	4161
CALPINE ENERGY SERVICES, L.P.	S	3294	5	SOx	4000	4000	4000	4000
AERA ENERGY LLC	S	3310	5	SOx	281	227	223	281

Table H-5 – List of Emission Reduction Credits
PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
CALPINE ENERGY SERVICES, L.P.	S	3348	5	SOx	9536	6336	6163	6545
LAND O' LAKES, INC.	S	3352	5	SOx	158	835	687	274
CALPINE ENERGY SERVICES, L.P.	S	3356	5	SOx	24000	24000	24000	24000
AERA ENERGY LLC	S	3363	5	SOx	21065	27266	29310	28564
ELEMENT MARKETS LLC	S	3370	5	SOx	3	2	2	2
CITY OF TULARE	S	3396	5	SOx	26	26	26	26
INERGY PROPANE LLC	S	3406	5	SOx	290	290	290	290
FRITO-LAY, INC.	S	3423	5	SOx	137	176	113	64
FRITO-LAY, INC.	S	3427	5	SOx	8	8	9	9
ALON BAKERSFIELD REFINING	S	3465	5	SOx	5548	5771	4951	5990
ALON BAKERSFIELD REFINING	S	3466	5	SOx	13479	23755	20724	27141
CALPINE ENERGY SERVICES, L.P.	S	3483	5	SOx	10832	8062	7209	10281
AERA ENERGY LLC	S	3525	5	SOx	1902	1902	1902	1902
CHEVRON USA PRODUCTION INC	S	3533	5	SOx	1	1	1	1
CHEVRON USA INC	S	3544	5	SOx	33	36	29	30
SAN JOAQUIN REFINING COMPANY	S	3547	5	SOx	40	39	39	39
SOUTH VALLEY GINS INC	S	3554	5	SOx	0	0	0	5
JR SIMPLOT COMPANY	S	3570	5	SOx	688	715	742	742
VINTAGE PRODUCTION CALIFORNIA LLC	S	3593	5	SOx	494	494	492	492
CHEVRON USA INC	S	3595	5	SOx	8675	18997	25244	24674
CHEVRON USA INC	S	3604	5	SOx	22	33	37	24
PLAINS EXPLORATION & PRODUCTION CO	S	3611	5	SOx	5	5	3	3

Table H-5 – List of Emission Reduction Credits
PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
LAND O' LAKES, INC.	S	3625	5	SOx	5	5	6	5
VECTOR ENVIRONMENTAL, INC.	S	3630	5	SOx	27	34	31	4
AGRI-CEL INC	S	3631	5	SOx	12	14	13	1
EVOLUTION MARKETS INC.	S	3669	5	SOx	13197	17604	0	0
3H CATTLE COMPANY	S	3672	5	SOx	0	14	0	0
AERA ENERGY LLC	S	3685	5	SOx	52466	53256	54044	54044
TURLOCK IRRIGATION DISTRICT	S	3709	5	SOx	29865	14110	0	32286
SENECA RESOURCES	S	3720	5	SOx	0	0	0	20
OXY USA, INC	S	3724	5	SOx	325	0	0	0
OXY USA, INC	S	3725	5	SOx	5	0	0	0
NORTHERN CALIFORNIA POWER AGENCY	S	3742	5	SOx	4638	3076	12619	13130
FRITO-LAY, INC.	S	3767	5	SOx	5203	5000	8796	8796
FOSTER FARMS, SPERRY RANCH	S	3795	5	SOx	175	175	0	0
OCCIDENTAL OF ELK HILLS INC	S	3823	5	SOx	4956	4956	4954	4954
AERA ENERGY LLC	S	3833	5	SOx	16508	18345	2147	8994
VINTAGE PRODUCTION CALIFORNIA LLC	S	3850	5	SOx	753	0	319	419
BERRY PETROLEUM COMPANY	S	3879	5	SOx	2331	2330	2330	2330
BERRY PETROLEUM COMPANY	S	3881	5	SOx	1396	1396	1396	1396
BERRY PETROLEUM COMPANY	S	3917	5	SOx	51750	52166	51970	53291
MACPHERSON OIL COMPANY	S	3927	5	SOx	0	3	13	4
AERA ENERGY LLC	S	3937	5	SOx	119859	82532	14195	40870
MACPHERSON OIL COMPANY	S	3938	5	SOx	1675	1675	1675	1675

Table H-5 – List of Emission Reduction Credits
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Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
ELEMENT MARKETS LLC	S	3939	5	SOx	2325	2325	2325	2325
E & J GALLO WINERY	N	2	1	VOC	9	9	26	28
LIVE OAK LIMITED	S	3	1	VOC	198	200	202	202
WESTERN STONE PRODUCTS, INC.	N	17	1	VOC	6	6	7	7
H. J. HEINZ COMPANY, L.P.	N	21	1	VOC	0	60	180	60
COTTON ASSOCIATES, INC	S	25	1	VOC	0	0	0	8
DUNCAN ENTERPRISES	C	33	1	VOC	26	26	27	18
CALMAT OF FRESNO	C	40	1	VOC	2	11	5	17
BUILDERS CONCRETE, INC.	C	41	1	VOC	35	35	35	35
HERSHEY CHOCOLATE & CONF. CORP	N	42	1	VOC	1	1	1	1
BROWN SAND INC	N	46	1	VOC	2	2	1	2
CALMAT CO.	C	50	1	VOC	2	2	3	3
ANDERSON CLAYTON CORP/STRATFOR	C	56	1	VOC	0	0	0	4
H. J. HEINZ COMPANY	N	60	1	VOC	0	23	129	0
LEPRINO FOODS COMPANY	C	60	1	VOC	137	139	136	138
SEQUOIA FOREST INDUSTRIES	C	67	1	VOC	2	9	0	6
CRAYCROFT BRICK COMPANY	C	71	1	VOC	24	20	19	19
SEQUOIA FOREST INDUSTRIES	C	72	1	VOC	7	0	1	1
ANDERSON CLAYTON CORP/HANFORD	C	74	1	VOC	0	0	0	5
ANDERSON CLAYTON CORP/KEARNY	C	75	1	VOC	0	0	0	7
ANDERSON CLAYTON CORP/SETTER	C	76	1	VOC	0	0	0	7
CALIFORNIA-WASHINGTON CAN CO.	N	77	1	VOC	2664	0	0	1583
CHEVRON USA INC	S	77	1	VOC	42	38	36	47

Table H-5 – List of Emission Reduction Credits
PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
ANDERSON CLAYTON CORP/FIVE PTS	C	78	1	VOC	0	0	0	8
ANDERSON CLAYTON CORP/SAN JOAQ	C	79	1	VOC	0	0	0	5
ANDERSON CLAYTON CORP/TRANQLTY	C	80	1	VOC	0	0	0	12
ANDERSON CLAYTON CORP/CORCORAN	C	81	1	VOC	0	0	0	15
GROWERS COOP	S	88	1	VOC	0	0	1	15
CALAVERAS MATERIALS INC	C	89	1	VOC	92	83	95	76
THE NESTLE COMPANY INC	N	93	1	VOC	997	1820	1874	1007
LOS BANOS GRAVEL GROUP, ASPHLT	N	125	1	VOC	16	81	258	86
CAMPBELL SOUP COMPANY	N	127	1	VOC	84	58	52	61
ECKERT FROZEN FOODS	N	133	1	VOC	3	11	41	8
ANDERSON CLAYTON CORPORATION	N	135	1	VOC	0	0	0	5
J.G. BOSWELL CO. (EL RICO)	C	135	1	VOC	1	0	0	1
GENERAL MILLS OPERATIONS, INC	N	139	1	VOC	16	13	13	19
WESTSIDE FARMERS COOP. GIN	C	164	1	VOC	0	0	0	31
CHEVRON USA INC	S	165	1	VOC	2970	3003	3036	3036
ANDERSON CLAYTON CORP.	N	181	1	VOC	0	0	0	6
FIBREBOARD CORP.	N	209	1	VOC	41	34	16	45
AERA ENERGY LLC	C	219	1	VOC	268	297	324	298
CHEVRON USA INC	C	221	1	VOC	357	395	431	396
CALAVERAS MATERIALS INC.	C	233	1	VOC	148	410	483	300
ANDERSON CLAYTON CORP/MURRAY	C	234	1	VOC	0	0	0	12
HANSEN BROTHERS	C	249	1	VOC	0	0	0	13
ANDERSON CLAYTON CORP/IDRIA #2	C	250	1	VOC	0	0	0	9

Table H-5 – List of Emission Reduction Credits
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Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
ARCO PIPELINE FACILITY	C	271	1	VOC	419	417	417	417
CHEVRON USA INC	C	277	1	VOC	2209	2209	2209	2209
PACIFIC GAS & ELECTRIC CO.	C	280	1	VOC	21981	68020	71348	53244
PARAMOUNT FARMS, INC.	C	291	1	VOC	0	0	63	12
ANDERSON CLAYTON CORP	S	314	1	VOC	0	0	1	18
DEL MONTE CORPORATION	N	316	1	VOC	82	71	116	28
MID-VALLEY COTTON GROWERS INC	S	317	1	VOC	0	0	0	6
ANDERSON CLAYTON CORP/PLSNT VA	C	326	1	VOC	0	0	0	18
CHEVRON USA INC	C	331	1	VOC	1220	1220	1221	1221
ANDERSON CLAYTON CORP/DAIRYLAN	C	332	1	VOC	0	0	0	7
ANDERSON CLAYTON CORP/SUNSET	C	333	1	VOC	0	0	0	5
ANDERSON CLAYTON CORP/MURIT #1	C	334	1	VOC	0	0	0	7
ANDERSON CLAYTON CORP/NAPA GIN	C	335	1	VOC	0	0	0	5
ANDERSON CLAYTON CORP/MURIT #2	C	336	1	VOC	0	0	0	7
HERSHEY CHOCOLATE & CONF. CORP	N	373	1	VOC	9	11	13	11
APTCO LLC	N	390	1	VOC	1370	1266	1618	948
LIDESTRI FOODS, INC	N	391	1	VOC	0	0	389	0
APTCO LLC	N	397	1	VOC	12104	11748	9416	0
CHEVRON USA INC	S	410	1	VOC	5	7	11	15
SEMI TROPIC COOP GIN	S	426	1	VOC	1	0	1	28
ANDERSON CLAYTON CORP/EL DORAD	C	427	1	VOC	1	0	0	17
ANDERSON CLAYTON CORP/KERMAN	C	428	1	VOC	0	0	0	11
SILGAN CONTAINERS LODI MFG CORP	N	431	1	VOC	5103	3464	3573	3865

Table H-5 – List of Emission Reduction Credits PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
HOLMES WESTERN OIL CORPORATION	S	439	1	VOC	281	595	667	265
MINTURN CO-OP GIN	N	441	1	VOC	0	0	0	20
HOLMES WESTERN OIL CORPORATION	S	458	1	VOC	31	63	70	31
ANDERSON CLAYTON CORP/KINGSRIV	C	460	1	VOC	2	0	0	31
LAWRENCE LIVERMORE NATL. LAB	N	464	1	VOC	2	1	0	1
SHELL CALIFORNIA PIPELINE COMPANY LLC	C	467	1	VOC	185	0	0	0
ANDERSON CLAYTON CORP	S	471	1	VOC	0	0	0	9
ANDERSON CLAYTON CORP/DAIRYLND	C	472	1	VOC	0	0	0	13
LOS ANGELES CNTY SANITATION DIST NO.2	N	472	1	VOC	5953	6019	6086	6086
SHELL PIPELINE COMPANY LP	N	474	1	VOC	400	400	400	400
MODESTO IRRIGATION DISTRICT	N	479	1	VOC	0	0	305	0
CALIFORNIA DAIRIES	N	497	1	VOC	33	33	33	33
ANDERSON CLAYTON CORP.	N	499	1	VOC	0	0	0	15
CANDLEWICK YARNS	C	507	1	VOC	23	20	16	14
CLARK BROTHERS-DERRICK GIN	C	511	1	VOC	0	0	0	2
DOLE PACKAGED FOODS LLC	N	520	1	VOC	3	11	41	8
CASTLE AIRPORT AVIATION & DEVELOP CENTER	N	523	1	VOC	31801	32175	32549	32549
COIT RANCH	C	532	1	VOC	0	0	0	8
COALINGA FARMERS CO-OP GIN	C	537	1	VOC	0	0	0	8
APTCO LLC	N	540	1	VOC	5000	5000	5000	5000
DART CONTAINER CORPORATION	C	555	1	VOC	30481	26626	14213	50680
BRITZ AG FINANCE CO., INC.	C	557	1	VOC	0	0	0	8

Table H-5 – List of Emission Reduction Credits PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
CORCORAN IRRIGATION DISTRICT	C	560	1	VOC	154	163	159	90
UNIVERSITY ENERGY SERVICES	S	561	1	VOC	63	54	59	61
DIAMOND FOODS INCORPORATED	N	572	1	VOC	126	45	138	120
VALERO LP	N	578	1	VOC	2372	2372	2372	2371
BRITZ INCORPORATED	C	586	1	VOC	0	0	0	21
WESTSIDE FARMERS COOP GIN #6	C	592	1	VOC	6	0	0	44
MODESTO TALLOW CO INC	N	599	1	VOC	184	165	202	196
OAKWOOD LAKE RESORT	N	601	1	VOC	0	72	115	0
WESTERN COTTON SERVICES	S	606	1	VOC	0	0	0	9
TURLOCK IRRIGATION DISTRICT	C	607	1	VOC	297	297	297	297
CHEVRON U S A INC	S	629	1	VOC	48	42	43	41
DIAMOND FOODS INCORPORATED	N	645	1	VOC	1695	1419	1451	783
EXXON MOBIL CORPORATION	S	645	1	VOC	128	130	131	131
WESTLAKE FARMS INC	C	645	1	VOC	0	0	0	18
CHEVRON USA INC	S	647	1	VOC	235	699	540	95
SAN JOAQUIN FACILITIES MGMT	S	648	1	VOC	116	93	118	120
HOLMES WESTERN OIL CORPORATION	N	652	1	VOC	324	326	311	301
HOLMES WESTERN OIL CORPORATION	N	653	1	VOC	30	30	25	24
CHEVRON USA INC (REFINERY)	S	657	1	VOC	35011	35399	35788	35788
UNITED STATES GYPSUM COMPANY	N	661	1	VOC	15000	16335	16334	12331
AERA ENERGY LLC	S	663	1	VOC	544	495	483	454
APTCO LLC	C	663	1	VOC	0	147	788	148
CHEMICAL WASTE MANAGEMENT, INC	N	663	1	VOC	7000	0	0	14000

Table H-5 – List of Emission Reduction Credits
PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
APTCO LLC	C	664	1	VOC	0	149	796	150
PWP INDUSTRIES, INC. DBA PACTIV LLC	N	664	1	VOC	23529	14812	15264	14520
APTCO LLC	C	665	1	VOC	0	141	758	143
SOUTHERN CALIF GAS CO	S	671	1	VOC	570	576	583	583
CHEVRON USA PRODUCTION INC	S	674	1	VOC	5779	5851	5903	5902
AERA ENERGY LLC	C	679	1	VOC	11014	11468	11508	11211
CALIFORNIA DAIRIES, INC.	C	683	1	VOC	0	0	454	0
APTCO LLC	C	684	1	VOC	0	138	241	139
CLEAN HARBORS BUTTONWILLOW, LLC	S	685	1	VOC	31195	31541	31888	31888
H. J. HEINZ COMPANY	N	694	1	VOC	0	0	701	0
ANDERSON CLAYTON-MARICOPA GIN	S	697	1	VOC	0	0	0	25
ANDERSON CLAYTON CORP/BUTTE	C	699	1	VOC	0	0	0	19
CHEVRON USA INC	S	703	1	VOC	2084	2107	2130	2130
AVENAL POWER CENTER, LLC	N	724	1	VOC	0	0	241	0
AVENAL POWER CENTER, LLC	N	725	1	VOC	0	0	709	0
VINTAGE PRODUCTION CALIFORNIA LLC	S	730	1	VOC	69	97	110	67
VINTAGE PRODUCTION CALIFORNIA LLC	S	734	1	VOC	4	8	8	4
VINTAGE PRODUCTION CALIFORNIA LLC	S	735	1	VOC	7	11	13	8
VINTAGE PRODUCTION CALIFORNIA LLC	S	736	1	VOC	80	157	165	81
ANDERSON CLAYTON CORPORATION	N	737	1	VOC	1	0	0	16
VINTAGE PRODUCTION CALIFORNIA	S	737	1	VOC	310	575	603	317

Table H-5 – List of Emission Reduction Credits
PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
LLC								
VINTAGE PRODUCTION CALIFORNIA LLC	S	738	1	VOC	192	375	395	198
MODESTO IRRIGATION DISTRICT	N	739	1	VOC	0	0	27	0
LATON CO-OP GIN, INC.	C	746	1	VOC	0	0	0	8
CANTUA COOPERATIVE GIN, INC.	C	760	1	VOC	0	0	0	38
STOCKTON EAST WATER DISTRICT	N	763	1	VOC	1627	2271	2299	2059
TRC OPERATION COMPANY, INC.	S	767	1	VOC	394	399	403	403
PACIFIC PIPELINE SYSTEM, LLC	S	776	1	VOC	28	67	77	34
OLDUVAI GORGE, LLC	N	794	1	VOC	14089	2531	5512	1043
THE DOW CHEMICAL COMPANY	N	799	1	VOC	218	212	236	224
ANDERSON CLAYTON CORP/BURREL	C	806	1	VOC	14	0	0	42
UNITED STATES GYPSUM COMPANY	C	818	1	VOC	0	0	0	40
HOLMES WESTERN OIL CORPORATION	C	823	1	VOC	0	0	0	10
PHOENIX BIO INDUSTRIES LLC	C	824	1	VOC	500	500	500	500
DIAMOND FOODS INCORPORATED	N	828	1	VOC	1495	671	1063	1914
OCCIDENTAL OF ELK HILLS INC	S	829	1	VOC	57	60	72	58
VINTAGE PRODUCTION CALIFORNIA LLC	N	832	1	VOC	30	30	32	30
VINTAGE PRODUCTION CALIFORNIA LLC	N	833	1	VOC	16	16	14	14
EAGLE VALLEY GINNING LLC	N	847	1	VOC	0	0	0	23
SEALED AIR CORPORATION	C	851	1	VOC	19000	19000	19000	19000
APTCO LLC	N	854	1	VOC	3141	4397	2894	0
CONAGRA CONSUMER FROZEN FOODS	N	858	1	VOC	5	0	0	8

Table H-5 – List of Emission Reduction Credits
PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
ANDERSON CLAYTON CORP/HANFORD	C	863	1	VOC	0	0	0	36
AERA ENERGY LLC	S	868	1	VOC	724	735	729	672
PACIFIC GAS & ELECTRIC CO.	N	868	1	VOC	926	5826	5035	615
BRITZ GIN PARTNERSHIP II	C	871	1	VOC	0	0	0	32
APTCO LLC	S	872	1	VOC	9	8	9	9
ASV WINES, INC.	N	892	1	VOC	0	0	189	0
AVENAL POWER CENTER, LLC	C	897	1	VOC	45	45	45	45
AVENAL POWER CENTER, LLC	C	898	1	VOC	5480	6496	4696	6616
VARCO PRUDEN BUILDINGS, INC.	N	898	1	VOC	5404	6473	10921	8632
ANDERSON CLAYTON CORP	C	903	1	VOC	0	0	0	4
PANOCHE GINNING CO	C	904	1	VOC	0	0	0	49
TEXACO EXPLOR & PROD INC	S	904	1	VOC	492	551	403	459
OLAM	N	920	1	VOC	0	0	3	0
CALPINE ENERGY SERVICES, L.P.	N	927	1	VOC	10503	10981	11573	11536
MADERA CO-OP GIN, INC.	C	943	1	VOC	0	0	0	11
ANDERSEN RACK SYSTEMS, INC	N	950	1	VOC	7335	7335	7335	7335
HERSHEY CHOCOLATE & CONF. CORP	N	952	1	VOC	5	5	6	6
FARMERS FIREBAUGH GINNING CO.	C	956	1	VOC	16	0	0	47
ANDERSON CLAYTON CORP/IDRIA #1	C	959	1	VOC	0	0	0	76
CHEVRON USA INC	C	966	1	VOC	6	6	6	6
BERRY PETROLEUM COMPANY	N	974	1	VOC	0	1027	0	0
BERRY PETROLEUM COMPANY	N	976	1	VOC	0	0	20	0
BERRY PETROLEUM COMPANY	N	978	1	VOC	157	144	137	134

Table H-5 – List of Emission Reduction Credits
PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
BERRY PETROLEUM COMPANY	N	979	1	VOC	6210	6210	6210	6210
TESORO LOGISTICS OPERATIONS LLC	N	997	1	VOC	2415	2415	2415	2415
CE2 ENVIRONMENTAL OPPORTUNITIES I LP	N	998	1	VOC	2385	2385	2385	2385
TESORO LOGISTICS OPERATIONS LLC	N	999	1	VOC	2625	2625	2625	2625
CE2 ENVIRONMENTAL MARKETS LP	N	1000	1	VOC	2575	2575	2575	2575
KERMAN CO-OP GIN & WAREHOUSE 1	C	1002	1	VOC	0	0	0	13
TKV CONTAINERS, INC.	C	1015	1	VOC	0	83	83	0
SAINT-GOBAIN CONTAINERS, INC	N	1019	1	VOC	0	0	0	135
LOS GATOS TOMATO PRODUCTS	C	1021	1	VOC	0	3	0	0
PLAINS EXPLORATION & PRODUCTION CO	N	1036	1	VOC	1536	1536	1536	1536
WESTSIDE FARMERS COOP #2 & #3	C	1038	1	VOC	5	0	0	57
ENRON OIL & GAS COMPANY	S	1044	1	VOC	5516	5576	5638	5638
LAND O' LAKES, INC.	C	1044	1	VOC	258	0	0	683
ANDERSON CLAYTON CORP	S	1045	1	VOC	0	0	0	22
NAS LEMOORE	C	1046	1	VOC	1607	453	1066	59
VINTAGE PRODUCTION CALIFORNIA LLC	N	1046	1	VOC	2000	2000	2000	2000
OLDUVAI GORGE, LLC	N	1047	1	VOC	5673	4370	6597	5580
CHEVRON USA INC	S	1049	1	VOC	3461	0	0	0
MARTIN ANDERSON	C	1051	1	VOC	8699	12348	6585	90
AERA ENERGY LLC	S	1058	1	VOC	8179	8280	8354	8353
CONOCOPHILLIPS COMPANY	N	1058	1	VOC	1624	1124	246	0
PACTIV CORPORATION	N	1062	1	VOC	27192	27192	27192	27192

Table H-5 – List of Emission Reduction Credits
PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
CITY OF TULARE	C	1063	1	VOC	0	107	678	109
MACPHERSON OIL COMPANY	N	1065	1	VOC	0	0	123	0
VINTAGE PRODUCTION CALIFORNIA LLC	N	1066	1	VOC	40	184	131	98
LOS ANGELES CNTY SANITATION DIST NO.2	N	1068	1	VOC	269	1452	271	426
CALPINE CORPORATION	C	1080	1	VOC	2235	2037	1988	2251
SAINT-GOBAIN CONTAINERS, INC	C	1082	1	VOC	0	0	0	7
CANANDAIGUA WINE COMPANY INC	C	1085	1	VOC	21	17	30	15
OILDALE ENERGY LLC	S	1096	1	VOC	100	100	100	100
MODESTO IRRIGATION DISTRICT	C	1109	1	VOC	4342	4331	4373	4371
SPRECKELS SUGAR COMPANY	C	1112	1	VOC	0	767	1032	454
PLAINS EXPLORATION & PRODUCTION CO	C	1114	1	VOC	2467	2439	2410	2411
TURLOCK IRRIGATION DISTRICT	C	1116	1	VOC	1080	1080	1079	1079
ASV WINES	C	1120	1	VOC	0	20	551	21
PELCO INC A DELAWARE CORPORATION	C	1121	1	VOC	374	374	349	349
PELCO INC A DELAWARE CORPORATION	C	1122	1	VOC	1842	2601	2219	1756
AERA ENERGY LLC	S	1138	1	VOC	162	233	2	25
AERA ENERGY LLC	S	1142	1	VOC	39631	39976	40411	40489
PLAINS EXPLORATION & PRODUCTION CO	C	1157	1	VOC	892	0	1736	2684
AERA ENERGY LLC	S	1162	1	VOC	713	719	730	730
ANDERSON CLAYTON CORP	S	1171	1	VOC	3	0	0	24

