AUG 2020
Received
Environmental Improvement
Board

STATE OF NEW MEXICO
ENVIRONMENTAL IMPROVEMENT BOARD

IN THE MATTER OF THE APPEALS
OF THE AIR QUALITY PERMIT
NO. 7482-M1 ISSUED TO 3 BEAR
DELAWARE OPERATING – NM LLC

EIB No. 20-21(A)

AND

REGISTRATION NOS. 8729, 8730, AND 8733
UNDER GENERAL CONSTRUCTION PERMIT
FOR OIL AND GAS FACILITIES

EIB No. 20-33(A)

WildEarth Guardians,
Petitioner

THE NEW MEXICO ENVIRONMENT DEPARTMENT'S STATEMENT OF INTENT TO PRESENT DIRECT TECHNICAL TESTIMONY

Pursuant to 20.1.2.206 NMAC, the Air Quality Bureau ("Bureau") of the Environmental Protection Division ("Division") of the New Mexico Environment Department ("Department") submits this Statement of Intent to Present Direct Technical Testimony in support of its approval of Air Quality Permit No. 7482-M1, issued to 3-Bear Delaware Operating – NM LLC ("3-Bear Permit") for the Libby Gas Plant in Lea County, New Mexico, and General Construction Permit for Oil and Gas Facilities ("GCP O&G") Registration Nos. 8729, 8730, and 8733 (collectively, the "Registrations") for XTO Energy Co.'s Corral Canyon 23 and Big Eddy Unit DI 38 (Nos. 8729 and 8730, respectively), and Spur Energy Partners LLC's Dorami 2H, 4H and 9H Federal Oil Tank Battery (No. 8733), all located in Eddy County, at the public hearing beginning September 23, 2020 on the consolidated appeal petitions filed by WildEarth Guardians.

1. Name of Person Filing the Statement

The Air Quality Bureau of the Environmental Protection Division of the Department.

2. The Division's Position on the Petition

The Bureau, on behalf of the Division, opposes the Petitions.

3. Technical Witness Information

The Bureau will call the following witnesses at the hearing to present technical testimony:

Sufi Mustafa: Mr. Mustafa is Manager of the Modeling and Emissions Inventory Unit in the Bureau's Planning Section. He has been employed by the Department for nineteen years. Mr. Mustafa's educational and professional backgrounds are described in his resume, attached as NMED Exhibit 2. His business address is 525 Camino de los Marquez, Suite #1, Santa Fe, New Mexico 87505. Mr. Mustafa is expected to provide testimony regarding ozone and how it is formed; the nature of ozone as an air pollutant and how it is modeled; and how the modeling informs the regulatory regime for controlling ozone pollution under the federal Clean Air Act and the New Mexico Air Quality Control Act.. Mr. Mustafa's written testimony is provided as NMED Exhibit 1.

Elizabeth Bisbey-Kuehn: Ms. Bisbey-Kuehn is Chief of the Department's Air Quality Bureau. She has held this position since 2017. She has been employed by the Department over fifteen years. Her business address is 525 Camino de los Marquez, Suite #1, Santa Fe, New Mexico 87505. Ms. Bisbey-Kuehn's educational and professional background is described in her resume, attached as NMED Exhibit 4. Ms. Bisbey-Kuehn is expected to provide testimony on the following topics: the regulatory regime for ozone set forth under the CAA and the State of New Mexico's role in that regime; the New Mexico statutory and regulatory framework for regulating ozone pollution; the Department's Ozone Attainment Initiative and the steps that the Department is currently taking to address areas of the State where monitors are registering exceedances of the ozone NAAQS; the path forward for the State in addressing ozone pollution. Ms. Bisbey-Kuehn's written direct testimony is provided as NMED Exhibit 3.

Kerwin Singleton: Mr. Singleton is the Chief of the Bureau's Planning Section. He has held this position since 2018. He has been employed by the Department for sixteen years. Mr. Singleton's educational and professional backgrounds are described in his resume, attached as NMED Exhibit 8. His business address is 525 Camino de los Marquez, Suite #1, Santa Fe, New Mexico 87505. Mr. Singleton will not be providing direct technical testimony in this proceeding, but he will be available for rebuttal and cross-examination as needed.

Ted Schooley: Mr. Schooley is the Chief of the Bureau's Permitting Section. He has held this position since 2014. He has been employed by the Department for nineteen years. Mr. Schooley's educational and professional backgrounds are described in his resume, attached as NMED Exhibit 9. His business address is 525 Camino de los Marquez, Suite #1, Santa Fe, New Mexico 87505. Mr. Schooley will not be providing direct technical testimony in this proceeding, but he will be available for rebuttal and cross-examination as needed.

Angela Raso: Ms. Raso is a Dispersion Modeler for the Bureau. She has held this position since 2018. Ms. Raso's educational and professional backgrounds are described in her resume, attached as NMED Exhibit 10. Her business address is 525 Camino de los Marquez, Suite #1, Santa Fe, New Mexico 87505. Ms. Raso will not be providing direct technical testimony in this proceeding, but she will be available for rebuttal and cross-examination as needed.

The Bureau hereby reserves the right to call any other person to present rebuttal testimony and to support the admission of any exhibit.

4. Estimated Length of Witness Direct Testimony at the Hearing

Mr. Mustafa	1 hour
Ms. Bisbey-Kuehn	1 hour
Mr. Singleton	No direct testimony
Mr. Schooley	No direct testimony
Ms. Raso	No direct testimony

5. Exhibit List

The Department intends to offer the following exhibits into evidence at the hearing:

EXHIBIT NUMBER	TITLE OF EXHIBIT
NMED Exhibit 1	Testimony of Sufi Mustafa
NMED Exhibit 2	Resume of Sufi Mustafa
NMED Exhibit 3	NMED Air Quality Bureau's Air Dispersion Modeling Guidelines (June 6, 2019)
NMED Exhibit 4	US EPA's Draft Guidance for Ozone and Fine Particulate Matter Permit Modeling (February 10, 2020)
NMED Exhibit 5	Testimony of Elizabeth Bisbey-Kuehn
NMED Exhibit 6	Resume of Elizabeth Bisbey Kuehn
NMED Exhibit 7	Southern New Mexico Ozone Study Technical Support Document (October 19, 2016)
NMED Exhibit 8	Resume of Kerwin Singleton
NMED Exhibit 9	Resume of Ted Schooley
NMED Exhibit 10	Resume of Angela Raso

The Bureau hereby reserves the right to introduce and to move for admission of any other exhibit in support of rebuttal testimony at the hearing.

Respectfully submitted,

NEW MEXICO ENVIRONMENT DEPARTMENT

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CERTIFICATE OF SERVICE

I hereby certify that a copy of the foregoing Statement of Intent to Present Technical Testimony was served via electronic mail on the following parties of record on August 3, 2020:

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/s/ *Lara Katz*
Lara Katz

NMED
EXHIBIT 1

STATE OF NEW MEXICO
ENVIRONMENTAL IMPROVEMENT BOARD

IN THE MATTER OF THE APPEALS
OF THE AIR QUALITY PERMIT
NO. 7482-M1 ISSUED TO 3 BEAR **EIB No. 20-21(A)**
DELAWARE OPERATING – NM LLC

AND

REGISTRATION NOS. 8729, 8730, AND 8733 **EIB No. 20-33(A)**
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WildEarth Guardians,
Petitioner

DIRECT TECHNICAL TESTIMONY OF SUFI MUSTAFA

I. INTRODUCTION

My name is Sufi Mustafa. I am Manager of the Modeling and Emissions Inventory Unit of the Planning Section of the Air Quality Bureau ("AQB" or "Bureau") of the New Mexico Environment Department ("NMED" or "Department"). I present this written testimony on behalf of the Department for the consolidated public hearings on the appeal petitions filed by WildEarth Guardians ("WEG") in EIB 20-21(A) and EIB 20-33(A). In EIB 20-21(A), WEG challenges the Department's approval of Air Quality Permit No. 7482-M1, issued to 3-Bear Delaware Operating – NM LLC ("3-Bear Permit") for the Libby Gas Plant in Lea County, New Mexico. WEG contends that the Department failed to perform air quality modeling or other technical analyses to evaluate the impacts of the permitted activities on ambient ozone levels in the area. WEG further objects that air quality monitors in Hobbs and Carlsbad are registering ozone levels in excess of the U.S. Environmental Protection Agency's ("EPA") National Ambient Air Quality Standard ("NAAQS"), and therefore the Department's decision to approve the Permit was arbitrary and capricious because it authorized additional ozone precursors that would necessarily "cause or contribute to air contaminant levels in excess of any [NAAQS]."

In EIB 20-33(A), WEG challenges the Department's approval of General Construction Permit for Oil and Gas Facilities ("GCP O&G") Registration Nos. 8729, 8730, and 8733 (collectively, the "Registrations") for XTO Energy Co.'s Corral Canyon 23 and Big Eddy Unit DI 38 (Nos. 8729 and 8730, respectively), and Spur Energy Partners LLC's Dorami 2H, 4H and 9H Federal Oil Tank Battery (No. 8733), all located in Eddy County, New Mexico. WEG points to Table 103 in the GCP O&G, which lists all applicable regulations that a registrant must comply with and includes ambient air quality standards. WEG contends that because monitors in the area are registering exceedances of the ozone NAAQS, it is impossible for the facilities to demonstrate compliance with the requirements of the GCP O&G, and therefore the Department's approval of the Registrations was unlawful, arbitrary and capricious.

As the Modeling Unit Manager, I am charged with reviewing and assigning air dispersion modeling analyses that are provided in support of air quality permitting actions. My staff and I ensure that the modeling analyses submitted by permit applicants conform to the most current US EPA modeling guidelines and predict concentrations below applicable ambient air quality standards. My testimony will address the following topics: what ozone is and how it is formed; the nature of ozone as an air pollutant and how it is modeled; and how the modeling informs the regulatory regime for controlling ozone pollution under the federal Clean Air Act and the New Mexico Air Quality Control Act.