Table H-5 – List of Emission Reduction Credits PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
SC JOHNSON HOME STORAGE INC	C	1173	1	VOC	1055	1415	1403	1447
E & J GALLO WINERY	C	1181	1	VOC	10197	10197	10163	10163
PACTIV, LLC	C	1182	1	VOC	9986	9206	9494	9041
PACTIV, LLC	C	1183	1	VOC	2001	1688	2462	1110
PACTIV, LLC	C	1184	1	VOC	47518	2227	0	17129
PACTIV, LLC	C	1185	1	VOC	51342	0	0	0
VINTAGE PRODUCTION CALIFORNIA LLC	C	1190	1	VOC	202	211	201	184
SAN JOAQUIN FACILITIES MGMT	S	1253	1	VOC	41	46	50	44
ANDERSON CLAYTON CORP	S	1262	1	VOC	1	0	0	19
ANDERSON CLAYTON CORP	S	1263	1	VOC	9	0	0	24
AERA ENERGY LLC	S	1476	1	VOC	190	0	0	54
AERA ENERGY LLC	S	1477	1	VOC	329	0	0	93
FOSTER FOOD PRODUCTS	S	1501	1	VOC	432	437	442	442
FOSTER FOOD PRODUCTS	S	1502	1	VOC	68	63	58	58
SAN JOAQUIN FACILITIES MGMT	S	1509	1	VOC	11	14	14	14
AERA ENERGY LLC	S	1587	1	VOC	26	28	26	26
OCCIDENTAL OF ELK HILLS INC	S	1593	1	VOC	3128	3163	3197	3197
CALPINE CORPORATION	S	1666	1	VOC	0	0	0	9
AERA ENERGY LLC	S	1681	1	VOC	10	10	10	10
OCCIDENTAL OF ELK HILLS INC	S	1703	1	VOC	394	1333	1998	1038
OCCIDENTAL OF ELK HILLS INC	S	1704	1	VOC	1695	3741	4523	1688
OCCIDENTAL OF ELK HILLS INC	S	1706	1	VOC	2314	5505	6449	2760
OCCIDENTAL OF ELK HILLS INC	S	1708	1	VOC	1664	3970	4474	1890

Table H-5 – List of Emission Reduction Credits
PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
OCCIDENTAL OF ELK HILLS INC	S	1710	1	VOC	1655	4021	5103	2114
OCCIDENTAL OF ELK HILLS INC	S	1713	1	VOC	1093	2620	3078	1181
OCCIDENTAL OF ELK HILLS INC	S	1714	1	VOC	1290	3038	3527	1472
OCCIDENTAL OF ELK HILLS INC	S	1717	1	VOC	1239	3804	4274	1639
OCCIDENTAL OF ELK HILLS INC	S	1719	1	VOC	928	1948	2037	1118
OCCIDENTAL OF ELK HILLS INC	S	1722	1	VOC	1132	2723	3230	1359
OCCIDENTAL OF ELK HILLS INC	S	1723	1	VOC	1723	4185	4934	2003
OCCIDENTAL OF ELK HILLS INC	S	1725	1	VOC	1169	2764	3251	1348
OCCIDENTAL OF ELK HILLS INC	S	1726	1	VOC	1603	3911	4662	1932
OCCIDENTAL OF ELK HILLS INC	S	1727	1	VOC	1061	2580	3064	1240
OCCIDENTAL OF ELK HILLS INC	S	1728	1	VOC	1692	4025	4596	2098
SOUTHERN CALIF GAS CO	S	1739	1	VOC	1322	1337	1354	1352
OCCIDENTAL OF ELK HILLS INC	S	1754	1	VOC	0	653	619	0
VINTAGE PRODUCTION CALIFORNIA LLC	S	1755	1	VOC	53	109	120	52
VINTAGE PRODUCTION CALIFORNIA LLC	S	1756	1	VOC	360	778	883	372
VINTAGE PRODUCTION CALIFORNIA LLC	S	1757	1	VOC	2	7	9	4
VINTAGE PRODUCTION CALIFORNIA LLC	S	1758	1	VOC	88	193	195	93
VINTAGE PRODUCTION CALIFORNIA LLC	S	1759	1	VOC	137	267	382	193
OCCIDENTAL OF ELK HILLS INC	S	1773	1	VOC	379	0	0	468
OCCIDENTAL OF ELK HILLS INC	S	1775	1	VOC	604	591	0	577

Table H-5 – List of Emission Reduction Credits PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
OCCIDENTAL OF ELK HILLS INC	S	1776	1	VOC	594	607	467	614
OCCIDENTAL OF ELK HILLS INC	S	1777	1	VOC	419	454	0	0
OCCIDENTAL OF ELK HILLS INC	S	1778	1	VOC	0	1021	0	0
OCCIDENTAL OF ELK HILLS INC	S	1779	1	VOC	0	656	559	0
OCCIDENTAL OF ELK HILLS INC	S	1780	1	VOC	0	1678	0	0
OCCIDENTAL OF ELK HILLS INC	S	1782	1	VOC	454	464	398	0
OCCIDENTAL OF ELK HILLS INC	S	1783	1	VOC	587	2	35	4
CHEVRON USA INC	S	1793	1	VOC	1420	1443	1335	1334
SHELL PIPELINE COMPANY LP	S	1807	1	VOC	86	58	26	26
VISALIA WASTEWATER TREATMENT	S	1837	1	VOC	5067	2634	4107	4614
CHEVRON USA INC LOST HILLS GP	S	1847	1	VOC	2764	2793	2825	2825
AERA ENERGY LLC	S	1874	1	VOC	40	10	1	22
CHEVRON USA INC	S	1878	1	VOC	230	136	143	82
AERA ENERGY LLC	S	1880	1	VOC	360	591	251	0
CHEVRON USA INC	S	1912	1	VOC	225	238	250	250
MONTEREY RESOURCES, INC.	S	1983	1	VOC	708	720	557	640
CHEVRON USA INC	S	1987	1	VOC	473	479	484	484
APTCO LLC	S	1990	1	VOC	1306	1709	1829	1157
KERN DELTA WEEDPATCH GINNING	S	2062	1	VOC	0	0	0	17
KERN LAKE COOP GIN	S	2074	1	VOC	0	0	0	134
CHEVRON USA INC	S	2107	1	VOC	651	638	666	666
OCCIDENTAL OF ELK HILLS INC	S	2120	1	VOC	55	794	1411	55
AERA ENERGY LLC	S	2136	1	VOC	3772	3393	3836	3913

Table H-5 – List of Emission Reduction Credits PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
LOS ANGELES COUNTY SANITATION DISTRICT 2	S	2147	1	VOC	12500	12500	12500	12500
CRIMSON RESOURCE MANAGEMENT	S	2161	1	VOC	54	49	31	63
AERA ENERGY LLC	S	2237	1	VOC	5394	5463	5539	5539
TRC CYPRESS GROUP LLC	S	2292	1	VOC	1412	1412	1412	1412
AMERICAN ENERGY OPERATIONS INC	S	2294	1	VOC	15	19	16	13
OCCIDENTAL OF ELK HILLS INC	S	2301	1	VOC	55	1046	1416	172
SHELL PIPELINE COMPANY LP	S	2303	1	VOC	0	658	431	0
VINTAGE PRODUCTION CALIFORNIA LLC	S	2310	1	VOC	1121	1723	2077	1280
VINTAGE PRODUCTION CALIFORNIA LLC	S	2342	1	VOC	1264	2028	3015	1713
AERA ENERGY LLC	S	2361	1	VOC	27	4	0	11
CHEVRON USA INC	S	2373	1	VOC	11698	11110	8970	9796
CHEVRON USA INC	S	2430	1	VOC	2459	2142	1336	1543
CHEVRON USA INC	S	2458	1	VOC	267	270	260	243
SFPP, L.P.	S	2464	1	VOC	2625	2625	2625	2625
OCCIDENTAL OF ELK HILLS INC	S	2488	1	VOC	9	4650	5387	2519
OCCIDENTAL OF ELK HILLS INC	S	2490	1	VOC	0	2806	3570	1534
M CARATAN INC	S	2516	1	VOC	0	0	26	6
FARMERS COOPERATIVE GIN INC	S	2533	1	VOC	0	0	0	39
ELBOW ENTERPRISES INC	S	2535	1	VOC	0	0	0	70
UNITED STATES GYPSUM COMPANY	S	2543	1	VOC	0	0	0	17
MALIBU BOATS LLC	S	2555	1	VOC	5000	5000	5000	5000
BAR 20 PARTNERS LTD	S	2593	1	VOC	0	9	345	350

Table H-5 – List of Emission Reduction Credits PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
BAR 20 PARTNERS LTD	S	2594	1	VOC	7	15	38	38
BAR 20 PARTNERS LTD	S	2595	1	VOC	873	882	892	892
OCCIDENTAL OF ELK HILLS INC	S	2623	1	VOC	0	895	988	68
OCCIDENTAL OF ELK HILLS INC	S	2625	1	VOC	22	110	96	68
OCCIDENTAL OF ELK HILLS INC	S	2627	1	VOC	52	52	52	52
BERRY PETROLEUM COMPANY	S	2642	1	VOC	284	0	0	0
CHEMICAL WASTE MANAGEMENT, INC.	S	2645	1	VOC	1513	2602	2033	2038
KAWEAH DELTA DISTRICT HOSPITAL	S	2656	1	VOC	460	738	828	938
CHEVRON USA INC	S	2674	1	VOC	1848	1848	1848	1848
CHEVRON USA INC	S	2675	1	VOC	1835	1835	1835	1835
TULE RIVER CO-OP GIN INC	S	2682	1	VOC	0	0	0	13
TULARE CITY WASTEWATER PLANT	S	2697	1	VOC	60	60	60	87
CHEVRON USA INC	S	2708	1	VOC	1605	1634	1664	1664
AERA ENERGY LLC	S	2725	1	VOC	65082	65830	66578	66578
E&B NATURAL RESOURCES MGMT	S	2773	1	VOC	7	12	5	9
AERA ENERGY LLC	S	2774	1	VOC	8176	5745	5185	3973
AERA ENERGY LLC	S	2782	1	VOC	44	43	42	46
UNITED STATES GYPSUM COMPANY	S	2816	1	VOC	20000	20000	20000	20000
BAR 20 PARTNERS LTD	S	2915	1	VOC	445	419	50	45
BUTTONWILLOW GINNING CO	S	2937	1	VOC	0	0	0	40
AERA ENERGY LLC	S	2939	1	VOC	6264	3536	3647	6483
AVENAL POWER CENTER, LLC	S	2951	1	VOC	12500	12500	12500	12500
PACTIV, LLC	S	2965	1	VOC	1513	1972	1571	1510

Table H-5 – List of Emission Reduction Credits
PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
BAKERSFIELD CITY WOOD SITE	S	2969	1	VOC	46	59	61	52
KERN DELTA-WEEDPATCH COTTON GINNING	S	2971	1	VOC	4	0	0	1
AVENAL POWER CENTER, LLC	S	2988	1	VOC	0	69	0	0
MID-VALLEY COTTON GROWERS INC	S	2989	1	VOC	0	0	0	16
INTERNATIONAL PAPER COMPANY	S	2995	1	VOC	875	875	875	875
SOUTH KERN INDUSTRIAL CENTER LLC	S	3006	1	VOC	0	190	382	0
OCCIDENTAL OF ELK HILLS INC	S	3053	1	VOC	137	139	140	140
PLAINS EXPLORATION & PRODUCTION CO	S	3066	1	VOC	840	840	840	840
OCCIDENTAL OF ELK HILLS INC	S	3077	1	VOC	121	123	124	124
OCCIDENTAL OF ELK HILLS INC	S	3078	1	VOC	81	82	83	83
STARWOOD POWER-MIDWAY, LLC	S	3095	1	VOC	0	0	0	10
AERA ENERGY LLC	S	3110	1	VOC	21914	22310	22708	22708
CALPINE CORPORATION	S	3116	1	VOC	1440	1546	1621	1621
PANOCHE ENERGY CENTER, LLC	S	3128	1	VOC	9877	9878	3774	8656
CILION, INC.	S	3132	1	VOC	13000	13000	13000	13000
CHEVRON USA INC	S	3148	1	VOC	181	163	274	216
SHELL PIPELINE COMPANY LP	S	3158	1	VOC	98	98	97	97
PLAINS EXPLORATION & PRODUCTION CO	S	3164	1	VOC	821	821	822	822
OCCIDENTAL OF ELK HILLS INC	S	3166	1	VOC	842	2545	2372	659
OCCIDENTAL OF ELK HILLS INC	S	3169	1	VOC	193	2665	3573	520
SAN JOAQUIN FACILITIES MGMT	S	3180	1	VOC	34	23	34	39
KERN DELTA WEEDPATCH GINNING	S	3199	1	VOC	0	0	0	38

Table H-5 – List of Emission Reduction Credits PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
SAN JOAQUIN FACILITIES MGMT	S	3210	1	VOC	33767	28482	32565	37850
AERA ENERGY LLC	S	3223	1	VOC	16	16	16	17
OCCIDENTAL OF ELK HILLS INC	S	3225	1	VOC	648	1755	1926	805
VANDERHAM WEST	S	3235	1	VOC	240	240	240	240
INERGY PROPANE LLC	S	3247	1	VOC	197	24	0	1
CALPINE ENERGY SERVICES, L.P.	S	3261	1	VOC	4454	4972	3890	4155
SHAFTER-WASCO GINNING COMPANY	S	3268	1	VOC	0	0	0	13
AERA ENERGY LLC	S	3272	1	VOC	2642	2701	2759	2759
CALPINE ENERGY SERVICES, L.P.	S	3283	1	VOC	0	150	171	0
LAND O' LAKES, INC.	S	3284	1	VOC	527	893	642	0
CALPINE ENERGY SERVICES, L.P.	S	3292	1	VOC	4804	6146	6632	3338
NUSTAR ENERGY LP	S	3299	1	VOC	1000	1000	1000	1000
CALPINE ENERGY SERVICES, L.P.	S	3300	1	VOC	4636	4705	4774	4771
HYDROGEN ENERGY CALIFORNIA, LLC	S	3305	1	VOC	14625	14625	14625	14625
AERA ENERGY LLC	S	3308	1	VOC	2266	1066	1090	2320
OCCIDENTAL OF ELK HILLS INC	S	3327	1	VOC	24	24	24	24
BREA OIL COMPANY, INC.	S	3355	1	VOC	149	391	193	112
CHEVRON USA INC	S	3365	1	VOC	5542	5627	5713	5055
PLAINS LPG SERVICES, L.P.	S	3367	1	VOC	356	2023	2767	1433
CALPINE ENERGY SERVICES, L.P.	S	3368	1	VOC	1500	1500	1500	1500
ELEMENT MARKETS LLC	S	3370	1	VOC	5	4	4	4
CILION INC.	S	3373	1	VOC	2978	2979	2979	2978
CHEVRON USA INC	S	3375	1	VOC	4698	4894	5090	5090

Table H-5 – List of Emission Reduction Credits
PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
OCCIDENTAL OF ELK HILLS INC	S	3379	1	VOC	386	6020	8655	1509
CRIMSON RESOURCE MANAGEMENT	S	3386	1	VOC	67	138	142	94
CRIMSON RESOURCE MANAGEMENT	S	3387	1	VOC	23009	20107	19072	13925
INERGY PROPANE LLC	S	3394	1	VOC	1131	1160	1191	1189
CHEVRON USA INC	S	3400	1	VOC	1903	2425	2836	2947
CHEVRON U S A INC	S	3404	1	VOC	171	202	232	232
FRITO-LAY, INC.	S	3411	1	VOC	4018	6573	9128	9128
FRITO-LAY, INC.	S	3426	1	VOC	380	474	377	337
FRITO-LAY, INC.	S	3429	1	VOC	55	57	58	58
FRITO-LAY, INC.	S	3430	1	VOC	76	96	74	72
AERA ENERGY LLC	S	3434	1	VOC	10466	11528	13111	10396
SENECA RESOURCES	S	3440	1	VOC	0	0	0	339
CRIMSON RESOURCE MANAGEMENT	S	3441	1	VOC	13	4	13	22
HECK CELLARS	S	3442	1	VOC	10000	10000	10000	10000
CHEVRON USA INC	S	3449	1	VOC	578	601	626	626
AERA ENERGY LLC	S	3451	1	VOC	20480	438	2608	1572
SAINT-GOBAIN CONTAINERS, INC	S	3498	1	VOC	0	0	0	34
CALPINE ENERGY SERVICES, L.P.	S	3503	1	VOC	5500	5500	5500	5500
CALPINE ENERGY SERVICES, L.P.	S	3504	1	VOC	1000	1000	1000	1000
CHEVRON USA INC	S	3518	1	VOC	1780	1780	1780	1780
CHEVRON USA PRODUCTION INC	S	3533	1	VOC	6	4	9	8
OCCIDENTAL OF ELK HILLS INC	S	3536	1	VOC	44	2319	3256	356
OCCIDENTAL OF ELK HILLS INC	S	3538	1	VOC	0	2333	3325	626

Table H-5 – List of Emission Reduction Credits PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
CHEVRON USA INC	S	3544	1	VOC	346	378	292	308
SAN JOAQUIN REFINING COMPANY	S	3551	1	VOC	193	193	193	192
SOUTH VALLEY GINS INC	S	3554	1	VOC	0	0	0	10
CALPINE ENERGY SERVICES, L.P.	S	3555	1	VOC	5000	5000	5000	5000
HYDROGEN ENERGY CALIFORNIA, LLC	S	3557	1	VOC	11437	11438	11438	11437
VINTAGE PRODUCTION CALIFORNIA LLC	S	3573	1	VOC	45	45	45	45
VINTAGE PRODUCTION CALIFORNIA LLC	S	3574	1	VOC	145	2915	4020	260
VINTAGE PRODUCTION CALIFORNIA LLC	S	3575	1	VOC	0	0	10	0
VINTAGE PRODUCTION CALIFORNIA LLC	S	3576	1	VOC	96	221	235	98
VINTAGE PRODUCTION CALIFORNIA LLC	S	3577	1	VOC	203	463	491	214
VINTAGE PRODUCTION CALIFORNIA LLC	S	3578	1	VOC	1178	4452	6003	1377
VINTAGE PRODUCTION CALIFORNIA LLC	S	3579	1	VOC	1190	4465	5981	1360
VINTAGE PRODUCTION CALIFORNIA LLC	S	3580	1	VOC	540	2873	3896	660
VINTAGE PRODUCTION CALIFORNIA LLC	S	3581	1	VOC	105	1473	2033	152
VINTAGE PRODUCTION CALIFORNIA LLC	S	3582	1	VOC	123	1513	2068	162
VINTAGE PRODUCTION CALIFORNIA LLC	S	3583	1	VOC	653	2997	4027	763
VINTAGE PRODUCTION CALIFORNIA	S	3584	1	VOC	362	290	454	518

Table H-5 – List of Emission Reduction Credits
PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
LLC								
CHEVRON USA INC	S	3601	1	VOC	40533	41484	42396	42430
CHEVRON USA INC	S	3604	1	VOC	223	345	388	256
HYDROGEN ENERGY CALIFORNIA, LLC	S	3605	1	VOC	7937	7938	7938	7937
LAND O' LAKES, INC.	S	3625	1	VOC	57	43	59	55
OCCIDENTAL OF ELK HILLS INC	S	3627	1	VOC	3730	3448	3015	3510
VECTOR ENVIRONMENTAL, INC.	S	3630	1	VOC	50158	60848	56284	6770
AGRI-CEL INC	S	3631	1	VOC	21495	26078	24122	2902
BERRY PETROLEUM COMPANY	S	3649	1	VOC	1427	6355	4508	738
BERRY PETROLEUM COMPANY	S	3650	1	VOC	12500	12500	12500	12500
BERRY PETROLEUM COMPANY	S	3653	1	VOC	1307	1307	1307	1308
ALON BAKERSFIELD REFINING	S	3663	1	VOC	38947	38947	38947	38948
INERGY PROPANE LLC	S	3677	1	VOC	7	22	14	4
CHEVRON USA INC	S	3683	1	VOC	4149	4194	4242	4242
AERA ENERGY LLC	S	3687	1	VOC	17245	18573	17870	17768
KERN OIL & REFINING CO.	S	3693	1	VOC	952	966	951	1099
BERRY PETROLEUM COMPANY	S	3695	1	VOC	21	1445	21	21
CHEVRON USA INC	S	3701	1	VOC	25142	25559	25976	25976
DELTA TRADING L P	S	3711	1	VOC	8361	8458	8552	8556
DTE STOCKTON, LLC	S	3715	1	VOC	1450	1450	1450	1450
CHEVRON USA INC	S	3722	1	VOC	127895	129399	130902	130902
HUNTER EDISON OIL DEVELOPMENT	S	3723	1	VOC	2186	2256	2234	2282
BIG WEST OF CALIFORNIA LLC	S	3727	1	VOC	758779	751001	781428	781430

Table H-5 – List of Emission Reduction Credits
PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
BRONCO WINE COMPANY	S	3732	1	VOC	125	125	125	125
CHEVRON USA INC	S	3737	1	VOC	104915	106191	107557	107578
NORTHERN CALIFORNIA POWER AGENCY	S	3744	1	VOC	240	103	0	0
TAUBER OIL COMPANY	S	3777	1	VOC	383	508	489	663
TAUBER OIL COMPANY	S	3778	1	VOC	123	57	121	0
TAUBER OIL COMPANY	S	3779	1	VOC	82	82	82	82
TAUBER OIL COMPANY	S	3780	1	VOC	330	398	459	413
E&B NATURAL RESOURCES MGMT	S	3791	1	VOC	7500	7500	7500	7500
PLAINS LPG SERVICES, L.P.	S	3793	1	VOC	583	583	583	583
SAN JOAQUIN FACILITIES MGMT	S	3801	1	VOC	228	225	223	223
E & J GALLO WINERY	S	3805	1	VOC	18000	18000	18000	18000
CE2 ENVIRONMENTAL OPPORTUNITIES I LP	S	3806	1	VOC	2500	2500	2500	2500
E & J GALLO WINERY	S	3807	1	VOC	11431	11424	11417	11417
E & J GALLO WINERY	S	3808	1	VOC	8098	8041	8086	8086
CE2 ENVIRONMENTAL MARKETS LP	S	3809	1	VOC	2834	2814	2831	2831
CHEVRON USA INC	S	3811	1	VOC	3947	4032	4121	4125
OCCIDENTAL OF ELK HILLS INC	S	3827	1	VOC	80295	81477	82660	82659
THE WINE GROUP LLC	S	3842	1	VOC	500	500	500	500
ALON BAKERSFIELD REFINING	S	3846	1	VOC	52595	53394	53803	53711
OCCIDENTAL OF ELK HILLS INC	S	3848	1	VOC	64149	72828	75404	70717
KERN OIL & REFINING CO.	S	3866	1	VOC	1000	1000	1000	1000
CHEVRON USA INC	S	3869	1	VOC	40200	41125	42051	42047

Table H-5 – List of Emission Reduction Credits
PM10 and PM2.5 Precursors

Current ERC Certificate Holder	ERC Number			Pollutant	Reductions (lb/qtr)			
					1st Qtr	2nd Qtr	3rd Qtr	4rd Qtr
O'NEILL VINTNERS & DISTILLERS	S	3886	1	VOC	404	404	404	404
G3 ENTERPRISES	S	3887	1	VOC	13000	13000	13000	13000
CHEVRON USA INC	S	3905	1	VOC	5284	5380	5476	5475
AERA ENERGY LLC	S	3919	1	VOC	178503	181091	183734	183787
PACIFIC ETHANOL VISALIA	S	3921	1	VOC	3147	3147	3146	3140
AERA ENERGY LLC	S	3923	1	VOC	123511	124964	126418	126418
VINTAGE PRODUCTION CALIFORNIA LLC	S	3929	1	VOC	7000	7000	7000	7000
BULLARD ENERGY CENTER, LLC	S	3931	1	VOC	8302	8303	8426	8302
AERA ENERGY LLC	S	3935	1	VOC	54219	54648	55792	56759
MACPHERSON OIL COMPANY	S	3942	1	VOC	3075	3075	2952	3075
VINTAGE PRODUCTION CALIFORNIA LLC	S	3943	1	VOC	2000	1999	1999	2000
KERN OIL & REFINING CO.	S	3944	1	VOC	2500	2500	2500	2500
AER GLAN ENERGY LLC	S	3945	1	VOC	2251	2249	2249	2251
OCCIDENTAL OF ELK HILLS INC	S	3947	1	VOC	83	2429	3196	464
E & J GALLO WINERY	S	3955	1	VOC	46813	46812	46811	46752

ATTACHMENT 1 TO APPENDIX H: EMISSION REDUCTION CREDITS

DEVELOPMENT OF $PM_{2.5}$ INTERPOLLUTANT TRADING RATIOS USED IN NEW SOURCE REVIEWS WITHIN THE SAN JOAQUIN VALLEY

Development of $PM_{2.5}$ Interpollutant Trading Ratios Used in New Source Reviews within the San Joaquin Valley

1. Introduction

EPA's 2008 $PM_{2.5}$ New Source Review (NSR) Implementation Rule[1] allows states to offset emissions increases of direct $PM_{2.5}$ emissions or $PM_{2.5}$ precursors in nonattainment areas with reductions of either direct $PM_{2.5}$ emissions or $PM_{2.5}$ precursors, where the emissions offsets are determined through interpollutant trading ratios. For the San Joaquin Valley (SJV), these ratios were determined using photochemical modeling. This document provides technical details of the procedures used.

2. Modeling Description

The modeling used in developing the interpollutant trading ratios follows the approach described in the Modeling Protocol for the 2012 24-hr $PM_{2.5}$ State Implementation Plan (SIP) in the San Joaquin Valley, which used a 2007 base year and 2019 future year. All modeling related to the development of interpollutant trading ratios is based on the 2019 simulations, where future year anthropogenic emissions are used, but all other modeling inputs (meteorology, chemical boundary conditions, biogenic emissions, etc.) reflect the 2007 base year.

Briefly, the Mesoscale Meteorological Model version 5 (MM5; Grell et al., 1994) was used to simulate gridded hourly meteorological fields for 2007, which were in turn used to drive the Community Multi-scale Air Quality (CMAQ) Model v4.7.1 (Byun and Schere, 2006; Foley et al., 2010), with the SAPRC99 chemical mechanism (Carter, 2000) and the aero5 aerosol module, for simulations covering January through March (the first quarter) and October through December (the fourth quarter). Simulations were conducted at a 12-km resolution for the entire state and nested down to 4-km for the SJV. Chemical boundary conditions for the 12-km domain were provided by downscaled MOZART global chemistry model (Emmons et al., 2010) output for the year 2007 (http://www.acd.ucar.edu/wrf-chem/mozart.shtml).

Annual average emissions for point and area sources from the CEIDARS database (http://www.arb.ca.gov/ei/drei/maintain/dbstruct.htm) were processed through the Sparse Matrix Operator Kernel Emission (SMOKE) version 2.6 emissions processor (http://www.smoke-model.org/) to generate month-specific weekday and weekend hourly gridded emissions for 2019. Day-specific hourly on-road mobile source emissions for 2019 were developed through the EMFAC2011 (http://www.arb.ca.gov/msei/modeling.htm) and DTIM (Fieber and Ireson, 2001) models, while the day-specific hourly biogenic emissions inventory was generated using the

[1] Implementation of the New Source Review (NSR) Program for Particulate Matter Less Than 2.5 Micrometers (PM2.5). 73 Fed. Reg. 96, pp. 28321-28350. (2008, May 16). Retrieved from http://www.epa.gov/NSR/fr/20080516_28321.pdf

MEGAN v2.01 (Guenther et al., 2006) model for 2007; MEGAN was modified to accept year-specific 8-day MODIS Leaf Area Index (http://modis.gsfc.nasa.gov/) and California-specific emission factor and plant functional type data (Scott and Benjamin, 2003). A more detailed description of the emissions inventory and model setup can be found in the Modeling Protocol for the 2012 24-hr $PM_{2.5}$ SIP for the San Joaquin Valley.

3. Trading Ratios

Trading ratios were developed based on CMAQ sensitivity simulations for the future year (2019) anthropogenic emissions inventory. Separate sensitivity simulations were conducted for direct $PM_{2.5}$, oxides of nitrogen (NO_x), and oxides of sulfur (SO_x) to compare the relative change in particulate concentrations that would occur from a Valley-wide 50% decrease in emissions of NSR source categories as determined by the SJV. Model simulations covered the January to March and October to December time periods (first and fourth quarters) of 2019. Results from these sensitivity simulations were compared with those for the 2019 base simulations, where NSR source categories were not adjusted. The relative change of projected particulate concentration as established by the sensitivity simulations are used to establish a trading relationship of relative effect for the direct and precursor reductions. The trading ratios were calculated as follows:

1) Future year $PM_{2.5}$ design values were calculated for each of the three sensitivity simulations based on the top 8 measured and top10% of simulated days in each quarter (For details on the design value calculation see the US EPA Memorandum on June 28th 2011 titled "Updates to the 24-hour $PM_{2.5}$ NAAQS Models Attainment Test" from Tyler Fox to the Regional Air Program Managers).

2) The reduction in the 24-hour $PM_{2.5}$ design value (DV) concentration per ton of emissions reduction (based on a 50% reduction) was calculated separately for direct $PM_{2.5}$, NO_x, and SO_x emissions from NSR source categories within the SJV (see Equation 1 and Table 1).

$$\frac{DV_{base} - DV_{sensitivity}\ [\mu g\ m^{-3}]}{average\ emissions\ reduction\ [tons\ day^{-1}]} \tag{1}$$

Here, DV_{base} is the 2019 baseline Design Value and $DV_{sensitivity}$ is the Design Value after a 50% reduction of a given pollutant from all NSR sources domain wide. The average emissions reductions are 50% of the annual average values for all NSR sources. The site-specific results from this calculation are shown in Table 1.

Table 1. Change in 2019 Design Value $PM_{2.5}$ concentrations due to 50% reduction in daily emissions of $PM_{2.5}$, NO_x, and SO_x from NSR source categories within the SJV [$\mu g\ m^{-3}\ ton^{-1}$].

Station	$PM_{2.5}$	NOx	SOx
Bakersfield – CA	0.29	0.04	0.06
Bakersfield – Planz	0.25	0.04	0.08
Fresno – 1st Street	0.14	0.03	0.03
Fresno – Hamilton	0.14	0.03	0.03
Clovis	0.14	0.03	0.03
Modesto – 14th Street	0.14	0.02	0.06
Merced – M Street	0.09	0.03	0.03
Stockton – Hazelton St.	0.09	0.02	0.08
Visalia – N. Church St.	0.11	0.03	0.03
Corcoran – Patterson	0.20	0.03	0.03

From the results found in Table 1, the trading ratios of NOx to PM2.5 and SOx to PM2.5 can then be calculated by relating NOx and SOx directly to PM2.5. This calculation results in the figures found in the following Table 2. The averages among the site specific trading ratios calculated in this table were 5.3 for NOx:PM2.5 and 4.1 for SOx:PM2.5.

Table 2. NOx:PM2.5 and SOx:PM2.5 trading ratios for Valley-wide emission reductions of NSR source categories within the SJV.

Station	NOx:$PM_{2.5}$	SOx:$PM_{2.5}$
Bakersfield – CA	7.0	5.2
Bakersfield – Planz	5.9	2.9
Fresno – 1st Street	4.0	4.8
Fresno – Hamilton	5.4	4.8
Clovis	4.0	4.8
Modesto – 14th Street	8.1	2.4
Merced – M Street	3.6	3.2
Stockton – Hazelton St.	5.4	1.1
Visalia – N. Church St.	3.4	4.0
Corcoran – Patterson	6.0	7.2
Average	*5.3*	*4.1*

4. Alternative Approaches

In addition to the Valley-wide reduction analysis described in the previous section, two alternative approaches were taken in order to compare the possible trading ratios that could come from other analysis options. These results are presented here in the interests of full disclosure and to demonstrate that EPA's preferred method is indeed more conservative and will require more precursor reductions to offset a given PM2.5 increase.

One alternative that was explored was the assumption of county based emissions reductions as opposed to Valley-wide. In this approach, the total tonnage of reductions used in the Valley-wide analysis was separated into county level tonnages based on the county specific emissions inventory from the NSR source categories. Furthermore, it was assumed that the sensitivity modeling conducted in the Valley-wide reduction analysis was driven mostly by days with stagnant meteorology, where the design value concentration was predominately affected by local sources as opposed to the whole Valley. Under this assumption, county based emissions reductions would have the same effect as Valley-wide reductions. With the separated county based emissions reductions from the NSR source categories, each station was assigned to its county's emissions, at which point the trading ratios were recalculated and summarized in Table 3.

Table 3. NOx:PM2.5 and SOx:PM2.5 trading ratios for county based emission reductions of NSR source categories within the SJV.

Station	$NOx:PM_{2.5}$	$SOx:PM_{2.5}$
Bakersfield – CA	4.8	2.4
Bakersfield – Planz	2.0	1.4
Fresno – 1st Street	4.1	4.8
Fresno – Hamilton	5.4	4.8
Clovis	4.1	4.8
Modesto – 14th Street	9.1	2.3
Merced – M Street	3.3	1.5
Stockton – Hazelton St.	11.7	4.0
Visalia – N. Church St.	2.3	1.9
Corcoran – Patterson	3.1	1.1
Average	*5.2*	*2.9*

The results of the county based emission reduction approach were slightly lower than the Valley-wide approach; however, since this was an analysis based on local sources of emissions, a distance ratio would need to be applied. For instance, if a distance ratio of 1.5 was found to be appropriate, this would increase the average ratios to values comparable to the Valley-wide emission reduction approach.

As a second alternative to the Valley-wide emission reduction analysis approach, and as an extension to the speciated linear rollback analysis that was conducted to corroborate the regional photochemical model (detailed in Appendix G), an evaluation of the sensitivity of the rollback model was investigated. By applying 50% cuts in the PM2.5, NOx, and SOx NSR source emissions inventories (as described in the Valley-wide reduction approach), the change in the projected 2019 PM2.5 design value was related to the change in the emissions inventory. Through these comparisons, interpollutant trading ratios were developed through the rollback model. Since the speciated linear rollback analysis was only conducted for the Fresno and Bakersfield areas, the following Table 4 shows the results for these areas of the Valley only.

Table 4. NOx:PM2.5 and SOx:PM2.5 trading ratios based on Speciated Linear Rollback Modeling Analysis of emission reductions of NSR source categories within the SJV.

Station	NOx:$PM_{2.5}$	SOx:$PM_{2.5}$
Bakersfield – CA	1.7	1.0
Fresno – 1st Street	2.9	1.0

Since the speciated linear rollback model is also heavily based on impacts from localized emissions sources, a distance ratio would also be required here for use as NSR offsets. Applying a distance ratio would increase the linear rollback figures, however the values would still be less than the more conservative Valley-wide emission reduction analysis approach.

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Appendix I

Summary of Significant Comments and Responses

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SUMMARY OF SIGNIFICANT COMMENTS FOR THE NOVEMBER PROPOSED PM2.5 PLAN

WRITTEN COMMENTS, NOVEMBER 20, 2012 PROPOSED PLAN

14 comment letters were received following the posting of the *Proposed 2012 PM2.5 Plan* on November 20, 2012.

Alvernaz, Colette (Alvernaz)
Bingham, Susan (Bingham)
Bowen, Rosita (Bowen)
Bucknell, Lee (Bucknell)
Concerned Citizen (Citizen)
Cook, Jim (Cook)
David, Milton C., MD (David)
Eden, Vicki (Eden)
Guith, David (Guith)
Hesson, Steve (Hesson)
Lemos, Roxanne (Lemos)
Macfarlane, Peter and Emmy (Macfarlane)
Schmitt, Gwen & Brent (Schmitt)
Witt, Paul (Witt)

District note: The vast majority of public comments received during this comment period, summarized below, are related to Rule 4901 and general air quality concerns.

1. **COMMENT:** All wood burning should be terminated in the Valley for both health and aesthetic reasons. (Guith)

RESPONSE: The current PM2.5 plan commitment is a proposal to lower the wood burning curtailment threshold to minimize emissions build-up during multi-day periods of stagnation. This is expected to increase the number of “no burn” days, though the exact increase in “no burn” days will depend on future air quality. Wood burning would still be allowed when dispersion is good and such activity would not be expected to lead to unhealthy 24-hour average PM2.5 concentrations.

2. **COMMENT:** The District should not amend Rule 4901 to increase the number of no-burn days because Valley residents rely on wood burning devices for heating during the winter, and further limiting their use could create more of an economic burden. (Alvernaz, Bingham, Macfarlane, Schmitt, Witt)

RESPONSE: Achieving additional emissions reductions from residential wood combustion is critical for the Valley to reach attainment of EPA’s 2006 PM2.5 standard. The proposed rule amendment would also achieve significant health benefits for Valley residents. A number of issues associated with lowering the curtailment threshold would need to be addressed in the process of amending Rule

4901, including the economic impact to Valley residents, and how clean certified devices would be treated under a lower threshold. The District would amend Rule 4901 under a full public process where all options would be evaluated, and public comments would be taken and considered.

3. **COMMENT:** EPA certified stoves and pellet stoves should not be subject to Valley "No Burn" day restrictions, since these devices burn much cleaner than fireplaces and non-certified wood stoves. Consideration should be given to those who have made an investment in these cleaner burner technologies. (Bucknell, Hesson, Lemos)

RESPONSE: The District commits to analyze the feasibility of allowing the use of clean certified wood-burning devices at some curtailment levels during the next rule-amending process. Enforcing this added flexibility would be difficult, given the challenge in distinguishing wood smoke emissions from various wood burning devices, and the District would explore various options during the rule development process for ensuring that this issue is addressed. The District values the cleaner burning technology that has been developed in recent years, as demonstrated by the implementation of the District's *Burn Cleaner Program*, which was implemented to help Valley residents upgrade their current wood-burning devices and open fireplaces to natural gas or propane devices, or clean pellet devices.

4. **COMMENT:** Time and resources could be better spent if the Valley was split into two regions, north and south, instead of issuing and enforcing individual county burn restrictions. Living on one side or the other of a county line is arbitrary since smoke travels and can affect neighboring counties. (Lemos)

RESPONSE: The District focuses on county-level forecast areas for several reasons: (1) to better allow for ease of communication to the public; (2) to make best use of the hourly PM2.5 data available from monitoring sites throughout the Valley; and (3) to allow residents to use wood burning devices when that activity is not projected to result in unhealthy PM2.5 levels in their area or downwind areas.

5. **COMMENT:** If the Valley has a "no burn" day, the Bay Area (BAAQMD) should impose a "no burn" day too, since the winds carry their smoke over the mountains and become trapped in our Valley. (Lemos)

RESPONSE: The Valley's exceedances of 24-hour PM2.5 standards typically occur during periods of stagnation (no wind) in the Valley, limiting the ability of transport of emissions from other air basins into the Valley. With that said, while the District does not have regulatory authority over the BAAQMD, the BAAQMD has adopted a wood burning curtailment program that helps to minimize emissions.

6. **COMMENT:** The District should better address almond and walnut harvesting, which is still generating significant pollutant emissions. The District should conduct more studies to determine the effect of these practices on our air quality and evaluate practices that can reduce emissions. (Citizen, David, Eden)

RESPONSE: District Rule 4550 (Conservation Management Practices) addresses fugitive dust emissions from agricultural operations, including requirements to reduce emissions from nut harvesting operations. There is ongoing research on new technology that can reduce emissions from harvesting nuts, and the District has also committed to further study the effectiveness of CMPs in reducing PM2.5 emissions and PM2.5 concentrations.

7. **COMMENT:** Air quality is a major issue year-round according to pulmonary specialists. The focus should also be during the summer when farming and trucking are at peak. (Cook)

RESPONSE: The District's air quality strategies address both PM2.5 (generally a winter issue) and ozone (generally a summertime issue). The Valley must continue to make air quality progress to reach EPA's air quality standards for both PM2.5 and ozone. Since oxides of nitrogen (NOx) are a precursor to both, NOx emissions reductions are a key part of District's overall air quality strategies. This *2012 PM2.5 Plan* focuses on PM2.5, but many strategies in the plan also benefit ozone. The District also has plans focused specifically on ozone.

8. **COMMENT:** The District should consider pushing wreckage off the road to reduce pollution from backed up traffic on Freeway 99 due to collisions, similar to other cities like San Francisco. Trucks should also be restricted to one lane within the city limits at a reduced speed limit until extra lanes are added. (Cook)

RESPONSE: The District does not have regulatory authority over traffic conditions or speed limits.

9. **COMMENT:** Permits and inspections need to be established for high polluting two-stroke engines, such as those in blowers and lawn mowers. (Cook)

RESPONSE: The District is pursuing emissions reductions from lawn care equipment through its incentive programs for both commercial and residential lawn care. The District has committed to continuing these programs and to further study of this source category. See the discussion in Appendix D for more information.

10. **COMMENT:** The District should consider regulating emergency equipment and tow trucks because these types of vehicles are heavy polluters and are often left idling for extended periods. (Cook)

RESPONSE: The District does not have regulatory authority over trucks or vehicles. ARB has a regulation addressing idling of sleeper berth equipped diesel trucks, but does not regulate idling of other diesel trucks at this time.

11. **COMMENT:** The air quality greatly impacts the severity of allergies and it should be improved. (Bowen)

RESPONSE: The Valley's air quality has greatly improved over the past couple of decades, and it will continue to improve under this and other attainment plans. Under its Risk-based Strategy, the District continues to study air quality health impacts, inform the public of current air quality conditions, evaluate the health benefits of its attainment strategies, and prioritize programs that improve public health.

12. **COMMENT:** The District should consider hourly usage as a part of the evaluation for replacing/upgrading agricultural equipment. It is not economically feasible to replace an older tractor that is only used for a limited number of hours in a year. (Alvernaz)

RESPONSE: The District does consider hourly usage as part of its Agricultural Tractor/Mobile Equipment Replacement Program. This program requires applicants to report annual operation measured in hours. This data is used with engine information and details on the replacement equipment to determine the emissions that will be reduced by the replacement project. All projects funded in the program must meet a cost effectiveness threshold, ensuring that the most cost-effective replacements are funded with District resources. The program uses the cost effectiveness limit set by ARB's Carl Moyer Memorial Air Quality Standards Attainment Program.

13. **COMMENT:** There is confusion in determining which government agency controls which emission sources. The agency that controls wood burning says they cannot control the smoking trucks, and vice versa. It seems as though wood burning restrictions are passed more easily than truck and bus regulations. (Lemos)

RESPONSE: Local air districts, such as the San Joaquin Valley Air Pollution Control District, have regulatory authority over stationary sources (for example, industrial sources) and area sources (such as residential wood combustion) whereas the California Air Resources Board (ARB) has regulatory authority over mobile sources (such as on-road vehicles, like trucks, and off-road vehicles, like construction equipment).

14. **COMMENT:** The District should consider land-use decisions to reduce air pollution in the Valley such as: limit drive-thru lanes to handicap use only; plant low-maintenance plants instead of grass on roadway medians to cut down on the use of lawn care equipment; encourage multi-use neighborhoods; and require truck stops to be built with plug-in stations to allow trucks to be plugged in overnight to keep truck loads cool and cut down on idling. (Alvernaz)

RESPONSE: The District does not have regulatory authority over land-use planning decisions, but does perform California Environmental Quality Act (CEQA) review of certain land-use projects to ensure projects do not worsen air quality in the Valley. While the District does not have regulatory authority to mandate plug-in stations at Valley truck stops, the District's *Public Benefit Grant Program* provides funding to a variety of clean-air public-benefit projects for cities, counties, special districts, and public educational institutions located within the District. One of the program options is "New Electric Vehicle Infrastructure," which provides funding towards new electric charging units. This program component is still under development, but this could be an option in the future for cities and/or counties to receive funding for additional charging stations at public rest areas.

15. **COMMENT:** "Bedroom communities" in the Valley, which serve as resting stops for commuters to and from the Bay Area, increase commute time and poor air quality. The District should educate the cities and counties that being bedroom communities for the Bay Area is not beneficial for air quality. (Alvernaz)

RESPONSE: Although the District does not have land use authority, the District continues to serve as a resource to cities and counties during their planning and CEQA processes. Through "Air Quality Guidelines for General Plans" and CEQA review, the District recommends a variety of more air quality-friendly practices that can be incorporated into developments and city planning. Also, many new developments are subject to the District's Indirect Source Review (ISR) rule, which enforces requirements to mitigate or offset emissions resulting from construction as well as increased traffic.

The Valley's "vehicle miles traveled" (VMT) is carefully analyzed in the District's air quality plans. The District will continue to support programs to reduce commute-related motor vehicle emissions reductions through its Healthy Air Living outreach, vanpool incentive program, and Employer-based Trip Reduction rule.

16. **COMMENT:** Cities and counties should design development plans that allow for increased traffic flow. Intentionally building and knowing the roadways may not be able to handle increased traffic from new development will worsen air quality. (Alvernaz)

RESPONSE: Mobile source emissions are an important consideration during the air quality planning process. While the District does not have authority to mandate particular transportation development patterns, the District works closely with ARB and the county Metropolitan Planning Organizations (MPO) to coordinate data and analysis of on-road mobile sources. The District's plan includes "mobile source air pollutant emissions budgets," and MPO transportation planning efforts must make sure that air pollutant emissions resulting from their transportation networks and mobile source activities in their counties are within those emissions levels.

17. COMMENT: The District should educate cities and counties on the importance of their planning designs and CEQA Environmental Impact Reports (EIRs), and require an adequate review of air quality issues within these documents. Cities and counties should also not be exempt from obtaining permits and undergoing CEQA review for city projects. (Alvernaz)

RESPONSE: The District has several resources, including the Guide for Assessing and Mitigating Air Quality Impacts (GAMAQI), made available to assist agencies in assessing air quality impacts and to satisfy the California Environmental Quality Act (CEQA). CEQA requires agencies to assess and disclose environmental impacts including air quality impacts for any development project subject to CEQA. As a Responsible or Trustee agency under the CEQA, the District will review the air quality assessment provided by the Lead Agency in the environmental document to ensure the air quality impacts are properly addressed and evaluated, and will provide comments. The District will also recommend mitigation measures that can assist in reducing the air quality impacts to the extent feasible as required under CEQA.

District permits are applicable to any entity or stationary source within the San Joaquin Valley Air Basin subject to District rules and regulations. Any applicable stationary source within a development project will not be exempt from District permitting. However, CEQA dictates what projects are exempt or not exempt from a CEQA review and provides the framework on how cities and counties are to assess environmental impacts.

18. COMMENT: The District should not issue permits to developers without notifying the property owners. The District should also make sure the project matches the actual project description and verify that the project it is not violating other land uses. (Alvernaz)

RESPONSE: The District only issues permits to applicants/developers for sources that meet the applicability requirements of District rules and regulations and has a process for notifying the public about proposed projects. The District cannot make land use decisions, but has a process for evaluating District permitting projects under CEQA, and mitigating emissions impacts from developments through its Indirect Source Review Rule.

LATE WRITTEN COMMENTS, NOVEMBER 20, 2012 PROPOSED PLAN

A comment letter was received from Earth Justice after the close of the written comment period for the *Proposed 2012 PM2.5 Plan* on November 20, 2012[1].

19. **COMMENT:** The District has not supported the 2019 attainment date. The plan should assess the ability to attain the standard by an earlier date, considering the additional control measure suggestions included in this letter.

RESPONSE: Attaining the federal PM2.5 standard is extremely challenging, particularly in the southern Valley, and will require tremendous reductions in emissions. Based on the extensive body of science developed through the San Joaquin Valley Study Agency's Central Valley Particulate Air Quality Study (CPRAQS), reductions in NOx emissions reductions are particularly important for reducing PM2.5 concentrations. To achieve the NOx reductions critical for reaching attainment in the Valley, ARB has adopted regulations that will significantly reduce NOx emissions from various mobile sources. However, achieving the level of needed emissions reductions requires is tremendously costly and requires time. The reductions will ultimately be achieved in time to bring most of the Valley into attainment well before 2019, with the exception of Bakersfield.

To illustrate, in order for Bakersfield to attain a year earlier by 2018, an additional 2.4 tons per day of NOx reductions would be needed in Kern County. To put this in perspective, achieving this level of emissions reductions is equivalent to virtually eliminating all passenger vehicles in Kern County. The District's "no stone unturned" evaluation of emissions sources and emissions controls did not reveal any additional reasonably available emissions reductions opportunities that could expedite attainment, with all new control strategies proposed for implementation by 2017. There are no unused control strategies available that could achieve the reductions necessary to accelerate attainment, because every reasonable control measure is already included in the plan. Thus, since the modeled emissions targets cannot be achieved for the entire San Joaquin Valley before 2019, and 2019 is the most expeditious attainment year available.

20. **COMMENT:** The Plan improperly ignores ammonia controls. The District's rationale, focused on the relative effectiveness of precursor reductions, is not one of the tests outlined by EPA to justify ignoring precursor controls. The District should evaluated cost-effectiveness of ammonia control measures. The analysis of ammonia controls in Chapter 5 is insufficient. The plan should include controls on stationary sources of ammonia.