II. QUALIFICATIONS

I have a doctorate in Chemistry from the New Mexico School of Mining and Technology. I started my career twenty-five years ago as an analytical chemist at the New Mexico State Health

Department's Scientific Lab Division. I joined AQB nineteen years ago as a Modeler, and later the Staff Manager for the Air Dispersion Modeling and Emission Inventory Section. In my current position with the Air Quality Bureau, I supervise three full time modelers who perform and review air dispersion modeling analyses. These analyses predict air quality in an area, and are used in the air quality permitting process to ensure facilities that obtain air quality permits will be in compliance with applicable air quality standards. My staff and I have extensive experience in the use of the EPA regulatory model known as the American Meteorological Society/Environmental Protection Agency Regulatory Model ("AERMOD"), which is used for short range air quality analyses under state and federal air quality regulations.

My full background and qualifications are set forth in my resume, which is marked as NMED Exhibit 2.

III. AMBIENT AIR QUALITY STANDARDS

The Clean Air Act requires EPA to set ambient air quality standards for pollutants it determines are harmful to human health and the environment. These standards are in the form of maximum allowable concentrations in the ambient air during a specified time period and are designed to protect the most sensitive individuals from harm from airborne pollutants. EPA has established ambient air quality standards for six "criteria" pollutants in outdoor air. These pollutants are carbon monoxide ("CO"); nitrogen dioxide ("NO2"); sulfur dioxide ("SO2"); particulate matter ("PM") at 10 microns or less, referred to as coarse particulate matter, and at 2.5 microns or less, referred to as fine particulate matter; ground level ozone; and lead.

To prevent relatively clean areas from degrading to levels just barely in compliance with the air quality standards, limits on the allowable change in air quality have been established by EPA in the form of Prevention of Significant Deterioration ("PSD") increments. Compliance demonstrations for PSD increments demonstrate that the deterioration is less than the allowable increment for a pollutant.

Along with the PSD increments and NAAQS concentrations of criteria pollutants, EPA also set up Significant Impact Level ("SIL") concentrations, which are thresholds below which the source is not considered to contribute to any predicted exceedance of air quality standards or PSD increments.

V. DEMONSTRATION OF COMPLIANCE WITH NAAQS FOR PERMITTED SOURCES

Demonstrating compliance with NAAQS for a new facility or a modification to an existing facility typically involves the use of air dispersion models to simulate the impacts of the proposed project. NMED and EPA both have guidance that prescribes the methodology and the types of modeling analyses to be used by applicants and NMED to demonstrate compliance with the NAAQS. The Bureau's Air Dispersion Modeling Guidelines (June 6, 2019) ("NMED Modeling Guidelines"), are attached hereto as NMED Exhibit 3; EPA's most recent guidance - Draft Guidance for Ozone and Fine Particulate Matter Permit Modeling (February 10, 2020) ("EPA Modeling Guidance") – is attached hereto as NMED Exhibit 4. Note that there are different types of models and modeling assessments used for different types of air pollutants, which is explained in detail the following section. Regulatory models such as AERMOD are used to determine short distance impacts up to approximately a few hundred square miles.

The Board's requirements for air dispersion modeling are detailed at 20.2.70.300.D.10 NMAC (Operating Permits), 20.2.72.203.A.4 NMAC (Construction Permits), and 20.2.74.305 NMAC (Permits - Prevention of Significant Deterioration), and 20.2.79 NMAC (Nonattainment). For a construction permit application, an air dispersion modeling analysis is typically required to demonstrate compliance with applicable ambient air quality standards.

When a construction permit application involving air dispersion modeling is received, modeling staff initially verify that the application contains the required application forms and modeling reports, and determine whether the modeling files provided by the applicant are readable. Once the application has been ruled complete, Bureau staff will perform a complete review of the modeling files. This analysis includes a review to make sure that the data in the modeling files are consistent with the information in the permit application, and may involve the emission rate of each emission point; the elevation of sources, receptors, and buildings; and other aspects of the modeling inputs. If the dispersion modeling analysis submitted with the permit application and reviewed by the Department adequately demonstrates that ambient air concentrations will be below air quality standards and/or PSD increments, the modeler will summarize the findings and include the report summary the permit file. If dispersion modeling predicts that the construction or modification causes or significantly contributes to an exceedance of a New Mexico standard, a NAAQS, or a PSD increment, the permit cannot be issued by the Department.

IV. OZONE BASICS

The ozone molecule is composed of three oxygen atoms. Ground level ozone is formed when nitrogen oxides and volatile organic compounds react in the presence of sunlight. As the amount of these compounds increase in the air during warm days and intense sunlight, the essential chemical reactions take place to form ozone. Therefore, we tend to see spikes in ozone concentrations during the summer months.