RESPONSE: Although the plan shows expeditious attainment and includes a comprehensive control strategy for direct PM2.5 emissions and significant PM2.5

[1] The comment letter from Earth Justice was submitted on behalf of the Center for Race, Poverty, and the Environment, the Coalition for Clean Air, Fresno Metro Ministry, the National Parks Conservation Association, the Association of Irritated Residents, medical Advocates for Healthy Air, and the Central Valley Air Quality Coalition.

precursors, the District and ARB explored the effectiveness of ammonia reductions in reducing PM2.5 concentrations. EPA's 2007 *Fine Particle Implementation* states that ammonia is presumed not to be a PM2.5 attainment precursor, but that the presumption can be reversed based on an acceptable technical demonstration showing that ammonia emissions significantly contribute to PM2.5 concentrations in a given area. The review of the extensive science available on this subject and new modeling conducted for this plan concludes that reducing ammonia emissions is orders of magnitude less effective in reducing PM2.5 concentrations than reducing directly emitted PM2.5 or NOx emissions. Additionally, the District has already reduced ammonia emissions from confined animal facilities, the largest source of ammonia emissions under its jurisdiction, by 100 tons per day through adoption of Rule 4570, the most stringent rule of its kind in the nation. The District has not found additional feasible measures that could significantly reduce ammonia emissions. Despite this current understanding of ammonia's relative insignificance as a precursor, the District has added a further study commitment to the plan to continue to analyze and support studies regarding ammonia emissions from confined animal facilities, for the purpose of evaluating the potential effectiveness of ammonia controls in reducing PM2.5 concentrations in the Valley.

21. **COMMENT:** The Plan must provide documentation that condensable PM2.5 emissions are reflected in the emissions inventory and that the analysis of controls includes these emissions.

RESPONSE: While this issue may be new and more relevant to other regions, the District has historically included condensable particulate emissions in its definition of total particulate emissions, well ahead of federal and other states' efforts to address this issue. This has included instituting permit requirements for various emissions sources that include condensable particulates as part of total particulate emissions limitations, and associated emissions testing requiring that condensable particulates be measured (including utilizing an EPA-approved modified test method ahead of EPA's official test method). Condensable particulates are thus a part of the total PM2.5 inventory, and reductions in condensable particulate matter emissions were included in the District's evaluation of various emission reduction opportunities for directly emitted PM2.5. Additional clarification regarding this issue is included in Chapter 4 of the plan.

22. **COMMENT:** The analysis does not include State or other control measures. The analysis should include consideration of available State mobile source controls, transportation control measures, and controls on new stationary and indirect sources that will limit emissions growth. The District needs to work with the relevant agencies to explore the full range of emission reduction strategies that could advance attainment. Concluding that because California has some of the most stringent control measures in the country, nothing more is required under RACM is insufficient.

RESPONSE: The District works with ARB and the Valley's Metropolitan Planning Organizations in compiling attainment plans, including control measures. Chapter 5 of the plan (Section 5.2.1) describes RACM requirements, noting that reasonableness must drive the analysis, and that RACM is a collection of measures that, taken as a group, advance attainment of the PM2.5 standard by at least one year. Technological feasibility and cost-effectiveness are the foundation of this analysis. Appendix C (Section C.10) notes that EPA very recently (2011) approved the California mobile source control program as RACM in the context of the most recent attainment plans. Subsequent to EPA's RACM approval, ARB strengthened its controls further, adopting the Advanced Clean Cars measure. There are no additional reasonably available control measures that could be implemented at the state level that have not been adopted (Chapter 9). All reasonable transportation control measures are being implemented by the MPOs (Section C.11.4).

23. **COMMENT:** The RACM analysis does not consistently evaluate expanding rule applicability to smaller sources. It does not provide sufficient information to assess whether the District has explored such options.

RESPONSE: The District evaluated all potential opportunities to reduce emissions from sources, as presented in Appendix D of this plan. These evaluations included rule applicability and removal of exemptions. For situations where staff was able to identify a potential opportunity by amending one of these portions of a rule, it is evaluated and discussed in Appendix D.

24. **COMMENT:** The Risk-based Strategy is flawed, misguided, and does not reflect sound science. The District's attempt to prioritize controls is overly simplistic and in certain circumstances misleading (for example, it does not address how much weight to give various health endpoints relative to other health endpoints). The District should drop this effort.

RESPONSE: It appears from this comment that the commenter may not understand the purpose of the District's Risk-Based Strategy. Under the Risk-based Strategy, the District pursues health-protective programs designed to maximize public health improvements resulting from the District's attainment plans and other strategies. This approach of maximizing public health is acknowledged and encouraged by EPA in its March 2012 implementation guidance memo. Within this guidance, and as discussed in this plan, EPA recognizes the distinction in health impact associated with different types of particulate matter species. This recognition adds a critical additional dimension to the preparation of this plan that only enhances the health benefits potentially achieved through various strategies. Rather than opposing this public-health driven strategy, opponents could instead make suggestions or otherwise assist the District in strengthening the strategy.

25. **COMMENT:** The plan should include new modeling showing emissions reductions needs, including reductions needed to attain in 2014.

RESPONSE: Development of this plan included extensive modeling efforts well beyond any PM2.5 modeling conducted in the past. ARB, working closely with the District, utilized a modeling protocol consistent with federal modeling guidance, and solicited feedback from independent researchers, experts, and EPA in developing the modeling protocol. While future year modeling may appear to be year specific (ex: 2019), it is really modeling emissions levels to determine what emissions levels are necessary to reach attainment. Once the emissions levels for attainment are determined (see the carrying capacity diagrams in Figures 4-15 through 4-24), the District evaluates the earliest year those emissions targets could be achieved (Chapter 9). As described in the response to comment 19, the majority of the Valley is projected to reach attainment before 2019 through the aggressive emissions reductions included in the 2012 PM2.5 Plan, with Bakersfield/Kern County the most challenging and last area to ultimately achieve attainment in 2019.

26. **COMMENT:** The plan should include controls for growth of stationary source emissions. Changing NSR would be an easy way to ensure that new sources will not undermine the progress the plan seeks to achieve from existing sources. The District should increase offset ratios.

RESPONSE: Growth is calculated as a part of the inventory that is used in the plan, so demonstrations of attainment already include growth. NSR is not designed to generate reductions in emissions. There are a multitude of source-specific rules that are designed to reduce emissions. NSR is intended to allow for growth without interfering with attainment, and the District has shown in the plan that NSR does exactly that.

27. **COMMENT:** The plan should add additional controls for indirect source emissions. ISR should be strengthened to (1) expand applicability, (2) increase the emission reductions required, (3) require sources to provide some minimum emission reductions before being allowed to mitigate through payment of fees, and (4) add limits on PM2.5.

RESPONSE: The District is the first air agency to adopt an indirect source rule regulating new development projects. The District's rule is recognized as the benchmark, or best available control, for regulating indirect sources. The legal issues associated with adopting and implementing indirect source regulations are numerous and complex, as is evidenced by the fact that the District has spent over five years successfully defending its existing rule in state and federal court.

ISR already includes a stringent applicability threshold that applies to a wide range of new developments. For example, the rule applies to transit projects where construction exhaust emissions result in a total of 2 tpd of NOx and PM10 combined– this applicability threshold is lower than the federal definition of major sources. Given the existing stringent requirements, expanding rule applicability to increase emissions reductions required would not be reasonable or cost-effective. Requiring minimum emissions reductions before mitigating through payment would have no net benefit on emissions reductions. For the mobile sources targeted under ISR, the PM10 emissions involved are almost all PM2.5 emissions, so the current PM10 limits are largely PM2.5 limits. More specific recommendations regarding what, in particular, could be expanded in the rule would assist the District to more fully consider this comment in the future.

28. **COMMENT:** The plan should evaluate the potential of revising Rule 9410 to increase incentives and expand coverage.

RESPONSE: Rule 9410 is a prohibitory rule and as such does not provide incentives. Rule 9410 is a unique rule, and full implementation is still being phased in. It would be premature to consider expanding coverage until the full effectiveness of the implemented rule can be evaluated. EPA has not yet approved District Rule 9410 as a revision to the SIP.

29. **COMMENT:** The plan should evaluate the potential of new fleet rules for government-owned fleets. South coast has nine separate fleet rules.

RESPONSE: Advancing the turnover of fleets is a critical component of reducing emissions. ARB has adopted fleet rules that have greatly reduced emissions from public fleet vehicles. The District also operates some of the most effective and robust vehicle grant programs in the nation. The District will continue to look into opportunities for new fleet rules, but at this time the District advances the turnover of fleets through the use of incentive funds.

30. **COMMENT:** The plan should evaluate the potential of limiting drive-through operations (limit hours of operation, restrict new construction, etc.).

RESPONSE: Drive-through operations are an indirect source of emissions in that they attract motor vehicle emissions. The District regulates indirect sources of emissions above the applicability thresholds of ISR (Rule 9510), but most drive-through operations fall below these thresholds given their low levels of emissions. In some instances, the potential benefits could also be completely offset by vehicles idling in parking lots while one of the passengers go into the restaurant, or by increased cold-start emissions in cases where engines are shut down. There would also be enforceability issues, particularly for limited hours of operations. As motor vehicle emissions decrease in general with cleaner engines, the potential benefit of limiting drive-through operations decrease further. That said, encouraging people to avoid voluntarily avoid drive-throughs is part of the District's Healthy Air Living Program.

31. **COMMENT:** The plan should evaluate the potential of usage fees on diesel trucks, for example tolls.

RESPONSE: The District already collects DMV fees for trucks that are registered in the Valley. It would take an act of Congress to allow for the establishment of toll roads in the Valley in a manner that would reduce emissions. Under federal law, there are many limits on how and for what purpose the tolls are collected; for example, collected revenues are typically dedicated to road maintenance and toll operation (23 USC Sections 129 and 131), which would not affect PM2.5 levels in the Valley. Any other types of fees on diesel trucks would potentially constitute a tax, requiring a 2/3 majority vote of support in each of the Valley's eight counties under Proposition 26. Further, this comment appears to conflict with other Earth Justice comments opposing the District's efforts to gain SIP credit for its incentive programs. The District would hope that Earth Justice would consistently support the District in its SIP creditability effort prior to advocating for the collection of new fees.

32. **COMMENT:** The plan should evaluate the potential of subsidies to encourage public transit for cities and rural areas.

RESPONSE: The District currently provides incentives for public transportation subsidies, such as transit and rail and vanpool subsidies, through the Public Transportation and Commuter Vanpool Subsidy Component of the District's *REMOVE II Grant Program*. Funding for public transportation kiosks and the construction of Park-and-Ride lots is also available through this program component.

33. **COMMENT:** The plan should evaluate the potential of investment in new transit serving the 99 corridor (South Coast is investing major funding in light rail).

RESPONSE: As noted in Appendix C, Section C.11.4, improved transit is incorporated in regional transportation plans as opportunities and funding allow, and is beyond the scope of the District's regulatory authority.

34. **COMMENT:** The plan should evaluate the potential of carpool lanes in Fresno and Bakersfield.

RESPONSE: As noted in Appendix C, Section C.11.4, high occupancy vehicle lanes are incorporated in regional transportation plans as opportunities and funding allow, and is beyond the scope of the District's regulatory authority.

35. **COMMENT:** The plan should evaluate the potential of time-use restrictions on dirty diesel trucks and equipment.

RESPONSE: EPA's PM2.5 implementation rule notes that reasonability must drive control measure analysis, and that any measures that are absurd, unenforceable, impractical, or that would cause severely disruptive socioeconomic impacts would not be required. Time-use restrictions on dirty diesel trucks and equipment could have potentially devastating socioeconomic consequences, and may be unreasonable and impractical. In addition, PM2.5 exceedances occur during multi-day periods of stagnation, so effective time-use restrictions would be overly broad. That said, the District prioritizes the replacement of diesel trucks and equipment through its incentive programs.

36. **COMMENT:** The plan should evaluate the potential of strengthening Rule 4103 (Open Burning) to eliminate exemptions and ensure that open burning is not allowed to occur on any day that fireplace burning is prohibited.

RESPONSE: The District evaluated the feasibility and cost effectiveness of alternatives to burning in the *2010 Final Staff Report and Recommendations for Agricultural Burning* (*2010 Report*). The District determined, and ARB concurred, that there were no economically feasible alternatives to open burning of certain crop categories as outlined in the 2010 Report; this conclusion was reaffirmed in the *2012 Update: Recommendations on Agricultural Burning* (*2012 Report*). Additionally, the District currently does not allow open burning on days when fireplace burning is prohibited.

37. **COMMENT:** The plan states that there are no NOx emissions reported for Rule 4104 (Reduction of Animal Matter), but also states that the source category uses thermal oxidizers. The plan should evaluate the potential of strengthening the rule to include NOx limits for thermal oxidizers.

RESPONSE: As discussed in Appendix D, rendering facilities subject to Rule 4104 generally use steam from a boiler (indirect-fired) or a rotary dryer (direct-fired) for their operations; which generate NOx emissions. These combustion units are regulated/controlled by other District rules and are therefore accounted for in the emission inventories under those source categories. See Appendix B for the complete emission inventory.

The purpose of Rule 4104 is to reduce emissions from rendering operations. Specifically, Section 5.1 states that "*A person shall not operate or use any article, machine, equipment or other contrivance for the reduction of animal matter unless all gases, vapors and gas-entrained effluent from such an article, machine, equipment or other contrivance are: 1) Incinerated at temperatures of not less than 1200°F for a period of not less than 0.3 seconds; or 2) Processed in such a manner determined by the APCO to be equally or more effective for the purpose of air* *pollution control than Section 5.1.1 above.*" Most rendering facilities use thermal oxiders as a pollution control device to incinerate effluent from the rendering process, and reduce odors and their potential nuisance impact. Although there are auxiliary NOx emissions from the combustion of supplementary fuel, there are only a few of these units in the San Joaquin Valley, and are not a significant NOx emissions source. Any new units would be evaluated through the District's Best Available Control Technology New Source Review requirements. As discussed in Appendix D, District Rule 4104 is as stringent as or more stringent than other air districts in California, and has been deemed as RACT by EPA. However, the District will continue to evaluate the potential for additional emissions reductions from this source category during future plan development projects.

38. **COMMENT:** The plan should evaluate the potential of strengthening Rule 4309 (Dryers and Dehydrators). Finding that reducing the NOx limit to 3.9 ppmv at 19% O2 for asphalt plants would reduce the margin of compliance for units is not a sufficient rationale for rejecting controls. If a lower limit is feasible, sources will achieve it and determine for themselves how best to ensure compliance.

RESPONSE: As stated in Appendix D, all of the asphalt plants in the Valley have already installed low-NOx burners or modified their units to meet the 4.3 ppmv limits applicable to them. As result of these alterations, these facilities meet the more stringent 3.9 ppmv limit discussed in the comment. Therefore, this type of amendment would be administrative in nature since it would not require any additional control equipment or changes in operating techniques or practices to comply and would not generate additional emission reductions from these units.

39. **COMMENT:** The plan should evaluate the potential of strengthening Rule 4311 (Flares) to strengthen the flare minimization planning requirement to cap the amount of produced gas that can be burned, like the Santa Barbara rule.

RESPONSE: More specific information on the commenters perceived differences between the Santa Barbara and San Joaquin Valley flare rules would help the District to more fully consider and respond to this comment. The District did a thorough analysis of flare rules in other air districts in California during both this plan development process and the 2009 rule-amending project and determined that District Rule 4311 is as stringent as or more stringent than flares rules in other air districts. EPA concurs with this assessment as illustrated by the approval of the rule as a SIP revision in 2011. The District has committed to a further study of the flare rules to continue to evaluate potential opportunities for additional emission reductions from these sources (see Appendix D, and Chapters 5 and 10 for more details).

40. **COMMENT:** The plan should evaluate the potential of strengthening Rule 4352 (Solid Fuel-Fired Boilers) to explore fuel switching requirements. There is no

reason, economically or otherwise, that sources in the Valley should be allowed to burn coal. Requiring such fuel switching is a permissible control measure and is both technologically and economically feasible.
RESPONSE: One former coal fired facility, DTE Stockton, has already switched to biomass, and the four other coal/coke fired boilers in the Valley are being fired on biomass part of the time. In addition, these units have installed highly effective emission control systems for NOx, SOx, and PM emissions. These four boilers even have more stringent NOx limits within their permit requirements than some of the biomass facilities and the municipal solid waste facility in the Valley. Source testing confirms that they are meeting even lower limits than those in their permits. Thus, mandating that these four facilities eliminate the use of coal would not generate additional emission reductions from these units. Like DTE Stockton, favorable market conditions will allow facilities to adapt to biomass fuel. The District evaluated additional potential emission reduction opportunities, as included in Appendix D.

41. **COMMENT:** The plan should evaluate the potential of strengthening Rule 4550 (Conservation Management Plans) to ensure all sources are applying the most effective emission reduction techniques. The District should revisit its menus and eliminate options that undermine the application of superior reasonably available control measures.

RESPONSE: As discussed in Appendix D, the District has adopted the most stringent regulatory requirements in the nation for reducing particulate matter emissions (primarily PM10) from agricultural sources. Agricultural operations are currently achieving significant emission reductions from the implementation of a broad set of conservation practices. While Rule 4550 has been successful in reducing both PM10 and PM2.5 emissions, recent studies have indicated that the PM2.5 fraction of emissions makes up a small portion of the total particulate emissions from agricultural operations. Additionally, PM2.5 emissions from these sources make up a minor fraction of 24-hour PM2.5 concentrations in the peak winter season, the geologic nature of these particulate matter emissions are of relative low toxicity. Therefore, District does not recommend any additional regulatory requirements under Rule 4550. The District has committed to continue to analyze and support studies in support of establishing a more accurate inventory of PM2.5 emissions and identifying potential additional emission reduction opportunities.

42. **COMMENT:** The plan should evaluate the potential of strengthening Rule 4702 (Internal Combustion Engines) to meet tighter NOx and PM limits by May 2013. The District should explore further emission reductions available for this source category, including a lower NOx limit and fewer exemptions for IC engines.

RESPONSE: Rule 4702 was amended in August 2011 to implement more stringent NOx limits for non-agricultural operations engines, with compliance dates ranging from 2014 through 2017. Based on this recent action and ongoing rule requirements, there are no additional emission reduction opportunities for non-agricultural engines at this time. Additionally, the District's analysis of Rule 4702 determined that lower NOx emissions limits are not currently technologically or economically feasible for agricultural operations engines. Refer to the control measure discussion for Rule 4702 in Appendix D for the complete analysis of the current NOx emissions limits in Rule 4702, which also includes the District's evaluation of potential opportunities by amending rule exemptions.

43. **COMMENT:** The District is working with SCAQMD to develop new technologies that will make it possible for the regulated community to comply with new regulations for Rule 4692 (Commercial Charbroiling). The District should implement controls on under-fired charbroilers now that would provide additional emission reductions, similar to those in BAAQMD such as controls on new under-fired charbroilers, and controls on existing under-fired charbroilers.

RESPONSE: While there are promising technology demonstration efforts underway, time is still needed to prove the technologies in actual restaurant conditions and for the technologies to become commercially available. Even though BAAQMD Regulation 6 Rule 2 already applies to under-fired charbroilers, restaurants have been able to avoid control devices by staying under the applicability limits. In fact, the District is not aware of any restaurants that have been required to install controls under BAAQMD's regulation. Given the current state of technology, considerable time, investment, and effort will be needed in order to develop viable technologies. A compliance date of 2017 would accelerate the development and demonstration of new technology. The District will utilize its Charbroiler Incentive Program (ChIP) to assist in the demonstration and implementation of the technologies in anticipation of the 2017 compliance date. Furthermore, the amendment of District Rule 4692 would go through an extensive public process, during which the District will address the cost effectiveness of installing the new technologies and the socio-economic impacts of the proposed regulation.

44. **COMMENT:** The District has committed to reviewing and amending Rule 4905 (Natural Gas-Fired, Fan-Type, Residential Central Furnaces) in 2014, that is too late given the public health consequences Valley residents face as a result of the District's delayed attainment of the PM2.5 standard. The District should commit to reviewing and amending the rule earlier than 2014.

RESPONSE: The District committed to amend Rule 4905 in the District's *2008 PM2.5 Plan* with a date of 2014 given the uncertainty that manufacturers will be able to meet the more stringent limits in the South Coast Rule 1111, the rule for which this commitment is based upon. In 2010, the SCAQMD released an RFP for the development of prototype ultra-low NOx natural gas-fired fan-type central furnaces; the resulting projects are currently on-going. The District will work closely with the SCAQMD staff throughout the technology development project and when Rule 4905 is amended, the NOx emission limits will be technologically feasible and cost effective requirements.

45. **COMMENT:** The plan should evaluate the potential of strengthening Rule 8061 (Paved and Unpaved Roads) to consider changes to the daily trip threshold and to evaluate tightening controls on the roads currently covered by the rule.

RESPONSE: The District evaluated opportunities to strengthen Rule 8061 and determined that lowering the trip threshold is not a viable emission reduction opportunity. Additionally, air quality monitoring and modeling shows that the geologic fraction of PM2.5 found in the San Joaquin Valley makes a relatively small contribution to overall PM2.5 mass, and studies have shown that geologic dust, by itself, has relatively low toxicity. In addition, emissions from unpaved roads are lowest in the winter when the majority of PM2.5 exceedances occur. For a more detailed analysis, see Appendix D.

46. **COMMENT:** The plan should evaluate the potential of strengthening Rule 8081 (Agricultural Sources). The District should revisit its dust control options and eliminate options that undermine application of superior options that are reasonably available.

RESPONSE: The District evaluated opportunities to strengthen Rule 8081 and did not identify any viable emission reduction opportunities. Additionally, air quality monitoring and modeling shows that the geologic fraction of PM2.5 found in the San Joaquin Valley makes a relatively small contribution to overall PM2.5 mass, and studies have shown that geologic dust, by itself, has relatively low toxicity. This rule applies to off-field agricultural sources and the dust control requirements are as or more stringent than those in other air districts. For a more detailed analysis, see Appendix D.

47. **COMMENT:** With regards to SC 005 (Asphalt/Concrete Operations), the District should investigate ways in which it can help local jurisdictions incorporate warm-mix asphalt technologies into their operations.

RESPONSE: The District has committed to a 2013 further study evaluation of the feasibility of warm mix asphalt over hot-mix asphalt. The District must first verify potential emission reductions as well as cost effectiveness and technological feasibility of warm mix asphalt before encouraging local jurisdictions to incorporate the technologies into their operations.

48. **COMMENT:** The current weight of evidence analysis is written to defend the modeling results and assumptions, but does not provide separate analyses or independent evidence supporting the conclusion that the area will attain. The plan should provide additional evidence and analyses to test the conclusions of the model.

RESPONSE: As a part of the weight-of-evidence analysis for the *2012 PM2.5 Plan*, the District conducted a speciated linear rollback analysis as discussed in Appendix 5 of Appendix G (PM2.5 Weight of Evidence). The District's speciated linear rollback analysis serves as a separate analysis with the goal of corroborating the results of regional model. This independent analysis arrived at similar projected design values in 2019 for the Fresno and Bakersfield areas, providing further evidence that the conclusions of the regional model are sound.

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SUMMARY OF SIGNIFICANT COMMENTS FOR THE OCTOBER DRAFT OF THE PM2.5 PLAN

VERBAL COMMENTS, OCTOBER 9, 2012 ARB PORTION OF PUBLIC WORKSHOP

Approximately 16 people (non-District, non-ARB) in attendance (9 Fresno, 5 Bakersfield, 2 Modesto)

City of Shafter (Shafter)
Environmental Protection Agency (EPA)
Kings County Department of Public Health (KCDPH)
Southern California Gas Company (SCGC)

49. **COMMENT:** Do other parts of the state have speciated monitors? (SCGC)

RESPONSE: Yes, there are 14 speciated monitors outside of the Valley. More information about California's state and local air monitoring networks is found at http://www.arb.ca.gov/aaqm/mldaqsb/amn.htm.

50. **COMMENT:** Is organic carbon a good indicator for diesel exhaust? (SCGC)

RESPONSE: Elemental carbon is a better indicator for diesel exhaust than organic carbon. However, there are other sources that contribute to elemental carbon so it is not the only source. There is no indicator unique to diesel exhaust only.

51. **COMMENT:** Can you explain organic nitrates? Peroxyacetyl Nitrate (PAN) acts as a night reservoir for NOx. Can it also provide a reservoir during the day in the wintertime? (SCGC)

RESPONSE: Nitrates are typically gases, but they can take the form of a particulate under certain conditions. In the summer, these compounds are less important and PAN acts as a nighttime reservoir. However, the colder temperatures during the winter season can create a daytime reservoir as well.

52. **COMMENT:** Are all federal, state, and local programs that have been incorporated into the ARB emissions modeling identified somewhere in the plan, along with their emission reduction benefits? (Shafter)

RESPONSE: EPA's March 2012 PM2.5 Implementation Guidance memo (page 3) recommends that states first identify emissions reductions programs that have been adopted and implemented at the federal, state, and local levels, and then use this information to evaluate the air quality improvement the programs are projected to provide. The context of this recommendation is for areas to consider the air quality improvement from the collective strategy to determine the area's likely attainment date and the amount of additional emissions reductions needed to reach attainment. Toward this end, the plan documents existing federal, state, and local measures in Appendices C and D, and in Chapter 5. Appendix B summarizes some of the major activities that have reduced emissions. Chapter 4 describes the design value progress that will result from all adopted and newly proposed measures. Additional information regarding adopted state and federal control measures may be found in the supporting staff reports and documentation for each of the respective measures.

53. **COMMENT:** In the March letter from EPA, they discuss greenhouse gases (GHGs). Will it be recognized and included in the modeling? (Shafter)

RESPONSE: This plan addresses the most recent 24-hour standard PM2.5 standard adopted by EPA in 2006, and does not address GHGs or global warming. GHGs and global warming are primarily being addressed at the state and federal level, for example, through California's passage of Assembly Bill 32 in 2006.

54. **COMMENT:** The organic nitrate reservoir is referred to in the modeling protocol, is there concrete evidence supporting it or is it measurement based? (EPA)

RESPONSE: The role Peroxyacetyl Nitrate (PAN) plays as a night reservoir is well established in the San Joaquin Valley Air Basin, as well as other air basins. For example, a study conducted by John Seinfeld[2] on air quality in the South Coast Air Basin demonstrated disbenefits of VOC reductions with regard to PM2.5 formation. ARB collected data on organic nitrates in the Valley in June 2012 and see similar evidence of this phenomenon in the San Joaquin Valley data.

55. **COMMENT:** What is the relative contribution of wood combustion and diesel mobile sources to organic carbon? (EPA)

RESPONSE: The receptor modeling conducted for this plan differentiates the sources of carbon, and recent data has determined the ratio of organic carbon to be about 50/50 between burning and mobile sources.

56. **COMMENT:** The District stated that reductions in ammonia were less effective at reducing ammonium nitrate, especially in urban areas. Is there any plan to do sensitivity studies of ammonia reductions in localized urban areas? (EPA)

RESPONSE: ARB has conducted ammonia sensitivity runs, with results included in Chapter 4 and Appendix G (Weight of Evidence). Carrying capacity diagrams

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[2] Meng, Z., Dabdub, D., and Seinfeld, J.H., 1997, Chemical Coupling Between Atmospheric Ozone and Particulate Matter, Science, 277, 116-119.

showing the effectiveness of ammonia reductions compared to other precursors have been added to Chapter 4. These modeling results and other studies conclude that reducing ammonia emissions is much less effective at reducing ammonium nitrate concentrations than reducing NOx or direct PM2.5 emissions. However, the District has committed to further study ammonia emissions at confined animal facilities, including potential ammonia controls and their effectiveness in reducing the Valley's PM2.5 concentrations.

57. **COMMENT:** What are some of the primary sources of ammonium nitrate? (KCDPH)

RESPONSE: Ammonium nitrate is formed from emissions of NOx and ammonia. The primary sources of NOx are on- and off-road mobile sources, while ammonia is emitted from livestock operations, fertilizer applications, and mobile sources. See Chapter 4 for the full discussion of ammonium nitrate formation in the Valley.

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VERBAL COMMENTS, OCTOBER 9, 2012 DISTRICT PORTION OF PUBLIC WORKSHOP

Approximately 19 people (non-District, non-ARB) in attendance (11 Fresno, 5 Bakersfield, 3 Modesto)

8TM, Fresno (8TM)
Aptco LLC (AC)
Center for Race, Poverty, and the Environment (CRPE)
Central Valley Air Quality Coalition (CVAQ)
City of Shafter (Shafter)
Coalition for Clean Air (CCA)
Golden Valley Health Centers (GVHC)
Paramount Farms (PF)
Sherriffs, Alexander C., M.D. (Sheriffs)
Southern California Gas Company (SCGC)
Spa Doctor Spa and Stove Center (SDSSC)

58. **COMMENT:** How much emissions reductions are expected for Rule 9610 and will those reductions count towards the District's attainment demonstration? (CCA)

RESPONSE: The emissions reductions credited under Rule 9610 will be determined through annual reporting. The procedure for these annual reports will be determined during the development of Rule 9610 in 2013. At this time, the District is identifying 1.9 tons per day (tpd) of NOx reductions in 2019 to serve as contingency reductions for this plan. These reductions were not credited as a part of the attainment demonstration. See Chapter 6 for the discussion for Rule 9610 and Chapter 9 for additional information on contingency measures.

59. **COMMENT:** Could ammonia emissions reductions be used for contingency purposes? Why doesn't the District pursue ammonia emissions reductions, since there is a surplus of ammonia emissions in the Valley and it is becoming more difficult for the Valley to achieve cost effective NOx emissions reductions? (CCA)

RESPONSE: This plan shows that sufficient reductions in NOx and PM2.5 are available to bring the Valley into attainment and to fulfill the contingency requirement. The extensive evaluation of the potential benefit of ammonia reductions to the Valley's PM2.5 concentrations demonstrates that it would take an unreasonable magnitude of ammonia reductions to significantly reduce PM2.5 concentrations. Additionally, there are not any feasible measures available to reduce ammonia emissions by this magnitude (see Chapters 4 and 5). Therefore, it would not be beneficial to use ammonia reductions as contingency in place of NOx or direct PM2.5 reductions. That said, District Rule 4570 (Confined Animal Facilities) is the most stringent regulation in the nation for livestock operations and already achieves significant ammonia and VOC reductions. Furthermore, the

District has committed to further study ammonia emissions at confined animal facilities, potential ammonia controls for these facilities, and the effectiveness of these controls in reducing the Valley's PM2.5 concentrations (see Chapter 5).

60. **COMMENT:** Under Rule 9610, how will the District get SIP credit for emissions reductions achieved through incentive programs and ensure that Clean Air Act requirements for enforceability are still met? (CRPE)

RESPONSE: District incentive programs have been modeled from effective state incentive programs like the Carl Moyer Program. Enforceability has already been built into the District incentive programs through requirements that include pre and post-project equipment inspections, monitoring and reporting. The development of Rule 9610 will provide the mechanism for the District to take credit for these surplus, quantifiable, and enforceable emissions reductions.

61. **COMMENT:** If the District does not know how many people will opt into their incentive programs, how will you estimate a certain amount of emissions reductions and take credit for those reductions as a part of Rule 9610? (CRPE)

RESPONSE: The proposed plan does not take any credit for emissions reductions from incentives to demonstrate attainment (see response to comment 58). Final credit for Rule 9610 emissions reductions will be based on reporting of actual participation in SIP-creditable incentive programs. The details of this process under Rule 9610 will be established through a public rule development process in 2013.

62. **COMMENT:** Are all federal, state, and local programs that have been incorporated into the ARB emissions modeling identified somewhere in the plan, along with their emission reduction benefits? (Shafter)

RESPONSE: See response to comment 52.

63. **COMMENT:** Page C-1 states that land use decisions are under the jurisdiction of the MPOs, but in actuality cities and counties have the authority. (Shafter)

RESPONSE: Appendix C has been corrected with the appropriate language.

64. **COMMENT:** EPA recently released new federal Corporate Average Fuel Economy (CAFE) standards. How will those new standards be accounted for in the plan? (SCGC)

RESPONSE: EPA's August 2012 CAFE standards set emissions limits for carbon dioxide for model years 2017-2025. ARB has also adopted a new regulation addressing light-duty motor vehicle efficiency known as the Advanced Clean Car regulation. ARB has recently found the federal regulation to be equivalent to the state regulation. Future reductions from implementation of these new efficiency and emissions standards have been accounted for in this plan.

65. **COMMENT:** The charbroiling source category is important for the District's risk-based strategy and reaching attainment. How does setting a compliance date for 2017 help to reach attainment as "expeditiously as possible"? (GVHC)

RESPONSE: Promising prototype technologies are being demonstrated through South Coast AQMD's charbroiler demonstration project, which the District has been actively participating in. However, time is still needed to prove the technologies in actual restaurant conditions (whereas the South Coast project is being conducted in a research facility) and for the technologies to become commercially available. Given the current state of technology, a compliance date of 2017 will accelerate the development and demonstration of new technology. The District will utilize its Charbroiler Incentive Program (ChIP) to assist in the demonstration and implementation of the technologies in anticipation of the 2017 compliance date. Furthermore, the amendment of District Rule 4692 will go through an extensive public process and will be the opportunity to address specific issues such as the cost effectiveness of installing the new technologies and the socio-economic impacts of the proposed regulation. See Appendix D for additional information on the Rule 4692 (Commercial Charbroiling) control measure.

66. **COMMENT**: When will the results of the SCAQMD technology demonstration project for charbroiling be completed? How much money has the District invested in the study thus far? (GVHC)

RESPONSE: Results from South Coast's technology demonstration project are expected later this year or early next year. The District has contributed $500,000 of funding to its own ChIP (Charbroiler Incentive Program) demonstration program thus far, and will use this program to seek partnering restaurants with which to demonstrate emissions controls at Valley operated restaurants. Additional funding may be contributed to the South Coast or other demonstration efforts as opportunities become available.

67. **COMMENT:** In regards to the commitment to establish emission limit(s) for under-fired charbroilers, is this the first time a rule has been adopted or committed to without sound knowledge regarding the availability or efficiency of potential control technologies? (GVHC)

RESPONSE: Similar to the Guiding Principle #2 for this plan (use sound science as the plan's foundation), the District uses sound science with every rule making action. The District has never adopted or committed to a regulation without sound knowledge regarding the availability or efficiency of potential control technologies. However, due to the severe nature of the Valley's pollution problems, the District has adopted regulations that have been "technology-forcing", whereby requiring emissions controls that are effective in controlling emissions, but have not yet been widely implemented for a specific source category. Examples include Rule 4306, where large boilers, steam generators and process heaters were required to install ultra-low NOx burner technologies in order to meet the emission limits established by the rule; or Rule 4703, where turbines have been required to install post-combustion controls such as Selective Catalytic Reduction (SCR) systems to achieve the NOx limits of the rule. Furthermore, the amendment of District Rule 4692 will go through an extensive public process and will provide opportunities to address specific issues such as the state of new technology, cost effectiveness of installing new technologies, and the socio-economic impacts of the proposed regulation.

68. **COMMENT:** How much of an emission reduction benefit would the Valley gain from the amendment to the charbroiling rule? (Sheriffs)

RESPONSE: Amending Rule 4692 to include charbroilers will reduce about 0.1 tons per day of directly-emitted PM2.5 in Kern County, and about 0.3 tons per day in other Valley counties combined for a total of 0.4 tons per day of reductions in directly-emitted PM2.5. Due to the location of these emissions reductions, and because this would reduce directly-emitted PM2.5, there would be a significant benefit to ambient PM2.5 concentrations as a result of this amendment: 0.6 $\mu g/m^3$ reduction in the PM2.5 concentration for Bakersfield. Not only does this help assure attainment in the Bakersfield area, but the PM2.5 species and location of emissions reduced will achieve relatively large health benefits, consistent with the District's Risk-based Strategy.

69. **COMMENT:** Some facilities operate thermal oxidizers year round to destroy VOCs. Given the potential disbenefit associated with reducing VOCs with regard to PM2.5 formation, could removing control equipment and allowing higher VOC emissions during the winter serve as a potential PM2.5 control strategy? (AC)

RESPONSE: While modeling shows there is a potential disbenefit from reducing VOC emissions with regard to PM2.5 formation, the magnitude is relatively small and will not assist with attaining the federal PM2.5 standard. Furthermore, weakening existing regulations may have a detrimental public health impact to workers and Valley residents working in or living near facilities.

70. **COMMENT:** When the District amends Rule 4901, it should consider allowing residents who have invested in cleaner burning, EPA-certified wood burning devices to use those devices at some curtailment levels, as an incentive for investing in these cleaner devices. (SDSSC)

RESPONSE: The District commits to analyze the feasibility of allowing the use of clean certified wood-burning devices at some curtailment levels during the next rule-amending process. Enforcing this added flexibility would be difficult given the challenge in distinguishing wood smoke emissions from various wood burning devices, and the District would explore various options during the rule development process for ensuring that this issue is addressed. The District values the cleaner burning technology that has been developed in recent years, as demonstrated by the implementation of the District's *Burn Cleaner Program*, which was implemented to help Valley residents upgrade their current wood-burning devices and open fireplaces to natural gas or propane devices, or clean pellet devices to alleviate the problem of particulates.

71. **COMMENT:** It would be helpful to provide a summary of the inventory, including the percentage of emissions reductions committed to from the state and the District, as part of workshops. (CVAQ)

RESPONSE: The District presented the emissions inventory for various PM2.5-related pollutants during the workshop, and detailed emissions inventory information was published as part of various drafts of the *2012 PM2.5 Plan* ahead of public workshops (see Appendix B).

72. **COMMENT:** The District should consider prohibiting open air charbroiling on No-Burn days. (CVAQ)

RESPONSE: During the rule-amending project for Rule 4692, the District will evaluate potential opportunities for emissions reductions and consider technological feasibility, cost-effectiveness, and socio-economic impact.

73. **COMMENT:** Social vulnerability should be considered as a part of the District's Risk-based Strategy. There also seems to be a low priority for rural communities as a by-product of the District's Risk-based Strategy. (CVAQ)

RESPONSE: Public health in all parts of the Valley, including rural communities, are important and considered in the proposed *2012 PM2.5 Plan* and the District's Risk-based Strategy. This vulnerability is also acknowledged in the District's Environmental Justice Strategy.

74. **COMMENT:** The District should consider addressing the stench of mega dairies as they can cause serious impacts on poor and/or small communities around them. (CVAQ)

RESPONSE: Dairies are subject to the District's permitting program and are inspected regularly to ensure compliance with District regulations. In fact, dairies are subject to Rule 4570 (Confined Animal Facilities), the most stringent rule of its kind in the nation, and are already required to implement best management practices to ensure emissions are minimized.

75. **COMMENT:** On Slide 16, what percentage of NOx emissions is on-road versus off-road? Is ARB rulemaking factored in? If their rules get delayed, how will the District handle not reaching these goals? (CVAQ)

RESPONSE: The emissions inventory is presented in Appendix B of the plan. In 2019, mobile source emissions account for about 79% of the total NOx emissions inventory. Of this, about 63% is on-road mobile and 37% is other mobile. ARB rulemaking is factored into the projected emissions, and the proposed plan (and other prior plans, including the *2007 Ozone Plan* and *2008 PM2.5 Plan*) includes enforceable commitments to achieve the emissions reductions necessary for attainment.

76. **COMMENT:** Every October in the last ten years has had an exceedance of the 35 $\mu g/m^3$ PM2.5 standard. Is there any evidence that these exceedances are not at least partially attributable to residential wood burning? Why is October not included in the wood burning curtailment period of Rule 4901? Why not ban residential wood burning altogether? (8TM)

RESPONSE: There have been measured PM2.5 concentrations above 35 $\mu g/m^3$ in Octobers of years past. Expanding the curtailment season to include October would potentially increase the number of curtailment days in each wood burning season based on recent air quality data. However, measured Valley concentrations of levoglucosan, a primary indicator for wood burning, are not nearly as high in October as found to be in November through February (refer to Appendix D for further discussion). While it appears that there would be little benefit in expanding the woodburning season to October, the District will consider this option when the rule is amended under this plan.

77. **COMMENT:** Can you address how you will be changing old regulations that are part of businesses being regulated to the point of diminishing returns and spending millions of dollars with minimal benefits? (PF)

RESPONSE: The District recognizes the significant cost associated with regulations that have been adopted to reduce emissions from stationary source businesses. This plan includes a thorough analysis of all sources of emissions of directly-emitted PM2.5 and the Valley's significant PM2.5 precursors to identify whether there are any additional opportunities for reducing emissions. This analysis is presented in the 200+ page Appendix D, and new rule commitments are included in Chapter 5.

VERBAL COMMENTS, OCTOBER 16, 2012 DISTRICT MEETING WITH CVAQ

The District, ARB, EPA, and members of CVAQ (Central Valley Air Quality Coalition) met to discuss the PM2.5 Plan and related issues.

78. **COMMENT:** The District should consider amending the Indirect Source Review (ISR) Rule to expand rule applicability.

RESPONSE: The District is the first air agency to adopt an indirect source rule regulating new development projects. The District's rule is recognized as the benchmark, or best available control, for regulating indirect sources. The legal issues associated with adopting and implementing indirect source regulations are numerous and complex, as is evidenced by the fact that the District has spent over five years successfully defending its existing rule in state and federal court. A specific recommendation would assist the District to more fully consider this comment.

79. **COMMENT:** The District should consider amending the flare rule (Rule 4311). For example, Santa Barbara has a stronger flare rule than the San Joaquin Valley.

RESPONSE: More specific information on the commenters perceived differences between the Santa Barbara and San Joaquin Valley flare rules would help the District to more fully consider and respond to this comment. The District did a thorough analysis of flare rules in other air districts in California during both this plan development process and the 2009 rule-amending project and determined that District Rule 4311 is as stringent or more stringent than flares rules in other air districts. EPA concurs with this assessment as illustrated by the approval of the rule as a SIP revision in 2011. The District has committed to a further study of the flare rules to continue to evaluate potential opportunities for additional emission reductions from these sources (see Appendix D, and Chapters 5 and 10).

80. **COMMENT:** District-issued variances undermine the strength of its rules.

RESPONSE: California state law establishes and requires that the District have three hearing boards which take petitions for, and make decisions on, variance requests from local District rules as well as certain specified provisions of state law. Such variances are only allowed in situations where compliance is beyond the reasonable control of the operator and where requiring immediate compliance would result in the practical closing of a lawful business or the arbitrary or unreasonable taking of property without a corresponding benefit in reducing air contaminants. For both short and long term variances, the District provides public notice of the hearing and members of the public are afforded the opportunity to attend the hearing and provide comments to the board before it acts on the variance request.

Many variances are purely administrative in nature and do not provide relief from emission standards contained in applicable rules and/or operating permits. For those variances which do provide relief from emission standards, the board must ensure that excess emissions will be reduced to the maximum extent feasible. As a result, excess emissions allowed by variances are minimal and represent less than 0.01% of the emission inventory for NOx and VOC emissions. Furthermore, prior to granting a variance the potential air quality impacts must be considered to ensure that the variance will not result in the creation of a public nuisance or the exceedance of an ambient air quality standard.

Aside from being required by state law, the variance process allows the District to develop and implement the most stringent rules and regulations knowing that if unique and unexpected circumstances arise, the variance process allows a mechanism to address these temporary situations. Without such a process, rules would have to be developed to address such unique and temporary circumstances and would not be as stringent as necessary to address attainment issues and plan commitments.

81. **COMMENT:** The District should consider adopting a public fleet rule like South Coast rule.

RESPONSE: ARB has adopted a Solid Waste Collection rule that, similar to South Coast's rule, reduces emissions from refuse vehicle fleets. South Coast Air Quality Management District's fleet rule requires that solid waste collection vehicle fleets transition to operating entirely on alternative fuel beginning in 2011. ARB's Solid Waste Collection Vehicles Rule gives fleet operators several options to meet Best Available Control Technology requirements for particulate emissions by the end of 2010. One compliance option under the ARB rule is the use of alternative fuel. Many of the District's SWCV fleets have already converted to alternative fuels. Transitioning a fleet from diesel to alternative fuel can be costly and may not be economically feasible (see Appendix C for a more detailed discussion). Additionally, the emissions benefit associated with such a transition is minimal given the stringent particulate matter requirements under ARB's rule. The District will continue to advance the turnover of SWCVs through the use of incentive funds rather than adopting a fleet rule.

82. **COMMENT:** Has ARB's upcoming agricultural equipment rule been accounted for in this PM2.5 plan?

RESPONSE: This rule is currently under development as an ozone plan control measure, and emissions reductions from this future strategy have not been accounted for in this PM2.5 plan. Any reductions in PM2.5 precursors from this rule would be in addition to the emissions reduction commitments included in this plan.

WRITTEN COMMENTS, OCTOBER 9, 2012 WORKSHOP

EPA REGION IX COMMENTS:

83. COMMENT: Since the plan projects attainment by 2017 for all locations except the Bakersfield-California Avenue monitor, the plan should document how the projected attainment dates for the other monitors were determined.

RESPONSE: The projected attainment dates for various regions of the Valley were based on the plan's attainment modeling. Projections of earlier attainment dates were based on 2019 emissions and modeled design values; 2007 emissions and actual design values; and emissions inventory trends between 2007 and 2019. As seen in Table 4-1, various regions of the Valley are projected to see concentrations much lower than the federal standard of 35 $\mu g/m^3$ in 2019.

84. COMMENT: The plan should include an economic and technological feasibility analysis of all identified control measures, and the measures found to be economically and technologically feasible should be evaluated for RACM.

RESPONSE: The plan identifies all potential opportunities to reduce emissions with associated economic and technological feasibility analyses (see Appendix D). All potential opportunities determined to be technologically feasible and cost effective, and therefore "reasonable" that are also under the District's jurisdiction are being recommended as control measures for this plan (see Appendix D and Chapters 5 and 10).

85. COMMENT: The plan should document the methods used to derive the interpollutant trading ratios, including an explanation of why the methods are reasonable for contingency measures and transportation conformity, if the plan includes a trading mechanism for transportation conformity purposes. The methods should be consistent with the results of ARB's sensitivity analyses using photochemical modeling.

RESPONSE: The 8:1 NOx to PM2.5 interpollutant ratio is included in the transportation conformity discussion in Appendix C. Discussion on the derivation of this trading ratio has been added to the contingency analysis in Chapter 9. The Weight of Evidence Analysis (see Appendix G) documents the methodology used to develop the relative efficacy of emission reductions from the different PM2.5 precursors based on photochemical modeling sensitivity runs.

86. COMMENT: The plan relies on new emissions reductions in 2019 and 2020 to meet the contingency measure requirement for failure to attain. All reductions for contingency purposes should be for the same year.

RESPONSE: The labeling of the attainment year contingencies will be reviewed for consistency. Since attainment would be based on air quality data collected through the end of 2019, all attainment year contingencies, if needed, would be triggered starting in 2020 (see Chapter 9).

87. **COMMENT:** CAA requirements for contingency measures cannot be fulfilled with commitments to adopt measures in the future. Therefore, the plan cannot rely on emission reductions from new and/or revised requirements in Rules 4692, 4901, and 9610 to meet the contingency requirement until the District adopts and EPA approves these new requirements.

RESPONSE: The District commits to adopting each of these measures before the year in which contingency reductions are credited in the *2012 PM2.5 Plan.* EPA should consider conditionally approaching these contingency measures, on the condition that the District adopts these contingency measures by the dates committed to in the plan.

88. **COMMENT:** The District should include an analysis in the plan supporting the specific emission reductions claimed for Rule 9610 for contingency purposes for on-going incentive programs. This should include a discussion of the funding level needed to achieve the claimed emission reduction, expected sources of funding, the basis for assuming that sufficient funding will be available, and the likely source categories and calculation assumptions that could result in sufficient surplus reductions.

RESPONSE: Chapter 6 of the Plan includes a detailed description of the various funding sources available to the District, as well as different incentive programs that are operated by the District. These programs have reduced over 93,000 tons of NOx, VOC, and PM2.5 emissions since 1992. The District conservatively estimates that $30 million of incentive funding would be needed to achieve the 1.9 tpd of contingency reductions committed to under this plan. Using a combination of secured funding sources, including, but not limited to funding available through motor vehicle surcharge fees (as authorized under AB 2522, AB 923, SB 709), and State Carl Moyer Program funds, the District is confident that incentive reductions in excess of the committed contingency reduction will be achieved as needed. It is important to note that the majority of incentive-based emission reductions generally have a life of five to ten years, with some as long as 20 years. The District expects that continued implementation of its incentive programs over the next several years, including expenditure of the $184 million of incentive funds included in the District's 2012-13 Budget, will achieve emissions reductions well in excess of the amount potentially needed in the event of contingency. Primary sources of these incentive-based emissions reductions would include the replacement of heavy duty diesel powered engines and equipment used in various on and off-road applications. Incentive program implementation, including verification of emissions reductions and calculation assumptions, are based on state methodologies, with the Carl

Moyer Program serving as the primary guideline for the District's heavy duty equipment incentive programs.