Man-made, or anthropogenic sources of nitrogen oxides (“NOx”) include products of fuel combustion. Volatile organic compounds (“VOCs”) are emitted from various anthropogenic sources and processes such as motor vehicles; chemical manufacturing facilities; evaporative losses from crude oil holding tanks; and consumer and commercial products. Natural sources of nitrogen oxides include lightning NO_X, microbial processes that occur in soils, and wildland fires. Vegetation is the major natural source of VOCs; other natural sources include animals and microbes.

Ozone is a reactive molecule that causes irritation and inflammation to the respiratory system and tissue damage to vegetation. While ozone is beneficial when it is present in the stratosphere to block harmful light radiation from reaching us, it is harmful when it is present in the lower troposphere, where we live and breathe. EPA has determined that ground level ozone is a criteria pollutant requiring a NAAQS for protection of public health. In 2015, EPA revised the ozone NAAQS downward from 75 ppb to 70 ppb.

VI. OZONE MODELING

Ozone is different from the other criteria pollutants in that it is not directly emitted from sources, but instead is primarily formed in the ambient air through chemical interactions between other precursor pollutants. Pollutants that are emitted directly by a source are known as "primary pollutants," and are generally NOx, SO2, PM10, PM2.5, and lead. Pollutants that are formed through chemical interactions in the ambient air, such as ozone, are known as "secondary pollutants." Dispersion modeling for primary pollutants simulates dispersion of that pollutant in the air after it is emitted from the source. By contrast, modeling for a secondary pollutant such as ozone must be capable of simulating chemistry in addition to dispersion. This is commonly done using photochemical models that simulate atmospheric chemistry as well as atmospheric mixing.

The addition of chemistry adds substantial complexity to the model. The impacts of a facility's emissions on primary pollutant concentrations are typically evaluated for a facility alone and is done with modeling that covers an area of a few hundred square miles. The impact of a facility's emissions on secondary pollutant concentrations must be evaluated in relation to emissions from other sources, since the precursors reacting to create secondary pollutants are often emitted from multiple sources and sectors. In addition to regulated facilities, ozone precursors are emitted from numerous other anthropogenic and natural sources, as well as being transported from surrounding states and countries. Precursors can travel hundreds of miles in the atmosphere before reacting to form ozone. This makes it necessary to have not only a detailed understanding of the emissions from regulated facilities in an area, but also emissions from sources hundreds of miles away.

The potential complexity of photochemical modeling has led several organizations, including EPA and the Western Regional Air Partnership ("WRAP"), to develop modeling platforms that contain most of the information necessary for photochemical grid modeling exercises. Despite the development of these platforms, photochemical modeling exercises are still highly complex, and are mostly conducted by private specialists under contract with state and local air quality agencies. These specialized studies are far more costly then dispersion modeling; for instance, the photochemical modeling associated with the Department's Ozone Attainment Initiative is being performed by highly specialized contractors at a cost of over three-hundred thousand dollars. The NMED Modeling Guidelines recognize the cost and difficulty of ozone modeling, stating as follows:

> In accordance with [EPA's MERPs Guidance], NMED performs ozone modeling on a regional scale as the need arises, rather than requiring permit applicants to quantify their contribution to a regional ozone concentration. Comprehensive ozone modeling is too resource intensive to attach this expense to a typical permit application, and screening modeling on an affordable scale currently cannot quantify a source's impacts to ambient ozone concentrations.

NMED Modeling Guidance, at p. 24.

Due to the cost and complexity of ozone modeling, NMED performs a different type of analysis to determine ozone impacts from facilities that are designated as “minor PSD sources”, as explained below.

VII. NEW SOURCE REVIEW PERMITTING AND OZONE

According to the New Mexico air quality regulations, facilities that require a New Source Review (“NSR”) air quality permit must demonstrate compliance with applicable air quality standards. For this purpose, applicants use air dispersion modeling analyses to predict what the concentrations of most criteria pollutants will be after the project construction. In general, a US EPA approved regulatory model, AERMOD, is used. The model requires various inputs, including the post-construction project emissions of various criteria air pollutants such as carbon monoxide, nitrogen oxides, sulfur dioxide, and particulate matter. The model’s output are the predicted pollutant concentrations, which are compared against the national and New Mexico air quality standards to demonstrate compliance after construction.

As noted above, because ozone is not directly emitted from a facility, but its formation is the result of precursor pollutants such as NOx and VOC emissions in a region undergoing complex chemical reactions, predicting an individual facility’s contribution to the ozone levels in a region is extremely difficult compared to the directly emitted pollutants. For this reason, the Board’s rules do not require the Department to evaluate ozone impacts for individual NSR minor source permit applications. *See* 20.2.72.500 NMAC (Table I – Significant Ambient Concentrations) (note the absence of ozone).