89. **COMMENT:** If the District intends to use incremental reductions in 2020 from non-mobile source measures for contingency purposes, the plan should identify these measures and their incremental reductions. Also, the plan should document the portions of the 2020 inventory relied on for contingency measures.

RESPONSE: Approximately 0.1 tpd of the emissions reductions in 2020 utilized for contingency purposes are resultant from District regulatory measures for stationary and area sources. The remaining 12.2 tpd of reductions in 2020 are from mobile sources. See Chapter 10 for the complete discussion of the control strategies fostering the needed emissions reductions for contingency purposes.

90. **COMMENT:** The proposed contingency measures include most of the reductions from the new charbroiling and wood burning controls, excluding the reductions in Kern County that are used to demonstrate attainment. The final plan should document that these reductions outside of Kern County are not included in the modeled attainment demonstration, and are therefore truly excess.

RESPONSE: Chapter 4 has been updated to clarify that only emissions reductions in Kern and Kings Counties were needed to model attainment.

91. **COMMENT:** The *2008 PM2.5 Plan* projected SOx levels at 21 tpd in 2014 while the draft *2012 PM2.5 Plan* projects 9 tpd in the same year. The District should include an explanation for this change in the SOx inventory in Appendix B.

RESPONSE: The changes to the SOx inventory for 2014 can be largely attributed to new stationary and area source control measures adopted by the District since 2008. Recent amendments to rules such as Rule 4354 (Glass Melting Furnaces) and Rule 4306/4320 (Boilers, Steam Generators, and Process Heaters Greater than 5.0 MMBtu/hr) have and will continue to foster significant SOx emissions reductions since new compliance dates will come into effect through 2014. In addition, the District and ARB have thoroughly reviewed the refine point source inventory and growth factors for SOx to ensure the accuracy of the SOx inventory.

92. **COMMENT:** For Rule 4692, EPA supports the District's plan to regulate under-fired charbroilers. EPA recognizes that the District allocates considerable funding to install and demonstrate retrofit controls at existing facilities and encourages the District to consider supporting the SCAQMD's current under-fired charbroiler demonstration project.

RESPONSE: The District appreciates EPA's recognition of efforts to develop new technology for under-fired charbroilers. The District will continue to support this effort, including exploring additional opportunities to collaborate with SCAQMD.

93. **COMMENT:** For Rule 4901, EPA supports the District's plans to lower the curtailment level. The District should consider revised wood burning device requirements including prohibiting the sale or installation of any uncontrolled, traditional fireplaces in new or existing developments, and requiring stronger standards for allowed wood-burning devices.

RESPONSE: During the rule amendment process, the District will consider all feasible options for strengthening Rule 4901. Additionally, the District commits to analyzing the feasibility of allowing the use of the cleanest EPA certified wood-burning devices during the next rule-amending process (See Appendix D and Chapters 5 and 10). The District will also continue to follow the ongoing process regarding potential amendments to the federal New Source Performance Standards (NSPS) for wood burning devices.

94. **COMMENT:** EPA supports the development of Rule 9610 and looks forward to collaborating with the District and stakeholders during the rule development process to ensure that reductions credited to incentive programs are real, quantifiable, enforceable and surplus.

RESPONSE: The District looks forward to continuing collaboration with EPA during the development of Rule 9610.

95. **COMMENT:** ARB's preliminary sensitivity modeling results presented at recent public meetings show that reductions in ammonia emissions were comparable to the reduction needed in 2019 at the Bakersfield-California Avenue for attainment. ARB and the District should analyze whether there are feasible ammonia controls that could deliver the comparable emission reductions.

RESPONSE: Chapter 4 has been revised to more clearly quantify the potential benefit of ammonia emissions reductions. As outlined in this plan, the District and ARB are proposing a control strategy that achieves the emissions necessary for attainment of the standard. The modeling sensitivity analysis conducted for this plan shows, reductions in ammonia emissions achieve insignificant reductions in the 2019 PM2.5 design values. One ton of reduced ammonia emissions would reduce the Bakersfield-California PM2.5 design value by just 0.008 $\mu g/m^3$. There are no feasible measures that would achieve this level of ammonia emissions reductions, and NOx emissions reductions are much more effective in reducing PM2.5 concentrations (see Chapter 5).

The Valley's largest source of ammonia emissions are dairies, which are already regulated under Rule 4570 (Confined Animal Facilities). District Rule 4570 has already reduced 100 tons per day of ammonia emissions in the Valley (see Chapter 5) and the District continues to review ongoing research of ammonia controls on dairies and other confined animal facilities. For example, the District has reviewed South Coast Air Quality Management District's potential measure of episodic application of sodium bisulfate (SBS) onto manure at dairies to reduce ammonia emissions, which, as discussed in Chapter 5, would not be cost-effective or feasible for the Valley, and may have detrimental unintended consequences.

See Chapters 4 and 5 for additional discussions regarding the efficacy and feasibility of ammonia controls in the Valley. Despite ammonia's relative insignificance as a precursor, the District has committed to further study ammonia emissions at confined animal facilities, potential ammonia controls for these facilities, and the effectiveness of these controls in reducing the Valley's PM2.5 concentrations (see Chapter 5).

96. **COMMENT:** For Rule 4702, the District should update the language that states the District's limits are as stringent as SCAQMD. SCAQMD Rule 1110.2 limits NOx from all engines to 11 ppm while the District's limits range from 11-150 ppm.

RESPONSE: The District has clarified the language in the Rule 4702 discussion in Appendix D. SCAQMD Rule 1110.2 specifies a NOx limit of 11 ppmv for landfill gas or digester gas fired engines effective July 1, 2012, based on a provision to complete a technology assessment by July 2010; this limit will only be implemented if the result of the technology assessment confirms that 11 ppmv is achievable for these engines. District staff has confirmed that the technology assessment completion has been pushed back to 2012. Until such time that SCAQMD's technology assessment confirms that it is technologically and economically feasible to achieve 11 ppmv, it would not be appropriate to consider this level of control (see Appendix D for the complete discussion).

97. **COMMENT:** For Rule 4702, the District's RACM analysis should evaluate if an 11 ppm NOx limit is feasible for all engines in Valley and whether additional emissions reductions are available by eliminating rule exemptions. The analysis should also quantify all existing engines and their contribution to the inventory.

RESPONSE: As discussed in the response to Comment 96, it has not yet been determined if an 11 ppmv NOx limit is feasible for non-agricultural waste gas fueled rich-burn engines. Additionally, the District's analysis determined that an 11 ppmv NOx emissions limit is not technologically or economically feasible for agricultural spark-ignited engines. Refer to the control measure discussion for Rule 4702 in Appendix D for the complete analysis of the current NOx emissions limits in Rule 4702, which also includes the District's evaluation of potential opportunities by amending rule exemptions.

Emissions from stationary source IC engines have been reduced significantly over the past several decades, and will be reduced by 71% from the baseline year of 2007, at 20.18 tons of NOx, to 5.8 tons of NOx per day in 2019. The quantification of the contributions to the emission inventory is summarized in the emission inventory table in the Rule 4702 control measure evaluation in Appendix D and presented in greater detail in Appendix B (Emission Inventory).

98. **COMMENT:** Page D-51 states, "Current Rule 4702 (requires) combustion of PUC-quality natural gas, or other equivalent ultra-low sulfur fuels." Clarify where this requirement is in Rule 4702.

RESPONSE: This requirement is in section 5.7 *"Sulfur Oxides (SOx) Emission Control Requirements"* of Rule 4702.

99. **COMMENT:** The District should clarify that while the compliance dates for agricultural operations engines range from 2009-2018, the compliance date for spark-ignited engines was 2009.

RESPONSE: In Rule 4702, the compliance dates for agricultural operations spark-ignited engines were set at January 1, 2009 or if owner has an agreement to electrify, January 1, 2010. The control measure discussion for Rule 4702 has been updated in Appendix D.

100. **COMMENT:** For Rule 4103, explain how the District arrived at the 3,500 acre feasibility threshold for citrus orchard removals, and why analyzing individual burns is required for all nut farmers wishing to burn more than 20 acres, but not for citrus farmers of similar size.

RESPONSE: The District evaluated the feasibility and cost effectiveness of alternatives to burning in the *2010 Final Staff Report and Recommendations for Agricultural Burning* (*2010 Report*). The District determined, and ARB concurred, that there were no economically feasible alternatives to open burning of certain crop categories as outlined in the 2010 Report; this conclusion was reaffirmed in the *2012 Update: Recommendations on Agricultural Burning* (*2012 Report*). Refer to Appendix D for the complete discussion regarding citrus orchard removal burning.

101. **COMMENT:** SCAQMD's September 2012 draft AQMP seeks to reduce emissions from start-up, shut-down and turnaround. The District should include a commitment in the plan to investigate start-up, shut-down, and turnaround emission reduction opportunities in the Valley.

RESPONSE: The SCAQMD AQMP commits to a technical assessment of potential opportunities for improved start-up, shut-down and turnaround procedures in 2013.

If their research determines that there are feasible emissions reduction opportunities, they will commit to regulatory action(s) at some point in the future. SCAQMD has not yet identified any viable opportunities for improved practices for any specific stationary sources with regards to start-up, shut-down, and turnaround. The District will closely follow the progress of their technical assessment, and if SCAQMD identifies any potential emission reduction opportunities, the District will assess these opportunities to determine if they are feasible for Valley sources and evaluate the possibility of potential rule amendments.

102. **COMMENT:** The District should add specific deadlines for commitments in the plan to perform additional analyses, including those listed in Chapter 5 and Chapter 9.

RESPONSE: Chapters 5 and 10 of the plan have been updated with completion dates for the further study measures.

103. **COMMENT:** In the Risk-based Strategy discussion, the plan cites EPA guidance referring to methods local air quality plans can use to maximize health benefits and minimize risk inequality. The plan should discuss the methodologies that the District intends to use.

RESPONSE: The District's Risk-based Strategy (RBS) approach maximizes public health benefits within the Valley's efforts to attain federal standards. To qualitatively evaluate the potential risk reduction benefits from various sources, the plan employs a scientifically based five-factor exposure assessment methodology that draws on the latest scientific understanding about health risk from PM2.5 exposure. The five factors evaluated under the RBS methodology include: relevance to attainment, toxicity of chemical species, particle size and deposition, proximity to PM0.1, and population intake fraction. For additional information on the five-factor assessment methodology, refer to Chapter 2.

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WRITTEN COMMENTS, OCTOBER 9, 2012 WORKSHOP

STAKEHOLDER COMMENTS:

14 comment letters were received following the third public workshop on October 9, 2012.

8TM, Fresno (8TM)
Association of Irritated Residents (AIR)
City of Shafter (Shafter)
Clean Energy (CE)
Clum, Carole A. (Clum)
Forgnone, Penny P. (Forgnone)
Hearth, Patio, and Barbeque Association Pacific (HPBAP)
Meloni, Chanda (Meloni)
Mountain Comforts (MC)
Schlenker, Andy (Schlenker)
Spa Doctor Spa and Stove Center (SDSSC)
Treat, Erica (Treat)
Verrinder, Joel (Verrinder)
Zapien, Sarafin (Zapien)

104. **COMMENT:** When the District amends Rule 4901, it should consider allowing use of pellet stoves and/or EPA certified wood stoves at some curtailment levels to incentivize the use of cleaner wood burning technologies. Many homeowners have invested in these clean burning devices, so consideration should be given to those who have made this investment. (8TM, HPBAP, MC, Schlenker, SDSSC, Zapien)

RESPONSE: The District commits to analyze the feasibility of allowing the use of clean certified wood-burning devices at some curtailment levels during the next rule-amending process. Enforcing this added flexibility would be difficult given the challenge in distinguishing wood smoke emissions from various wood burning devices, and the District would explore various options during the rule development process for ensuring that this issue is addressed. The District values the cleaner burning technology that has been developed in recent years, as demonstrated by the implementation of the District's *Burn Cleaner Program*, which was implemented to help Valley residents upgrade their current wood-burning devices and open fireplaces to natural gas or propane devices, or clean pellet devices to alleviate the problem of particulates.

105. **COMMENT:** The District should not increase the number of no-burn days. Firewood is an inexpensive heating source and further limiting its use will create more of an economic burden on Valley families, especially in these current tough economic times. (Forgnone, MC, Meloni, Schlenker, Treat, Verrinder)

RESPONSE: As discussed in Chapter 4, achieving additional emissions reductions from residential wood combustion is critical for the Valley to reach attainment of EPA's 2006 PM2.5 standard. Furthermore, as discussed in Chapter 2 and Appendix D, reducing emissions from residential wood combustion achieves significant health benefits. During the public rule-amendment process for Rule 4901, the District will evaluate the economic impacts of reducing the wood burning curtailment level for Valley residents.

106. **COMMENT:** The District should extend the wood burning curtailment season to include March, April, and October. There have been days in all three months that the Valley has exceeded the 30 µg/m^3 wood burning curtailment threshold and if the threshold is lowered to 15 or 20 µg/m^3 there will be even more exceedance days in these months. (8TM)

RESPONSE: See response to comment 76.

107. **COMMENT:** Is the District considering any restrictions on the sale or use of charcoal briquettes for barbeques? (Zapien)

RESPONSE: The District is not considering the implementation restrictions on residential barbeques at this time. These devices are used more frequently in the summer months, whereas winter emissions reductions are most critical for attainment of the 2006 PM2.5 standard.

108. **COMMENT:** Since the District has to meet a yearly average PM2.5 standard of 15 µg/m3, residential wood burning should not be allowed on any day throughout the year that is predicted to exceed a 15 µg/m^3 daily average. The District should also adopt a contingency measure to automatically lower the wood burning curtailment threshold to 12 µg/m^3, or whatever more healthful standard EPA may adopt. (8TM)

RESPONSE: The 15 µg/m^3 is an annual standard, not a 24-hour standard, so the form of this standard allows for days and quarters above 15 µg/m^3. Compliance with this annual standard is determined by first averaging the daily values of each calendar quarter, then averaging those four quarters.

The residential wood-burning curtailment program targets specific episodic days when PM2.5 levels in the air quality are elevated, in order to curtail residential wood burning activity to prevent impacts to public health and exceeding the 24-hour PM2.5 NAAQS. However, by lowering winter PM2.5 concentrations, this program significantly contributes to the Valley's progress towards the annual standard. The District's *2008 PM2.5 Plan* outlines the control strategy for attaining the annual standard of 15 µg/m^3, with a projected attainment date of 2015.

109. COMMENT: The District should prioritize the mitigation of emissions from sources based on the seasonality of emissions, location of emissions, and likelihood to occur on days with high PM2.5 concentrations. (Clum)

RESPONSE: These factors are all considered, as these all relate to the Valley's progress towards attainment. In addition, as described in Chapter 2 of this plan, the District uses a five-factor exposure assessment methodology to evaluate the PM2.5 attainment strategy under the Risk-based Strategy: relevance to attainment; toxicity of chemical species; particle size and deposition; proximity to PM 0.1; and population intake fraction.

110. COMMENT: Residential fuel combustion and managed burning needs to be effectively mitigated. The District should ban greenwaste burning in the Valley and ban woodstoves and fireplaces in all new developments. (Clum)

RESPONSE: Agricultural burning is regulated by Rule 4103, the most stringent rule in the nation for agricultural burning and is evaluated every five years for effectiveness of rule requirements (see Appendix D). Under this rule, burning is only allowed on days and in amounts that do not cause violations of air quality standards. Residents are prohibited from burning any green waste. Section 5.3 of Rule 4901 already limits the installation of wood burning fireplaces and heaters in new residential developments; these requirements eliminate the installation of wood burning fireplaces in urban environments, and significantly limits the installation of wood burning heaters in urban environments (and limits these heaters to EPA-certified devices).

111. COMMENT: Residents in the foothills and mountains trim trees and brush that present a fire hazard to their homes or other buildings. The District should pay local chipping/shredding companies to dispose of these trimmed trees and plants rather than allowing these materials to be burned. (Clum)

RESPONSE: The District has committed to do a further study of the feasibility and potential opportunities for emissions reductions of a program similar to the one suggested. Refer to Chapters 5 and 10 for more details of this further study commitment.

112. COMMENT: The District should install air pollution monitors downwind of the Harris Ranch feedlot and near the mega dairies in Tulare County, monitor dairy emissions, and devise effective mitigations to these emissions. (Clum)

RESPONSE: Through partnership with other agencies and academic institutions, the District continues to study the nature and source of ammonia emissions in the San Joaquin Valley. However, as discussed in Appendix G, Chapter 4, and Chapter 5, in order to expedite attainment of the PM2.5 NAAQS, ammonia emissions would have to be reduced by an amount that is not feasible at this time. However, the District continues its pursuit of ammonia emission reductions, as evidenced by the commitment to continue to evaluate ammonia emissions at confined animal facilities (see Chapter 5).

113. **COMMENT:** The District should not assume that there will be no growth for the residential wood combustion category. New homes developed on five acres are allowed to have woodstoves, which allows for a potential increase of wood burning devices in rural areas, the foothills, and the mountains. (Clum)

RESPONSE: While new homes developed on five acres are allowed to have woodstoves, this allowance is limited by Section 5.3 of Rule 4901; also, there is a steady turnover of wood burning stoves in the Valley. If a Valley resident sells their home with a wood burning stove, the home cannot be sold unless the stove is removed or replaced with an EPA certified wood burning device. The turnover of older, higher-polluting wood burning stoves by either uninstalling or replacing the units with newer EPA certified devices will effectively offset the potential increase in emissions that could result from any new units in the rural areas of the Valley. See the control measure discussion for Rule 4901 in Appendix D for additional information regarding this source category.

114. **COMMENT:** EPA plans to lower the PM2.5 federal standard this year. Why isn't this plan focused on mitigating emissions to achieve the new, lower PM2.5 standard? (Clum)

RESPONSE: The proposed federal PM2.5 standards are still under review with EPA and a new limit has not been finalized for approval. An attainment plan for the new PM2.5 standard will most likely be due to EPA in late 2017 or early 2018. That said, emissions reduced as a result of this plan will continue to reduce emissions in the Valley and will contribute to attainment of the new federal PM2.5 standard.

115. **COMMENT:** The plan should identify each adopted federal and state regulation that is contributing to PM2.5 improvement in the Valley and explain the degree to which each regulation is improving PM2.5 levels. Chapter 5 of the plan identifies several ARB regulations, but does not elaborate upon the effectiveness of each state regulation and it does not identify any federal regulations. (Shafter)

RESPONSE: See response to comment 52.

116. **COMMENT:** Page C-1 states that land use decisions are under the jurisdiction of the eight counties and their MPOs, but the cities and eight counties have this authority. (Shafter)

RESPONSE: Appendix C has been updated with the appropriate language.

117. COMMENT: In reference to the District's *Risk-based Strategy*, how is ammonium nitrate less harmful to public health than other forms of PM2.5? Also, are the ammonium nitrate levels in Kern County related to the preterm birth rate in Kern County? (AIR)

RESPONSE: Despite the substantial mass contribution of ammonium nitrate to regional PM2.5, the oral toxicity of nitrate is very low, with an LD50 (dose causing death for 50% of the exposed subjects) reported to be two thirds that of table salt. In reference to the relationship between ammonium nitrate and preterm births, epidemiological studies have emphasized the need to further study the links between pre-term birth and exposure to varying pollutants. See Chapter 2 for a discussion of ammonium nitrate and its potential health effects.

118. COMMENT: Does size of the particulate or the chemical makeup of the particulate determine the extent of the potential damage to one's health? (AIR)

RESPONSE: The toxicity of the chemical species and particle size both play a role in the relative health risks of various particulates. See Chapter 2 for the full discussions on the toxicity of various chemical species and risks of particulates based on particle size and deposition.

119. COMMENT: What does ammonia in the atmosphere do from the time it is emitted to when it mixes with NOx? Does the ammonia from dairies in Fresno County travel to Kern County? What is the accepted emission rate per milk cow for ammonia? (AIR)

RESPONSE: During PM2.5 episodes, high concentrations of ammonium nitrate can occur over large regions, including both urban and rural areas. Ammonia is mostly concentrated in rural areas, particularly between Fresno and Bakersfield. The regional ammonium nitrate component can be traced back to the emission sources and subsequent formation and transport processes. Gaseous precursors of ammonium nitrate (NOx and ammonia) are transported much more efficiently than directly emitted organic matter particles. Although some of the emitted NOx forms ammonium nitrate in urban areas, it is also transported to downwind regions where it reacts with ammonia to form particulate ammonium nitrate in the rural areas. While transport does occur, the distances are still limited, with transport distances of 50 to 60 kilometers in the central and southern Valley. Ying et.al. (2009) found for example that most of the PM2.5 nitrate in Bakersfield is produced from sources within the southern Valley.

Since the chemistry of NOx to nitric acid formation involves multiple steps and also depends on the availability of oxidants, only a portion of the NOx emitted ultimately forms ammonium nitrate. Photochemical modeling studies indicated that the fraction of NOx converted varied by location, with urban regions converting little NOx to ammonium nitrate, while in remote areas up to 70 percent NOx was converted. Additional information on the formation of ammonium nitrate can be found in Appendix G (PM2.5 Weight of Evidence Analysis) of the plan.

The current emission factor for ammonia from milk cows is 74 lbs/head-year.

120. **COMMENT:** What is the relative abundance, in tons, of ammonia emissions versus NOx emissions in Kern County? Would reductions in ammonia emissions in Kern County reduce PM2.5 levels? (AIR)

RESPONSE: For Kern County, the 2012 winter average NOx emissions are 71.55 tpd and ammonia emissions are 44.4 tpd. The District has explored the effectiveness of ammonia as a precursor to PM2.5 formation, and has found ammonia to not be a significant precursor.

121. **COMMENT:** Does the chart on page 4-11 of Chapter 4 indicate that all NOx molecules react with ammonia molecules? How many tons of ammonium nitrate reductions result from one ton of NOx reduction? (AIR)

RESPONSE: The chart is a simplified representation of the ammonia surplus. Not all NOx molecules react with ammonia molecules. Only a portion of NOx emissions from motor vehicles and stationary combustion sources react through photochemical processes during the day, or react with ozone at night, to form nitric acid. When ammonia emissions react with the nitric acid, ammonium nitrate is created. CRPAQS observational data indicates that reductions in nitrate concentrations of 30% to 50% were realized through a 50% reduction in NOx. See Chapter 4 for additional information on the formation of ammonium nitrate.

122. **COMMENT:** Present evidence that the current dairy rule is already reducing ammonia emissions by 100 tpd. (AIR)

RESPONSE: The District analyzed emissions reductions achieved through implementation of Rule 4570 during development of the rule. Rule 4570 reduces VOC and ammonia emissions through a range of manure management measures (in addition to silage and other measures). Since ammonia emissions on dairies originates from manure, measures that more quickly and effectively handle and treat manure are effective in reducing ammonia emissions (as well as VOCs).

123. **COMMENT:** Reducing off-street parking and controlling curb parking will reduce pollution. The District should consider charging fees for off-street and curb parking and for the construction of parking spaces as Transportation Control Measures in the plan. Also, in some European countries there are rules requiring the shutting off of engines at stoplights and anywhere else if the idling will be longer than 15 seconds, this might be advisable for the Valley. (AIR)

RESPONSE: The District looks forward to receiving scientific research, analysis, and data to confirm the commenter's statements that parking in a parking lot reduces emissions from parking on the street. Also, District staff were unable to confirm which European countries have laws requiring cars to be shut off. The commenter's suggestions related to parking and shutting off vehicle engines are beyond the District's regulatory authority, since it pertains to land use, and a requirement to shut off engines would likely be impossible to enforce.

124. COMMENT: The District should consider eliminating all agricultural burning except for disease control in certain rice field situations, tumbleweeds on private property, and carefully controlled burning of small quantities of dead trees or attrition in orchards. Exemptions for grape and citrus removal should be totally removed. (AIR)

RESPONSE: As evaluated in the *2010 Final Staff Report and Recommendations for Agricultural Burning* (2010 Report) and *2012 Update: Recommendations on Agricultural Burning* (2012 Report), certain categories of agricultural materials do not have economically feasible alternatives to open burning practices. Any burning allowed for these categories is strictly limited and evaluated under the District's Smoke Management System, which restricts burning under conditions that would cause a violation of air quality standards. The District reevaluates these categories every five years, with the next evaluation projected to occur in 2015. Refer to the 2010 Report for additional analyses of this rule: http://valleyair.org/Board_meetings/GB/agenda_minutes/Agenda/2010/October/Agenda_Item_7_Oct_21_2010.pdf.

125. COMMENT: All charbroilers should have to reduce 90% of particulate emissions or shut off the charbroilers on no-burn days. (AIR)

RESPONSE: During the public rule-amending process for Rule 4692, the District will evaluate potential opportunities for feasible and cost-effective methods for reducing emissions from these sources.

126. COMMENT: Discuss why the indirect source review (ISR) rule should not apply to facilities in the Valley that burn or compost biomass which has to travel more than 50 miles from collection points to processing facilities in the Valley. This is a huge source of pollution that is not covered by any rule. There should be no exception to the rule for permitted sources because these sources do not consider their transportation related emissions in their totals. (AIR)

RESPONSE: The Indirect Source Review (ISR) rule was developed to address indirect emissions from new development projects. Stationary source projects are exempted from ISR requirements because stationary source equipment are subject to District permit and in particular to the District New Source Review (Rule 2201). When exceeding specific thresholds identified under Rule 2201, stationary source equipment are required to meet Best Available Control Technology and the facility may be required to provide offsets. In addition, under the California Environmental Quality Act (CEQA) process, emission impacts resulting from mobile sources are evaluated by the lead agency (such as a land use agency) when approving the project, and mitigation could be required to reduce mobile sources associated impacts.

127. COMMENT: Flares should be strictly limited and there should be a fine for emergency flares used on no-burn days. (AIR)

RESPONSE: Flaring activities in the Valley are regulated by District Rule 4311, which is one of the most stringent rules in the nation for flares. Rule 4311 has a strict definition of what qualifies as an emergency flaring event; any flare event that an operator determines is an emergency flare event must be recorded and reported to the District for evaluation. If the District determines that the flare event does not qualify as an emergency flaring event then the operator will be issued a notice of violation. That said, the District has committed to do a further study of flaring in the Valley for potential opportunities for additional emissions reductions. The proposed commitment for the study completion date is 2013.

128. COMMENT: At the August 2012 Governing Board meeting, it was stated that the COGs may need to use some "creative accounting" in their transportation proposals in the future. What is meant by "creative accounting" in the context of the plan? (AIR)

RESPONSE: This comment is presented out of context. The discussion centered on using the most and up-to-date methods for forecasting emissions given their critical role in meeting both attainment and transportation needs.

129. COMMENT: It has been stated that 55% of truck traffic is passing through the Valley without stopping anywhere to do business with the intent of saying truck pollution is significant and the District can do nothing about it. A recent study done by the COGs states that the vast majority of tonnage moved by trucks within the valley is either intraregional, or one-way to or from points in the Valley.(AIR)

RESPONSE: The referenced study from the comment is referring to tonnage of material transported, not mileage traveled. Regardless of miles traveled, the primary regulatory authority over mobile sources lies with the ARB and EPA.

130. COMMENT: The PM2.5 Plan could greatly benefit from including a more informed discussion of natural gas (NG) as a transportation fuel in compressed, liquefied, and renewable forms. It is a missed opportunity that natural gas was absent from the mobile sources sections of the plan. Natural gas delivers similar compelling emissions benefits for mobile sources as it does for stationary sources. Additionally, natural gas is a cost effective strategy, every truck manufacturer is now in the business of natural gas vehicle (NGV) trucks due to demand, light duty NGV trucks are coming to the market, and the NG infrastructure is flourishing nationwide. (CE)

RESPONSE: The District has primarily targeted mobile sources through its incentive programs, and has maintained those programs as technology neutral. Incentive programs have included a wide array of natural gas projects including buses, package delivery vehicles, municipal vehicles such as refuse trucks and street sweepers, agricultural pumping engines, and passenger vehicles. The District will continue to maintain the technology neutral nature of the incentive programs where possible, ensuring there is opportunity for all potential solutions to be considered. Natural gas, as a cost effective solution, will likely have a continued role as an important option for emissions reductions through incentive programs.

131. COMMENT: CE supports the implementation of a refuse vehicle replacement program; CE recommends that natural gas refuse trucks be a key replacement of diesel refuse trucks and believes incentive funding would accelerate the conversion rate of Valley trucks to NG. (CE)

RESPONSE: See response to comment 130.

132. COMMENT: While funding is necessary to spur the growth of zero-emission vehicles, it is critical for the District to continue to support all promising alternative fuel strategies, such as natural gas, to ensure that the Valley has a diversified portfolio that is capable of achieving the region's air quality goals. Battery electric and hydrogen fuel cell technologies have many hurdles to overcome become becoming practical so other strategies should be considered. (CE)

RESPONSE: The District's Technology Advancement Program has at its core a set of three technology focus areas, including mobile sources. As identified in Chapter 7, the mobile source technology focus area includes zero- or near-zero emissions solutions and clean alternative fuels. It is expected that natural gas will play an important role in the future of near-zero emissions technology development, and be a significant contribution to a solution to the Valley's goods and people movement emissions.

SUMMARY OF SIGNIFICANT COMMENTS FOR THE JUNE 2012 DRAFT PM2.5 PLAN

VERBAL COMMENTS, JUNE 27, 2012 WORKSHOP

Approximately 15 people (non-District, non-ARB) in attendance (13 Fresno, 2 Bakersfield, 0 Modesto)

California Cotton Ginners and Growers Association (CCGGA)
California Dairy Campaign (CDC)
Central Valley Air Quality Coalition (CVAQ)
City of Fresno (COF)
Dennis Fox (Fox)

133. **COMMENT:** The timeline for this PM2.5 Plan seems aggressive. The plan documents were posted last Friday, leaving very little time for a thorough review. (CCGGA, CDC)

RESPONSE: Public feedback on the *2012 PM2.5 Plan* will be accepted and evaluated until the public hearing for adoption of the plan in December. Interested persons may attend and provide feedback during the District's October public workshop and other meetings, and may also provide written feedback at any time during the development of the plan. Additionally, the District may be contacted directly at any time by phone at 559-230-5800, or by email at pmplans@valleyair.org.

134. **COMMENT:** The plan should be revised to include mention of the incentives programs for unpaved roads and chipping efforts, as well as provide a full account of all the agricultural engine and pump replacements. (CCGGA)

RESPONSE: Appendix C and Appendix D have been updated as appropriate to incorporate information about the unpaved roads, chipping efforts, and agricultural engine and pump replacements.

135. **COMMENT:** There are some discrepancies with the United States Department of Agriculture National Resources Conservation Service (NRCS) funding values given in the Incentives chapter that need to be corrected. (CCGGA)

RESPONSE: The funding value discrepancies in the Incentives chapter have been reviewed and discussed with NRCS, and Appendix C and Appendix D have been updated accordingly.

136. **COMMENT:** The District should provide a reference for the stated 99.9% PM2.5 control efficiency of PTFE bags in the almond hulling control measure discussion. (CCGGA)

RESPONSE: Appendix D has been updated to include a reference for the 99.9% PM2.5 control efficiency in the almond hulling discussion.

137. **COMMENT:** The District should account for the permit condition requiring almond and pistachio hullers to have replacement bags accounting for 10% of the total number of bags in the respective control measure cost effectiveness estimates. (CCGGA)

RESPONSE: The permit conditions have been reviewed and the extra 10% of bags has been included in the cost effectiveness estimates. Refer to Appendix D for the updated cost effectiveness analysis.

138. **COMMENT:** The emissions inventory should be corrected by the next draft of the plan. Agricultural emissions are shown to be increasing and the opposite is true in the Valley, as the Farmland Mapping and Monitoring Plan (FMMP) data shows. (CCGGA)

RESPONSE: The draft PM2.5 emission estimates has been reviewed by ARB staff, and has been updated to reflect the latest California Department of Conservation's Farmland Mapping and Monitoring Program (FMMP) data.

139. **COMMENT:** In reference to the PM2.5 trends slide, what caused the spikes in emissions in 2007 and 2008? (COF)

RESPONSE: The San Joaquin Valley experienced extremely stagnant conditions in 2007 and 2008. The winters were filled with severe fog and the summers were much dryer and hotter than usual which concentrated and kept the PM pollution in the Valley. There were also extensive wildfires in 2008, further worsening the air quality in the Valley.

140. **COMMENT:** How does the District monitor or regulate emissions from off-road recreational vehicles? There is a motorcycle track in Taft that is concerning because of the resulting dust emissions. (Fox)

RESPONSE: The California Air Resources Board (ARB) has regulations in place for emissions from off-road recreational vehicles. ARB's State Strategy, adopted in 2007 and revised in 2011, included commitments to revisit emissions standards for the *Other Off-Road Sources* category. One of the three commitments is for expanded emissions standards for Off-Road Recreational Vehicles, which entails adopting exhaust and evaporative emission standards to reduce VOCs from off-highway motorcycles and all-terrain vehicles. However, this is only applicable to the emissions from the engines. ARB plans to address these commitments in 2013 or 2014.

In terms of the District's role for this sort of project, this type of site would be subject to a California Environmental Quality Act (CEQA) review if creating this track is a new use and requires approval by the city or county. This would help mitigate any potential emissions or other environmental hazards resultant from the track. In addition, if the site is equal to or greater than 20,000 square feet, the construction and operational aspects of the project would be subject to District Rule 9510 (Indirect Source Review).

141. **COMMENT:** The District should include diagrams of background levels of PM emissions in the plan. (CDC)

RESPONSE: Naturally occurring background PM2.5 concentrations in the San Joaquin Valley cannot be monitored as a separate value from the rest of the mass, and therefore it would not be possible to display a trend of measured background concentrations over time. Scientific research continues to explore this topic, and any value that is proposed from such research would be theoretical. Understanding and identifying the background PM2.5 in the Valley will continue to be a topic of importance in the future.

142. **COMMENT:** The modeling numbers do not reflect daytime and nighttime variations, as well as seasonal variations, and they should reflect both. (CDC)

RESPONSE: ARB currently provides emissions inventory modeling support for the District. At this point, ARB does not have the capability to calculate separate emissions inventories to reflect daytime and nighttime variations so the annual and wintertime emissions inventories for each source category have been included. While summertime emissions have adverse health impacts, reducing these emissions will not accelerate attainment because PM2.5 exceedances in the Valley occur during winter months. Therefore, summertime inventories have not been included in this plan.

143. **COMMENT:** On slide 16 of the ARB modeling presentation, what does ARB mean by saying the nearest monitors have the greatest impact? Are we at risk of only focusing on emissions close to monitors rather than ambient emissions in the whole Valley? (CVAQ)

RESPONSE: Emissions near monitors have a tremendous impact on the Valley's control strategies because they provide a snapshot of the trends occurring throughout the entire Valley. This does not mean that only emissions around air quality monitors will be focused on. Rather, control strategies that are regionally based and target emissions reductions throughout the entire Valley will continue to be implemented. Control strategies will also continue to be evaluated through the District's Risk-based Strategy, maximizing strategies that prioritize public health.

144. COMMENT: On slide 17 of the ARB presentation, which monitoring site is not expected to reach attainment by 2019? (CVAQ)

RESPONSE: The site referenced on slide 17 is the Bakersfield-California Avenue monitoring site.

145. COMMENT: What is the new proposed federal PM2.5 standard? How far away is the Valley from meeting that standard in the future? (CVAQ)

RESPONSE: EPA recently proposed a new annual PM2.5 standard of 12-13 µg/m3. EPA accepted comments on the proposed standard until August 31, 2012. According to EPA data, the Valley is expected to be in compliance with the proposed new annual PM2.5 standard. However, the District will use due diligence in performing our own analysis to confirm compliance with the new standard at a later date. The current 24-hour standard of 35 µg/m3 has not been proposed to be amended.

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WRITTEN COMMENTS, JUNE 27, 2012 WORKSHOP

EPA REGION IX STAFF COMMENTS:

146. COMMENT: The plan should identify the specific measures that are providing the identified baseline reductions and the emissions reductions associated with each measure, including compliance dates during the period that the plan covers.

RESPONSE: Measures that provide baseline reductions are summarized in Chapter 4 and Chapter 9 with a complete discussion in Appendix D.

147. COMMENT: The plan should include a discussion of the population growth factors including information on their values, the sources from which they are derived and the source categories they are used to project.

RESPONSE: The discussion of population growth factors is included in Appendix B.

148. COMMENT: As part of the RACM demonstration, the Plan should include a list of the potential measures considered by the State, District, and the SJV MPOs and analysis sufficient to show that all RACM, including reasonably available control technologies (RACT), have been adopted and are being implemented expeditiously. As part of this analysis, the plan should estimate the additional emission reductions needed to advance attainment by one year and should include a table similar to Table 9-1 from SJV's 2008 PM2.5 Plan with information on the added reductions needed for attainment in each year beyond those already anticipated from the adopted control strategy.

RESPONSE: This analysis has been incorporated into Chapter 9 of the October 2012 draft *2012 PM2.5 Plan*.

149. COMMENT: In addition to calculating the amount of additional emissions needed to advance attainment by a year under mainly NOx-focused controls, the Plan's air quality modeling should evaluate the additional emission reductions that would be necessary if additional reductions in VOC and ammonia emissions were considered as well.

RESPONSE: The modeling and related precursor sensitivity analysis conducted for this plan evaluates emissions of directly emitted PM2.5, NOx, SOx, ammonia, and VOCs. This analysis shows that directly emitted PM2.5, NOx, and SOx reductions contribute to improvements in PM2.5 concentrations, whereas reductions in VOC and ammonia were not significant for attaining the 24-hour federal PM2.5 standard. That said, VOC and ammonia emissions have been reduced through District regulations adopted under the District's ozone plans.

150. COMMENT: If the Plan will include provisions that rely on trading between PM2.5 and its precursors to meet CAA requirements or if the District intends to allow interpollutant trading for offsets in its New Source Review (NSR) program, the Plan should document the methods used to derive equivalency ratios and explain why the methods are reasonable. The methods should be based on the photochemical modeling used in the attainment demonstration and should account for the variability of pollutant and precursor relationships across the air basin.

RESPONSE: This analysis is in progress and will be included as an appendix to the final draft *2012 PM2.5 Plan*.

151. COMMENT: For Rule 4307, the District should consider adding PM2.5 limits to the rule in addition to existing SOx limits for non-PUC quality natural gas boilers (e.g., liquid fuel fired boilers). Also, provide a more detailed cost-effectiveness analysis (or citation to analysis) for technologies discussed and more detailed information to clarify the relative size of emission inventories associated with Rules 4307, 4308 and 4320.

RESPONSE: The possibility of adding PM2.5 limits to the rule for liquid-fired units was evaluated and it was determined that the PM2.5 control technologies available were either technologically infeasible or not cost effective, given the small emissions inventory for liquid-fired units. The previously combined emissions inventory for Rules 4307, 4308, and 4320 have been separated into three inventories. See Appendix D for the full technology evaluation and the individual inventories.

152. COMMENT: For Rule 4308, provide a more detailed cost-effectiveness analysis (or citation to analysis) for the potential opportunities identified.

RESPONSE: The possibility of reducing the instantaneous water heaters NOx limit from 55 ppm to 20 ppm was evaluated. The possibility of removing the mobile homes and recreational vehicles exemption was also evaluated; however, it was determined that these units do not fall under the size category of Rule 4308 and thus, did not require cost effectiveness analyses. See Appendix D for the full evaluation of these items.

153. COMMENT: For Rule 4320, the District should consider adding PM2.5 limits to the rule in addition to SOx limits for liquid fuel-fired boilers.

RESPONSE: The possibility of adding PM2.5 limits to the rule for liquid-fired units was evaluated and it was determined that the PM2.5 control technologies available are either technologically infeasible or not cost effective, given the small emissions inventory for liquid-fired units. See Appendix D for the full technology evaluation.

154. COMMENT: For Rule 4702, the District should consider adding PM2.5 limits to the rule in addition to SOx limits and analyze whether it is reasonable to require agricultural IC engines to comply with the same limits required of non-agricultural IC engines.

RESPONSE: District staff considered EPA's recommendations, which are addressed in Appendix D.

155. COMMENT: For Rule 4703, 40 CFR 60 Subpart KKKK (Standards of Performance for Stationary Combustion Turbines) should be referenced. Additionally, the District should consider adding SO2 limits at least as stringent as the Subpart KKKK requirements.

RESPONSE: Rule 4703 was compared to 40 CFR 60 Subpart KKKK and it has been added it to the list of federal rules and regulations evaluated. The current SO2 limits in place for facilities subject to Rule 4703 are more stringent than Subpart KKKK's requirements due to California Diesel Fuel SO2 limits and District permitting SO2 limits. See Appendix D for the full evaluation.

156. COMMENT: For Rule 4703, the District should add a PM2.5 BACT cost-effectiveness analysis to provide context for the PM2.5 RACM analysis.

RESPONSE: PM2.5 reduction technologies for turbines were researched in an effort to conduct a PM2.5 technology cost effectiveness analysis; however, the technologies evaluated have not been achieved-in-practice for turbines and are not technologically feasible for certain units. See Appendix D for the full technology evaluation.

157. COMMENT: For Rule 4703, Page D-28 references "the potential control of...fuel treatment sulfur removal systems to reduce SOx emissions and foster additional PM2.5 reductions." It appears that at least one facility in the District is equipped with this system. However, it is unclear whether this facility is subject to District Rule 2201 and therefore was required to analyze PM2.5 BACT cost effectiveness. The District should include additional discussion of this facility to help evaluate whether this control is appropriate for PM2.5 RACM.

RESPONSE: Further clarification has been added in the SOx section of the emission reduction opportunities discussion explaining why this facility is equipped with a sulfur removal system. See Appendix D for the full discussion.

158. COMMENT: For Rule 4703, the District should provide more narrative regarding the status of its research regarding baghouses, scrubbers and electrostatic precipitators.

RESPONSE: The analysis for Rule 4703 has been updated and it includes a complete discussion of the aforementioned control technologies. See Appendix D for the full discussion.

159. COMMENT: For Rule 4311, the District should review the newly submitted annual flare reports to update the emissions inventory and analyze EPA's additional recommendations (from the TSD associated with the proposed approval of Rule 4311, at 76 FR 52623) to help reduce emissions.

RESPONSE: The deadline of submission for the newly submitted annual flare reports was July 31, 2012. The District commits to evaluating the submitted reports for potential emission reduction opportunities, and has included a commitment to further study this category in the future. See Appendix D for the full discussion.

160. COMMENT: For Rule 4311, the District should consider developing separate refinery and non-refinery flare rules.

RESPONSE: Bifurcation of the rule for refinery and non-refinery flares was considered; however, since both types of flares are currently regulated by Rule 4311 this would be an administrative change and would not foster additional emissions reductions. See Appendix D for the full discussion.

161. COMMENT: For Rule 4354, the District should consider lowering the existing SOx limits for container plants, which currently stand at 0.9 and 1.1 lbs of SOx/ton of glass depending on cullet content. District BACT for this category is 0.8 lbs/ton.

RESPONSE: District staff evaluated the potential opportunity to reduce the SOx emissions limit to 0.8 lbs/ton of glass produced and determined that this is not a technologically feasible option. See Appendix D for the full technology evaluation.

162. COMMENT: For Rule 4802, provide a more detailed cost-effectiveness analysis (or citation to analysis) of additional controls, including those required by BAAQMD Rule 9-1.

RESPONSE: The current sulfur emissions limit in Rule 4802 is equivalent to limits in other air districts. According to source tests conducted in 2010 and 2011, the one facility subject to Rule 4802 is already meeting the EPA BACT emissions limit for these units and is equipped with the best available control technology; therefore, amending the rule would not result in reduce emissions. See Appendix D for the full evaluation.

163. **COMMENT:** For Rule 4103, the District should ensure that the case-by-case analysis of citrus orchard removals described in the June 27, 2011 letter from Seyed Sadredin to Deborah Jordan is being implemented.

RESPONSE: The economic analysis performed in the 2010 Final Staff Report and Recommendations on Agricultural Burning demonstrated that the chipping and hauling of citrus orchard removal material to biomass plants was not an economically feasible alternative to open burning except in the case of very large growers (>3,500 acres). Since July 2011, the largest citrus farms have not been approved to burn citrus orchard removal material. To date, no large citrus farms have submitted applications to burn citrus removal material. Accordingly, no burn permits have been issued for citrus orchard removal material for the largest citrus farms in the Valley.

The District annually evaluates each crop category still allowed to bring and determines a cost threshold based on the economic feasibility of alternatives to burning. Even for those smaller farms without economically feasible alternatives only a small amount of citrus orchard material is actually being burned in the field. It is critical to note that the small amount of burning that did occur was authorized under the Smoke Management System on days where the amount burned would not cause or contribute to an exceedance of any air quality standard.

The economic feasibility of alternatives to burning was reevaluated in May 2012 in the 2012 Update: Recommendations on Agricultural Burning and determined that there has been no significant change to the economic feasibility of chipping and hauling removals since the 2010 Report. The District has committed to reevaluate the appropriate threshold for citrus growers annually.

164. **COMMENT:** For Rule 4106, Page D-48 suggests chipping and burn boxes through grant programs may be an alternative to burning for communities subject to fire hazard reduction burning. Placer County Air Pollution Control District conducted such a pilot program and estimated significant emission reductions.

RESPONSE: District staff reviewed the literature for the Placer County APCD pilot program and analyzed them for feasibility in the Valley. Refer to the Rule 4106 control measure for in the Stationary and Area Source Control Strategy Evaluation Appendix for this discussion. Staff have determined that there are too many variables to between the Valley and Placer County to commit to a program at this time. However, there is a recommendation for further study of this potential opportunity to determine its feasibility for the Valley. It is again important to note that any prescribed or hazard reduction burning is regulated through the District's Smoke Management System and only allowed on days where the amount burned would not cause or contribute to an exceedance of any air quality standard.

165. COMMENT: For Rule 4204, provide a more detailed cost-effectiveness analysis (or citation to analysis) for additional controls.

RESPONSE: Additional analysis has been included for potential emission reduction opportunities; however, all of the potential opportunities identified were either technologically infeasible or not cost effective. More detailed information has been provided for this source category in Appendix D.

166. COMMENT: For Rule 4550, provide a more detailed cost-effectiveness analysis (or citation to analysis) for additional controls. Also, analyze whether it is appropriate to allow selection of the Conservation Tillage CMP to have greater weight and to fulfill the requirement for CMP selection for multiple cropland categories.

RESPONSE: As discussed in the Stationary and Area Source Control Strategy Evaluation Appendix, the District has adopted the most stringent regulatory requirements in the nation for reducing particulate matter emissions (primarily PM10) from agricultural sources. PM2.5 emissions from these sources make up a minor fraction of 24-hour PM2.5 concentrations in the peak winter season, the geologic nature of these particulate matter emissions are of relative low toxicity. The District does not recommend any additional regulatory requirements under Rule 4550.

With regard to conservation tillage, Rule 4550 does allow and encourages the use of conservation tillage as one of multiple menu-based conservation practices that achieve emissions reductions. Given the inherent potential fuel and other cost-benefits associated with conservation tillage, the San Joaquin Valley has seen an increasing trend in agricultural operations utilizing that practice. Agricultural operations currently employing a broader set of conservation practices are also complying with the requirements of Rule 4550 and are achieving significant emission reductions from the implementation of those practices. The District would not anticipate any additional increase in the use of conservation tillage through the suggested approach as the selection of such practices by agricultural sources involve other critical factors such as economics, cultural practices, and soil type.

167. COMMENT: For Rule 4692, the District should consider adopting a requirement to record the date and time of cleaning and maintenance for the catalyst or other certified control device similar to SCAQMD Rule 1138 (d)(l)(B) to help ensure rule effectiveness.

RESPONSE: The recommendations for regulatory action in the plan identify emission reduction commitments and not amendments for specific rule language. While there will be no recommendation for recordkeeping requirements in the plan, it is one aspect of the rule that will be evaluated during the rule-amending project, and implemented if deemed appropriate at that time.

168. **COMMENT**: For Rule 4692, given the significant emissions from under-fired charbroilers, the District's PM2.5 Plan should include when the joint evaluation with SCAQMD on under-fired charbroilers controls is expected to be completed.

RESPONSE: The South Coast study for under-fired charbroilers is expected to be complete by the end of 2012. See Appendix D for more information regarding this study.

169. **COMMENT:** For Rule 4901, it is agreed that further strengthening of the District's existing successful wood burning device program should be considered.

RESPONSE: Comment noted. See Appendix D for the full emission reduction opportunities discussion and recommendations to further strengthen Rule 4901.

170. **COMMENT:** For Rule 4902, rule exemptions (e.g., for LPG or liquid fuels) should be evaluated to determine whether they are still appropriate.

RESPONSE: The possibility of extending the applicability of Rule 4902 to LPG-fired water heaters was evaluated. However, other California air districts also exempt LPG-fired water heaters from their rules. Refer to Appendix D for additional information.