The Bureau follows the EPA Modeling Guidance, which uses a two-tiered demonstration approach to address single-source impacts on ambient ozone concentrations from major sources (those that emit more than 250 tons per year of any regulated pollutant). This type of demonstration is included in the NMED Modeling Guidelines and is the basis for NMED's modeling requirements. Tier I is a screening tool under the PSD permitting program that uses Modeled Emission Rates for Precursors ("MERPs"), and Tier II requires the application of photochemical grid models to determine whether the source makes a significant impact on ozone and secondary $PM_{2.5}$. MERPs provide a scaling factor for emissions at a subject facility based on photochemical modeling done for a 'representative facility'. These scaling factors allow precursor emissions to be converted to an estimated ozone concentration based on the atmospheric conditions in the area surrounding the representative facility. The closest representative facilities to Carlsbad and the Permian Basin are located 90 miles to the northwest in Otero County, New Mexico, and 150 miles to the northeast in Terry County, Texas. The scaling factors from both representative facilities indicate that an individual facility would have to emit more than 250 tons per year of both NO_X and VOCs to cause ozone concentrations to increase more than a significant amount (the SIL) of ozone.

Because the allowable emissions from minor sources such as 3-Bear Libby Gas Plant do not, by definition, have the potential to emit NOx or VOCs in quantities exceeding 250 tons per year, there is no basis for the Department to require further analyses of ozone impacts from such sources. This determination and methodology is in accordance with the EPA Modeling Guidance and the NMED Modeling Guidelines, which does not require source specific ozone modeling for minor sources.

VIII. GENERAL CONSTRUCTION PERMITS AND OZONE

General Construction Permits are issued for minor emission sources in a specific industry sector. The Department issues general permits in order to register groups of sources that have similar operations, processes, and emissions and that are subject to the same or substantially similar requirements. *See* 20.2.72.220.A(1) NMAC. General permits provide an additional permitting option for specific source types that can meet the predetermined permit requirements *See* 20.2.72.220.C(1) NMAC. The GCP O&G authorizes an owner or operator to construct, modify, and operate an oil and gas facility in New Mexico (excluding Bernalillo County, tribal lands, and designated nonattainment areas) under the conditions set forth in the permit.

In the permit hearing before the Board on the GCP O&G, the Department presented testimony regarding the air dispersion modeling analyses that were performed for hypothetical oil and gas facilities to determine conditions under which a permitted facility would be in compliance with applicable ambient air quality standards. Because only minor sources can register under the GCP O&G, the MERP analyses show that the impact of such facilities will be below the ozone SIL, and therefore are not considered to significantly contribute to ozone formation. This determination and methodology is in accordance with the EPA Modeling Guidance and the NMED Modeling Guidelines, which does not require source specific ozone modeling for minor sources.

IX. CONCLUSION

The Department evaluated the 3-Bear NSR Permit and the GCP Registrations as directed under the Act and the Board’s regulations. It is my opinion that the both the NSR Permit and the GCP Registrations comply with the AQCA and the air quality rules. It is also my opinion that there is no scientific or technical evidence on which the Department could determine that the activities authorized by the NSR Permit or any of the Registrations would cause or contribute to violations of the ozone NAAQS. Therefore, the Board should uphold the Department’s decision to approve the Permit and the Registrations.

NMED
EXHIBIT 2

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EDUCATION & TRAINING:

Ph.D. in Chemistry, August 2000
New Mexico Institute of Mining and Technology, Socorro, New Mexico, USA.

MS in Organic Chemistry, January 1988
University of the Punjab - Institute of Chemistry, Lahore, Pakistan.

BS in Chemistry, Minors in Statistics and Zoology, January 1985
University of the Punjab, Lahore, Pakistan.

PROFESSIONAL WORK EXPERIENCE:

New Mexico State Environment Department, Air Quality Bureau:
Manager - Air Dispersion Modeling Section: March 2004 to present

- Manage staff, assign tasks to complete the section workload, conduct employee performance appraisals.
- Strategic planning and coordination with other Bureau managers and supervisors.
- Support the development of new air quality regulations.
- Extensive experience working with the regulated industry and consultants.

New Mexico State Environment Department, Air Quality Bureau:
Environmental Scientist: June 2001 to March 2004

- Performed *Air Dispersion Modeling* for air quality permits using regulatory air dispersion models to ensure compliance with national and state air quality standards.
- Familiar with State and US Environmental Protection Agency (EPA) air quality regulations including New Source Review (NSR) and Prevention of Significant Deterioration (PSD).
- Developed a good understanding of Atmospheric Science and Air Pollution Dispersion.
- Employed Fourier Transform IR Spectrometer for real-time air toxics monitoring.
- Attended comprehensive training related to air quality regulations, emission sources, public outreach, etc. Following is alisting of few training classes:
    - Basic New Source Review
    - Principles and Practice of Air Pollution Control
    - Air Dispersion Modeling and Risk Assessment
    - Air Quality Compliance and Enforcement
    - Air Dispersion Modeling using AERMOD
    - Consent Building

NMED Exhibit 2

New Mexico State Health Department, Scientific Laboratory Division:
Laboratory Scientist III: December 1993 to October 1998

- Analyzed water, soil and air samples for organic contaminants using gas chromatography/mass spectrometer and various other detectors.
- Wrote Quality Control Procedures and analytical reports using MS Office software.
- Worked with clients regarding environmental sampling and regulatory issues.
- Responsible for troubleshooting and maintenance of analytical equipment.
- Used comprehensive database of organic compounds and sample analyses, devised analytical data quality control checks.