171. **COMMENT**: For Rule 4902, Southern California Gas Company indicates development of low-NOx burners may achieve < 6ppm NOx for residential water heating. The District should investigate this research effort and include the research in Chapter 7, Technology Advancement, of the PM2.5 Plan as appropriate.

RESPONSE: The District appreciates the information provided by Southern California Gas Company and will continue to work with them during the development of this low-NOx technology. Any additional information on this technology will be included in Chapter 7 as information is provided to the District.

172. **COMMENT:** For Rule 8061, provide a more detailed cost-effectiveness analysis (or citation to analysis) of a lower trip threshold.

RESPONSE: This potential opportunity was evaluated and it was determined that lowering the threshold would not generate additional emissions reductions. The full analysis is included in Appendix D.

173. **COMMENT:** For SC 005, the District should evaluate whether warm mix asphalt is technically and economically feasible and appropriate for RACM. The review should include the potential of using warm mix asphalt on public and private roads/lands.

RESPONSE: Warm-mix asphalt was researched and it was found that while Caltrans uses warm-mix asphalt technologies for certain projects, use by local jurisdictions has not been well-received. See Appendix D for the full technology evaluation.

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ADDITIONAL STAKEHOLDER COMMENTS

Three comment letters were received during the public comment period following the second public workshop on June 27, 2012.

Dairy Cares (DC)
Kenneth Cannon (Cannon)
Ag Coalition[3] (AC)

174. COMMENT: The average daily ammonia emissions for the Farming Operations category as presented in "Appendix B: Draft Emissions Inventory" of the draft plan are not consistent with cited studies. DC's concern is that the dairy ammonia emissions are overestimated during the winter high-PM2.5 season. The District should share the dairy-specific ammonia emission inventory including both annual average and winter average day inventories and relevant diurnal/seasonal/monthly source profiles used in developing the inventory and used in attainment modeling. (DC)

RESPONSE: The updated draft inventory has incorporated controls from Rule 4570 (Confined Animal Facilities) and shows a decrease in ammonia emissions due to the implementation of Rule 4570. The District will continue to evaluate the latest research to further understand the seasonal and diurnal factors for ammonia emissions from agricultural operations.

175. COMMENT: The emissions reductions achieved through the replacement and control of engines used for irrigation pumping purposes, tractors, forklifts, harvesters and trucks through District incentive programs should be quantified and accounted for accurately in this plan. The discussion surrounding the development of the Memorandum of Understanding (MOU) between EPA, USDA, State and local Air Pollution Control Districts, including CARB and the SJVAPCD, must be highlighted. This MOU would provide a formal mechanism by which to quantify and account for these types of real emission reductions. (AC)

RESPONSE: The District concurs and appreciates the highlighting of this significant agreement. A Statement of Principles was developed in 2010 that established a general framework for ensuring that reductions in air emissions

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[3] The following groups are represented in the Ag Coalition (AC) comment letter: African American Farmers Association of California, Air Coalition Team, Allied Grape Growers, California Blueberry Association, California Citrus Mutual, California Cotton Ginners Association, California Cotton Growers Association, California Farm Bureau Federation, California Grape and Tree Fruit League, Fresno County Farm Bureau, Kings County Farm Bureau, Kern County Farm Bureau, Madera County Farm Bureau, Merced County Farm Bureau, Milk Producers Council of California, National Hmong American Farmers, Nisei Farmers League, Olive Growers Council, Raisin Bargaining Association, San Joaquin Farm Bureau Federation, San Joaquin Valley Association of Certified Air Permitting Professionals, Stanislaus County Farm Bureau, Tulare County Farm Bureau, Tulare Lake Drainage District, Tulare Lake Resource Conservation District, Tulare Lake Water Basin Storage District, Western Agricultural Processors Association, and Western Growers Association.

resulting from voluntary incentives to replace off-road agricultural equipment received credit in the SIP. The MOU states that the District, NRCS, ARB and EPA will work collaboratively to develop a mechanism to provide SIP credit for emissions from incentive programs that are surplus, quantifiable, enforceable, and permanent. Additionally, in July 2012, EPA and USDA agreed to specifically implement this concept to ensure that emissions reductions from incentive programs were given their proper credit in the SIP context. As explained in Chapter 6, the District will be seeking to adopt a rule that establishes the framework for this to occur.

176. **COMMENT:** The significant emission reductions created by the implementation of the USDA Natural Resources Conservation Service (NRCS) Environmental Quality Incentive Program (EQIP) and Conservation Innovation Grant Program (CIGb) should be quantified. The current information does not provide enough details and does not capture all of the emission reduction projects being funded by NRCS. (AC)

RESPONSE: The District has worked with NRCS to identify a fuller breadth of their programs, and has incorporated that information into the Mobile Source Control Strategies Appendix and the introduction to Combustion Devices in the Stationary and Area Source Control Strategy Evaluation Appendix. Refer to those appendices for more details. As described in the preceding comment, the District recognizes the importance of quantifying and providing credit for emissions reductions achieved under the NRCS and District incentive programs.

177. **COMMENT:** The agricultural industry remains seriously concerned with the purported increase in directly emitted PM2.5 emissions as set forth on page B-6. As stated previously, and acknowledged by both the Air District and the ARB, this is in direct conflict with a previously accepted annual acreage reduction in the San Joaquin Valley of 0.30 percent. (AC)

RESPONSE: The emission inventory has been updated. Refer to the response to Comment 138.

178. **COMMENT:** The District should provide a reference for the estimated 99.9% efficiency for the PTFE bags, in Section D.7.6 Almond Hulling and Shelling Operations, as well as D.7.7 Pistachio Hulling/Shelling Operations. (AC)

RESPONSE: The reference has been added to Appendix D. Refer to the response to Comment 136.

179. **COMMENT:** Current District policy requires that sources maintain an extra 10% bag supply on hand for hulling and shelling operations. Therefore, the District must increase its estimated bag cost for the cost analysis by 10%. (AC)

RESPONSE: The referenced permit condition has been taken into account and the cost effectiveness has been updated. Refer to the response to Comment 137.

180. COMMENT: Eliminating leaf blowers, gas lawn mowers, and drive through fast food restaurants and banks would help Valley air pollution problems. (Cannon)

RESPONSE: Options to address emissions from lawn care equipment have been evaluated. Refer to Appendix D for more details about this evaluation. Also, the District's Healthy Air Living program provides information on what Valley residents can do to help clean up the air, including avoiding idling at fast food restaurants and banks.

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SUMMARY OF SIGNIFICANT COMMENTS FOR THE APRIL DRAFT PM2.5 PLAN

VERBAL COMMENTS, APRIL 30, 2012 WORKSHOP

Approximately 18 people (non-District, non-ARB) in attendance (9 Fresno, 7 Bakersfield, 2 Modesto)

BGC Environmental Brokerage Services (BGC)
California Cotton Ginners and Growers Association (CCGGA)
Central Valley Air Quality Coalition (CVAQ)
Coalition for Clean Air (CCA)
Shipp, Evan (Shipp)
Evolution Markets, Inc. (EM)
Fresno Metro Ministry (FMM)
Southern California Gas Company (SCGC)
Krazan and Associates (KA)

181. COMMENT: Will the PM2.5 plan address the offset ratio for inter-pollutant trading using SOx emission reduction credits (ERCs) to offset PM2.5 and if so, will the proposed ratio be different than 40:1 ratio set by EPA? (EM)

RESPONSE: The District and ARB are in the process of conducting the modeling and other analysis necessary to document appropriate interpollutant trading ratios for the Valley for both NOx to PM2.5 and SOx to PM2.5. These ratios would replace EPA defaults for the Valley. This analysis will be available in future plan drafts.

182. COMMENT: Are any reductions to existing inter-pollutant ERC holdings anticipated to meet objectives of the PM2.5 plan? Is there a timeline proposed for labeling PM10 ERCs in the ERC registry as PM2.5 vs. PM10? (BGC)

RESPONSE: ERCs will be addressed in future plan drafts. At this time, the District does not expect to retire any existing ERC holdings as a part of the attainment planning effort. The District does not plan to identify the percentage of PM10 ERCs that are PM2.5. For purposes of the plan, we intend to conservatively consider all PM10 ERCs to be PM2.5.

183. COMMENT: PM2.5 trends over the last five years appear to be flat. The weight of evidence analysis should include an examination of trends among more recent years, including meteorologically-adjusted trends and species trends. (Shipp)

RESPONSE: Appendix A includes an extensive discussion of PM2.5 trends since 1999, when PM2.5 monitoring began. This analysis considers both long term trends as well as more recent patterns. This analysis will be expanded in future drafts. This will include meteorologically adjusted PM2.5 trends and speciated trends that are currently being evaluated by the District and ARB.

184. **COMMENT:** Do the PM2.5 species pie charts on slides 16-17 represent one day with a high PM2.5 concentration? If so, which day? (FMM)

RESPONSE: The PM2.5 species pie charts represent an average among days in Fresno and Bakersfield with high PM2.5 concentrations. They are not tied to any particular day.

185. **COMMENT:** Ammonium nitrate trends for Bakersfield and Fresno were presented. What is the difference between Bakersfield and Fresno in regards to NOx and ammonia emissions? (FMM)

RESPONSE: A monitor can be impacted by emissions from outside its county, and down-wind missions in its county may not affect the monitor at all. As such, rather than focus on county emissions, the District's receptor modeling (also known as linear rollback) will evaluate emissions that occur in an area of influence near that monitor. This analysis (to be included in a future draft) will corroborate photochemical modeling to determine the contribution of ammonium nitrate in future years as well as the magnitude and types of emissions that are driving that contribution.

186. **COMMENT:** In regards to the rule effectiveness evidence presented for the Rule 4901 (Wood Burning Fireplaces and Wood Burning Heaters), what was the contribution from agricultural burning and how can you tell if emissions are coming from fireplaces versus agricultural open burning? (FMM)

RESPONSE: Since agricultural burning is minimal during the winter in the San Joaquin Valley, the improvement in PM2.5 concentrations shown through the Rule 4901 effectiveness analysis is mostly attributable to residential wood-burning.

187. **COMMENT:** Will the 1-hour ozone plan be prepared concurrently? What is the timeline for the 1-hour ozone plan? (CCA)

RESPONSE: The 1-hour ozone plan will not be prepared concurrently with the *2012 PM2.5 Plan*. There is currently not a timeline for a 1-hour ozone plan.

188. COMMENT: Please describe why July 4 - 5, 2007 would be considered an exceptional event, as described on page A-9. (CCA)
RESPONSE: Federal regulations (40 CFR 50.14(b)(2) indicates that fireworks disploys qualify as an "exceptional event" and, with EPA concurrence of local or state documentation, are not used in design value calculations.

189. COMMENT: How will incentive programs be utilized as control strategies, as stated on Slide 44? (CCA)

RESPONSE: As noted in the Chapter 5 summary, incentive programs are an integral part of the emission reduction efforts of the District. The District is thoroughly evaluating potential control measure opportunities for technological feasibility, reasonably available control technology, cost effectiveness, relevance to attainment, and opportunities for improved public health. Based on this analysis, the District will determine which type of strategy, if any, is most appropriate for each control measure opportunity. These control strategies options will include regulations, incentive programs, and other approaches.

190. COMMENT: Does the emissions inventory for farming operations include the latest information from recent research studies? This includes the cotton gin study, the almond study, and the new emission factors that resulted from the MRI study for the off road dust. (CCGGA)

RESPONSE: The draft emissions inventory is based on information that was available to ARB staff as of December 2011. It does not yet include the results of the cotton gin or the almond studies. ARB plans to include the revised almond emission factors in the final inventory. The cotton gin study is not yet completed. The District recognizes the value of these and other related studies, and will work to ensure that they are used as appropriate to enhance the emission inventory.

The unpaved road dust emission estimates reflect an emission factor derived from recent Western Regional Air Partnership (WRAP) studies, which include the MRI study cited by the commenter. ARB uses a 10% PM2.5/PM10 size fraction, which is the same fraction used in the U.S. EPA's AP-42 emission factor equation for unpaved roads.

191. COMMENT: Are reductions from incentive programs included in the inventory for farming equipment? (CCGGA)

RESPONSE: The farm equipment inventory is based on ARB's OFFROAD2007 model, and it does not include reductions from incentive programs. ARB is working with a group of agricultural stakeholders and District staff to determine how best to reflect incentive programs in the SIP.

192. **COMMENT:** The inventory for farming operations listed on page B-5 states that directly emitted emissions are increasing, which seems to be contrary to other sources of information and should be reviewed. (CCGGA)

RESPONSE: The draft PM2.5 emission estimates presented for the April public workshop for farming operations were based on projections derived from harvested crop acreage for the years 1999 to 2010, as reported by the county agricultural commissioners to the USDA's National Agricultural Statistics Service.

District staff has worked with ARB to review the data from both sources and has come to the agreement that the data from the FMMP is more accurate and appropriate for the Valley. As such, the emission inventory will be updated as appropriate

193. **COMMENT:** Our company has developed an apparatus that could reduce emissions from open hearth fireplaces. As previously discussed with the District Staff, the project does not fit within the categories needed to qualify for funding under the Technology Advancement Program (TAP). We ask that you expand the TAP categories to include retrofits of fireplaces so that our device fits into your rule. (KA)

RESPONSE: District Rule 4901 (Wood Burning Fireplaces and Wood Burning Heaters) does not require or prohibit specific technologies be installed, only that those technologies meet EPA certification requirements. The District will consider revising its TAP categories to include fireplace retrofits.

194. **COMMENT:** Clarify the use of long-term trends versus short term trends. (CVAQ)

RESPONSE: Meteorology fluctuates from year to year, and this can cause -to-year variation in PM2.5 concentrations due to meteorology. Longer trends can smooth out these fluctuations and provide a better perspective on the overall progress. Trends relating to the "cleanest winter on record," for example, are long-term trends based on all available data. Shorter term trends can help you understand the impacts of recent weather patterns or recent emissions reductions efforts.

195. **COMMENT:** What are the key components in the formation of nitric acid? (CVAQ)

RESPONSE: Nitrogen dioxide (NO2) reacts with OH in the atmosphere to form nitric acid (HNO3). This requires the formation of OH radicals from hydrocarbon gases by interaction with NO in photochemical action during the day.

Nitric acid can also form when nitrogen dioxide (NO2) reacts with the nitrate radical (NO3) in the presence of atmospheric water (H2O). This happens at night when NO2 reacts with ozone (which was formed during the day for surface level ozone) to form the NO3 radical.

Both pathways involve photochemical action. The night reaction is not as obviously from photochemistry, but if the ozone (near the surface) was not formed in the day by photochemistry, it would not be available at night for the alternative nitric acid formation pathway.

196. **COMMENT:** When will VOCs and ammonia be added to the inventory? (CVAQ)

RESPONSE: VOCs and ammonia inventories will be included in the next draft plan.

197. **COMMENT:** Distribution centers have zero idling rules imposed on them. Can incentive funding be used for electrification at distribution centers under the ARB Idling Rule? These operations should be viewed as stationary sources and not mobile sources. (CVAQ)

RESPONSE: The District reminded the commenter that ARB has already adopted an anti-idling regulation that already prohibits idling from trucks, including at distribution centers (California Health and Safety Code Section 2485). Prior to this regulation, the District funded a number of projects providing idling alternatives. However, since idling is now prohibited, such reductions would not be surplus and incentives are not available. The District also informed the commenter of restrictions on the District's authority to regulate interstate commerce and mobile sources.

198. **COMMENT:** What PM2.5 AQI scale was used in the AQI analysis within Appendix A? Was it a District defined scale, or the official scale from EPA? (CVAQ)

RESPONSE: The current and official EPA PM2.5 AQI scale was used in the AQI analysis within Appendix A.

199. **COMMENT:** What is the difference in the annual versus winter time emissions inventory? (SCGC)

RESPONSE: The annual emissions inventory represents the average daily emissions for the entire calendar year. The winter emissions inventory represents the average daily emissions for November through April.

200. **COMMENT:** What is the commending procedure for this plan? Are there 45-day comment periods, or 30-day? (SCGC)

RESPONSE: Comments received by 5:00 PM on May 14, 2012 will be presented in the next draft of the plan as appropriate. Comments received after this time will be presented in later drafts of the plan. Stakeholders are encouraged to provide comments whenever possible for evaluation and incorporation into the plan as appropriate.

The District generally provides a two week comment period after public workshops for stakeholders to submit comments that will be incorporated into the next draft of a staff report or plan document. However, there is no governing body or regulation that requires this timeline.

The 30-day period is a public noticing requirement pursuant to California Health and Safety Code Section 40725. This is not a public commenting requirement, rather it is a requirement that a notice of the time and place of a public hearing to adopt, amend, or repeal any rule or regulation shall be given not less than 30 days prior to thereto. Subpart (c) of this section of the health and safety code requires that the notice invite written public comment, but does not require a specific comment time period.

The 45-day period is a public noticing requirement for the Air Resources Board (ARB), not the San Joaquin Valley Air Pollution Control District. The 45-day public noticing requirement is related to public hearings at ARB for the adoption, amendment, or repeal of a regulation. For more information about this refer to the California Government Code 11346.4.

201. **COMMENT:** The District should consider having technical workgroup meetings with the District in addition to the scheduled public workshops. There are concerns that the timeline for this plan does not allow sufficient time for public involvement. (SCGC)

RESPONSE: The District welcomes public participation, including technical input, throughout this public process and encourages stakeholders to submit information to us for consideration and review while drafting this plan. The District has been actively involved in a modeling technical workgroup that includes technical staff from ARB and EPA, and researchers with expertise in PM2.5. The District and ARB hosted a public technical symposium on April 27th that included panel presentations on a range of technical issues relevant to development of the *2012 PM2.5 Plan*. In addition to the April workshop, the District anticipates holding additional workshops in June and August. The plan would be considered by the Governing Board at a public hearing October 2012 after multiple opportunities for public input.

202. COMMENT: What is the Clean Air Vision document, and when will it be available to the public? (SCGC)

RESPONSE: The *Vision for Clean Air: 2012 to 2050* is an interagency policy collaboration will outlining a common ARB, South Coast, and Valley vision for strategies to meet federal air quality standards for ozone and PM2.5, the State's greenhouse gas goals, and reduced public exposure to toxics (such as diesel particulates). Meeting these long-term goals will depend on introduction and deployment of transformative measures and emerging technologies, including zero-emissions goods movement. Thus, the *Vision* document will evaluate potential policies, legislation, infrastructure, and efficiencies that might provide the groundwork for ensuring that South Coast, the Valley, and California as a whole are prepared to meet the demands of long-term goals. This is to be the starting point for identifying actions that need to begin in the short-term. These actions can also contribute to the more near-term air quality needs – including the *2012 PM2.5 Plan* – as well. ARB anticipates taking this document to their Board in June 2012. The document will be posted for public review before this meeting.

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WRITTEN COMMENTS, APRIL 30, 2012 WORKSHOP

One comment letter was received during the public comment period following the first public workshop on April 30, 2012. This comment letter was submitted by the following stakeholders, and for purposes of this plan will be referred to as the “Ag Coalition” (AC)[4].

203. **COMMENT:** The agricultural industry has made huge strides in the past few years in reducing emissions of NOx and PM2.5 through the replacement and control of engines used for irrigation pumping, tractors, forklifts, harvesters and trucks. These emissions must be quantified and accounted for in this plan. There is currently an effort to formalize this concept in the form of a Memorandum of Understanding (MOU) and would provide a formal mechanism by which to quantify and account for these emission reductions. The emissions inventory should also be updated with the emission reductions resulting from the implementation of the USDA NRCS Environmental Quality Incentive Program (EQIP) and Conservation Innovation Grant Program (CIGb). (AC)

RESPONSE: Please refer to the response to Comment 191.

204. **COMMENT:** The District’s draft emissions inventory shows an increase in directly emitted PM2.5 emissions from farming operations which utilizes data derived from County Ag Commissioners reports that are based upon “harvested” acreage. This is in direct conflict with a previously accepted annual acreage reduction from the California Department of Conservation Farmland Mapping and Monitoring Program (FMMP). The FMMP data is based on actual planted acreage which more accurately reflects true agricultural land use for emissions inventory planning purposes. We urge the District to work with the Air Resources Board to rectify the emissions inventory for agricultural sources, and demonstrate the actual reduction in agricultural land. (AC)

RESPONSE: Please refer to the response to Comment 192.

205. **COMMENT:** Significant research on PM2.5 emissions from agricultural sources should be incorporated wherever and whenever possible. This includes research that has been conducted on cotton gin emissions under the USDA Agricultural Research Service’s (ARS) multi-year study known as “Characterization of Cotton Gin Particulate Matter Emissions.” While the sampling phase is over, data analysis

[4] The following groups are represented in the AC comment letter: Air Coalition Team, Allied Grape Growers, California African American Farmers Association, California Blueberry Association, California Citrus Mutual, California Cotton Ginners Association, California Cotton Growers Association, California Grape and Tree Fruit League, California Farm Bureau Federation, Fresno County Farm Bureau, Kings County Farm Bureau, Madera County Farm Bureau, Merced County Farm Bureau, Milk Producers Council of California, Nisei Farmers League, San Joaquin Farm Bureau Federation, Stanislaus County Farm Bureau, Tulare County Farm Bureau, Tulare Lake Basin Water Storage District, Tulare Lake Drainage District, Tulare Lake Resource Conservation District, and Western Agricultural Processors Association.

is also nearing completion and preliminary data is forthcoming, which indicate that PM2.5 emissions from a cotton gin would be insignificant. Furthermore, there has been significant work in almond harvesting operations which report PM2.5 emissions to be an insignificant portion of total suspended particulate (TSP) emissions. (AC)

RESPONSE: Please refer to the response to Comment 190.

206. **COMMENT:** For purposes of focusing emissions on sources that operate during the "winter time" (November through April), the current characterization can be misleading and causes sources to be regulated that may not impact the current exceedances of the PM2.5 ambient air quality standard. The SIP should clearly identify the actual seasonal variances since seasonal, episodic, regional measures and incentive funding can strategically target limited resources for optimum air quality benefits throughout the Valley. (AC)

RESPONSE: Through the Risk-based Strategy, the District places an emphasis on winter time emissions in the emission reduction efforts presented in this plan because they are most impactful on achieving attainment of the federal air quality standards. However, the Risk-based Strategy has additional components to consider (such as toxicity of pollutants) and therefore the District is seeking to reduce all emissions in the Valley as expeditiously as practicable to benefit the health of its residents. Please refer to chapter two of the plan for a more detailed discussion about the Risk-based Strategy.

207. **COMMENT:** There is one technical error that needs to be corrected in the 3rd paragraph on page C-22 where the District indicates that new tractor equipment can be up to 25% of the existing tractor's horsepower to be eligible. That should be up to "125%". (AC)

RESPONSE: The technical error will be corrected in the next draft of the plan.

208. **COMMENT:** The District should expand the discussion regarding the contribution of PM 2.5 from gross polluting vehicles and direct resources towards gross polluting on-road vehicles, and towards enforcement ensuring that all vehicles are registered in the District. After all, vehicle registration fees are a major source of incentive funding for the Valley Air Basin. (AC)

RESPONSE: The District intends to expand discussions regarding mobile sources throughout the public process of the development of this plan. Refer to Appendix C for more details and updated language throughout the process.

WRITTEN COMMENTS, AFTER APRIL 30, 2012 WORKSHOP DEADLINE

One public comment letter was submitted to the District after the public comment period concluded.

Southern California Gas Company (SCGC)

209. **COMMENT:** California's innovative and robust energy-efficiency programs have resulted in a 24% reduction of natural gas use per customer since 1990. We would like to work with the District and CARB to ensure the PM2.5 Plan accurately reflects the energy-efficiency savings and the proper natural-gas usage forecasts. (SCGC)

RESPONSE: Chapter 7 of the *2012 PM2.5 Plan* will be the chapter that discusses the energy efficiency strategies generally as potential policy initiatives and innovative opportunities. In any future work to refine innovative strategies regarding usage forecasts, the District will work with stakeholders to determine the most accurate and reliable usage forecasts. The District looks forward to receiving submittal of data to assist us with this process.

210. **COMMENT:** We would like to discuss the advances and potentials for natural-gas technology, especially for natural-gas vehicles, to ensure that the natural-gas vehicle-penetration rates and associated emissions benefits are accurately reflected in the PM2.5 Plan. (SCGC)

RESPONSE: The District appreciates and looks forward for the opportunity to discuss advances and potential in natural gas technology. Incentive strategies and technology advancement are important components to the District's attainment strategy. The *2012 PM2.5 Plan* addresses mobile sources in Appendix C. Refer to that appendix current for discussions regarding advances for mobile sources.

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