Petroleum Recovery Research Center, NMIMT, Socorro, NM.
Research Assistant: January 1990-August 1993

- Dissertation Project: *“Direct Thickeners for Dense CO2”*
- Synthesized new organic initiators.
- Investigated electron donors for the electron donor-mediated living carbocationic polymerization of isobutylene.
- Synthesized and characterized living sulfonated polyisobutylene telechelic ionomers and their association in various solvents.
- Investigated one-pot synthesis of narrow molecular weight distribution living sulfonated telechelic Polyisobutylenes.
- Wrote grant requests, project progress reports and research papers.

Chemistry Department, NMIMT, Socorro, NM:
Teaching Assistant in Chemistry: August 1989-May 1990

- Taught General Chemistry, Quantitative Analytical Chemistry and laboratory courses.

Imperial Chemical Industries (ICI) Paints Business Area, Lahore, Pakistan
Management Trainee Chemist: January 1988-August 1989

- Developed and tested automotive and industrial paints according to the need of the clients.
- Performed quality control and assurance checks on the production line.
- Tested raw material.
- Supervised technical staff in the development laboratory.

NMED
EXHIBIT 3

New Mexico Air Quality Bureau

Air Dispersion Modeling Guidelines

Revised June 6, 2019

Recent changes to the Modeling Guidelines are described in Appendix A at the end of this document.

Notes:
EPA in-stack ratio database:
https://www.epa.gov/scram/nitrogen-dioxidenitrogen-oxide-stack-ratio-isr-database

Significance levels for PM2.5 and ozone:
https://www.epa.gov/sites/production/files/2016-08/documents/pm2_5_sils_and_ozone_draft_guidance.pdf
2017 Appendix W:
https://www3.epa.gov/ttn/scram/appendix_w/2016/AppendixW_2017.pdf

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NMED Exhibit 3

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1.0 INTRODUCTION

1.1 Introductory Comments

Air pollution has been proven to have serious adverse impacts on human health and the environment. In response, governments have developed air quality standards designed to protect health and secondary impacts. The only way to predict compliance with these standards by a facility or modification that does not yet exist is to use models to simulate the impacts of the project. Regulatory models strike a balance between cost-effectiveness and accuracy, though the field of air quality prediction is not necessarily an inexpensive or a highly accurate field. The regulatory model design is an attempt to apply requirements in a standard way such that all sources are treated equally and equitably.

It is the duty of the NMED/Air Quality Bureau (the Bureau) to review modeling protocols and the resulting modeling analyses to ensure that air quality standards are protected and to ensure that regulations are applied consistently. This document is an attempt to document clear and consistent modeling procedures in order to achieve these goals. Occasionally, a situation will arise when it makes sense to deviate from the guidelines because of special site-specific conditions. Suggested deviations from the guidelines should be documented in a modeling protocol and submitted to the Bureau for approval prior to submission of modeling.

In general, the procedures in the EPA document, Guideline On Air Quality Models[1] (EPA publication number EPA-450/2-78-027R (revised)) as modified by Supplements A, B, and C should be followed when conducting the modeling analysis. This EPA document provides complete guidance on appropriate model applications. The purpose of this document is to provide clarification, additional guidance, and to highlight differences between the EPA document and New Mexico State modeling requirements.

Please do not hesitate to call the Bureau modeling staff with any questions you have before you begin the analysis. We are here to help; however, we will not conduct modeling courses. There are many courses offered which teach the principles of dispersion modeling. These courses provide a much better forum for learning about modeling than the Bureau modeling staff can provide.

1.2 The Modeling Review Process

1.2.1 Modeling Protocol Review

A modeling protocol should be submitted and approved before submitting a permit application. The Bureau will make every attempt to approve, conditionally approve, or reject the protocol within two weeks. Details regarding the protocol are described in section 6.0, Modeling Protocols. Protocols will be archived in the modeling archives in the protocol section until they can be stored with the files for the application.

1.2.2 Permit Modeling Evaluation

When a permit application involving air dispersion modeling is received, modeling staff has 30 days to determine whether the modeling analysis is administratively complete. The modeling section staff will make a quick determination to see if the modeling analysis appears complete. This involves checking to see if

---

[1] Environmental Protection Agency, 40 CFR Part 51, Revision to the Guideline on Air Quality Models http://www.epa.gov/ttn/scram/guidance/guide/appw_05.pdf

modeling files are attached and readable and verifying that application forms and modeling report are present. If the analysis is incomplete, the staff will inform the applicant of the deficiencies as quickly as possible. This will halt the permitting process until sufficient information is submitted. Deficiencies not resolved prior to the completeness determination deadline may result in ruling the application incomplete.

After the application has been ruled complete, Bureau staff will perform a complete review of the modeling files. This analysis includes a review to make sure that information in the modeling files are consistent with the information in the permit application and may involve the emission rate of each emission point, the elevation of sources, receptors, and buildings, evaluation and modification of DEM data, property fence line, or other aspects of the modeling inputs. If the dispersion modeling analysis submitted with the permit application adequately demonstrates that ambient air concentrations will be below air quality standards and/or Prevention of Significant Deterioration (PSD) increments, the Bureau modeler will summarize the findings and provide the information to the permit writer. If dispersion modeling predicts that the construction or modification causes or significantly contributes to an exceedance of a New Mexico or National Ambient Air Quality Standard (NMAAQS or NAAQS) or PSD increment, the permit cannot be issued under the normal permit process. For nonattainment modeling, refer to 20.2.72.216 NMAC, 20.2.79 NMAC, or contact the Bureau for further information.

The application (including modeling) is expected to be complete and in good order at the time it is received. However, the Bureau will accept general modifications or revisions to the modeling before the modeling is reviewed provided that the changes do not conflict with good modeling practices. Once the modeling review begins, only changes to correct problems or deficiencies uncovered during the review of the modeling will normally be accepted, and the Bureau will provide a deadline by which changes need to be submitted to allow for them to be reviewed and for the permit to be issued. No changes to modeling will be allowed after the review has been completed.

2.0 MODELING REQUIREMENTS AND STANDARDS

2.1 Regulatory Requirement for Modeling

The requirements to perform air dispersion modeling are detailed in New Mexico Administrative Code (NMAC) **20.2.70.300.D.10 NMAC** (Operating Permits), **20.2.72.203.A.4 NMAC** (Construction Permits), and **20.2.74.305 NMAC** (Permits - Prevention of Significant Deterioration), and 20.2.79 NMAC (Nonattainment). The language from these sections is listed below for easy reference.

Basically, with a construction permit application, an analysis of air quality standards is required, which normally requires air dispersion modeling. In some cases, previous modeling may satisfy this requirement. In these cases, the applicant may seek a modeling waiver from the Bureau. In any case, it is the responsibility of the applicant to provide the modeling, or the justification for the modeling waiver, or the air quality analysis for nonattainment areas. Title V sources that have not demonstrated compliance with a standard or increment are required to come into compliance with this applicable requirement. This may be accomplished by modeling to show the area is in attainment with this standard or increment. If they are not able to model compliance, then a compliance plan will be needed.

2.1.1 Title V Operating Permits

Federal air quality standards are applicable requirements for sources required to have an operating permit. Modeling is usually not required to issue a Title V operating permit. If a facility is not required to have a construction permit (e.g., some landfills and “Grandfathered” facilities) then it will need to model any new emissions or changes that could increase ambient pollutant concentrations.

Selected Title V regulatory language applying to modeling is copied below for easy reference.

> **20.2.70.7 NMAC DEFINITIONS:** In addition to the terms defined in 20.2.2 NMAC (definitions), as used in this part the following definitions shall apply.
>
> E. "Applicable requirement" means all of the following, as they apply to a Part 70 source or to an emissions unit at a Part 70 source (including requirements that have been promulgated or approved by the board or US EPA through rulemaking at the time of permit issuance but have future-effective compliance dates).
>
> (11) Any national ambient air quality standard.
>
> (12) Any increment or visibility requirement under Part C of Title I of the federal act, but only as it would apply to temporary sources permitted pursuant to Section 504(e) of the federal act.
>
> **20.2.70.201 NMAC REQUIREMENT FOR A PERMIT:**
>
> D, Requirement for permit under 20.2.72 NMAC.
>
> (1) Part 70 sources that have an operating permit and do not have a permit issued under 20.2.72 NMAC or 20.2.74 NMAC shall submit a complete application for a permit under 20.2.72 NMAC within 180 days of September 6, 2006. The department shall consider and may grant reasonable requests for extension of this deadline on a case-by-case basis.
>
> (2) Part 70 sources that do not have an operating permit or a permit under 20.2.72 NMAC upon the effective date of this subsection shall submit an application for a permit under 20.2.72 NMAC within 60 days after submittal of an application for an operating permit.
>
> (3) Paragraphs 1 and 2 of this subsection shall not apply to sources that have demonstrated compliance with both the national and state ambient air quality standards through dispersion modeling or other method approved by the department and that have requested incorporation of conditions in their operating permit to ensure compliance with these standards.

20.2.70.300.D.10 NMAC
(10) Provide certification of compliance, including all of the following.

(a) A certification, by a responsible official consistent with Subsection E of 20.2.70.300 NMAC, of the source's compliance status for each applicable requirement. For national ambient air quality standards, certifications shall be based on the following.

(i) For first time applications, this certification shall be based on modeling submitted with the application for a permit under 20.2.72 NMAC.

(ii) For permit renewal applications, this certification shall be based on compliance with the relevant terms and conditions of the current operating permit.

2.1.2 New Source Review (NSR) Permitting for Minor Sources

For new permits, a demonstration of compliance with air quality standards, PSD increments, and toxic air pollutants subject to 20.2.72.403.A(2) is required for all pollutants emitted by the facility. For significant revisions, a demonstration of compliance with air quality standards, PSD increments, and toxic air pollutants subject to 20.2.72.403.A(2) is required for all pollutants affected by the modification or permit revision. For technical revisions involving like kind replacement, as specified in 20.2.72.219B(1)(d), a demonstration that the replacement unit has stack parameters which are at least as effective in the dispersion of air pollutants is required (provided previous modeling determined the area to be in compliance with air quality standards). Permits for sources not in attainment with standards should refer to 20.2.72.216 NMAC, NONATTAINMENT AREA REQUIREMENTS.

If previous modeling has demonstrated compliance for each averaging period of each pollutant with a state or federal ambient air quality standard or toxic air pollutant, and that modeling used current modeling practices and is up-to-date for that area, then a modeling waiver may be used as the discussion demonstrating compliance. Otherwise, new modeling is required. For other minor source permitting actions, modeling is not part of the permitting process. Modeling waivers do not apply to nonattainment areas.

Selected NSR regulatory language applying to modeling is copied below for easy reference.
Definition of modification:

20.2.72.7 **DEFINITIONS:** In addition to the terms defined in 20.2.2 NMAC (Definitions) as used in this Part:

P. "Modification" means any physical change in, or change in the method of operation of, a stationary source which results in an increase in the potential emission rate of any regulated air contaminant emitted by the source or which results in the emission of any regulated air contaminant not previously emitted, but does not include:

(1) a change in ownership of the source;

(2) routine maintenance, repair or replacement;

(3) installation of air pollution control equipment, and all related process equipment and materials necessary for its operation, undertaken for the purpose of complying with regulations adopted by the board or pursuant to the Federal Act; or

(4) unless previously limited by enforceable permit conditions:

(a) an increase in the production rate, if such increase does not exceed the operating design capacity of the source;

(b) an increase in the hours of operation; or

(c) use of an alternative fuel or raw material if, prior to January 6, 1975, the source was capable of accommodating such fuel or raw material, or if use of an alternate fuel or raw material is caused by any natural gas curtailment or emergency allocation or any other lack of supply of natural gas.

Requirements for permit:

20.2.72.200 APPLICATION FOR CONSTRUCTION, MODIFICATION, NSPS, AND NESHAP - PERMITS AND REVISIONS:

A. Permits must be obtained from the Department by:

(1) Any person constructing a stationary source which has a potential emission rate greater than 10 pounds per hour or 25 tons per year of any regulated air contaminant for which there is a National or New Mexico Ambient Air Quality Standard. If the specified threshold in this subsection is exceeded for any one regulated air contaminant, all regulated air contaminants with National or New Mexico Ambient Air Quality Standards emitted are subject to permit review. Within this subsection, the potential emission rate for nitrogen dioxide shall be based on total oxides of nitrogen;

(2) Any person modifying a stationary source when all of the pollutant emitting activities at the entire facility, either prior to or following the modification, emit a regulated air contaminant for which there is a National or New Mexico Ambient Air Quality Standard with a potential emission rate greater than 10 pounds per hour or 25 tons per year and the regulated air contaminant is emitted as a result of the modification. If the specified threshold in this subsection is exceeded for any one regulated air contaminant, all regulated air contaminants with National or New Mexico Ambient Air Quality Standards emitted by the modification are subject to permit review. Within this subsection, the potential emission rate for nitrogen dioxide shall be based on total oxides of nitrogen;

Like-kind-replacement required modeling:

20.2.72.219 PERMIT REVISIONS:

B. Technical Permit Revisions:

(1) Technical permit revision procedures may be used only for:

(d) Modifications that replace an emissions unit for which the allowable emissions limits have been established in the permit, provided that the new emissions unit:

(i) Is equivalent to the replaced emissions unit, and serves the same function within the facility and process;

(ii) Has the same or lower capacity and potential emission rates;

(iii) Has the same or higher control efficiency, and stack parameters which are at least as effective in the dispersion of air pollutants;

(vi) Would not, when operated under applicable permit conditions, cause or contribute to a violation of any National or New Mexico Ambient Air Quality Standard; and

Modeling requirements for new permits or significant revisions:

20.2.72.203.A.4 NMAC

Contain a regulatory compliance discussion demonstrating compliance with each applicable air quality regulation, ambient air quality standard, prevention of significant deterioration increment, and provision of 20.2.72.400 NMAC - 20.2.72.499 NMAC. The discussion must include an analysis, which may require use of US EPA-approved air dispersion model(s), to (1) demonstrate that emissions from routine operations will not violate any New Mexico or National Ambient Air Quality Standard or prevention of significant deterioration increment, and (2) if required by 20.2.72.400 NMAC - 20.2.72.499 NMAC, estimate ambient concentrations of toxic air pollutants.

2.1.3 NSR Permitting for PSD Major Sources

PSD major sources and major modifications have additional modeling requirements beyond those of minor sources. PSD major source modeling authority is contained here:

> **20.2.74.305 NMAC AMBIENT AIR QUALITY MODELING:** All estimates of ambient concentrations required by this Part shall be based on applicable air quality models, data bases, and other requirements as specified in EPA's Guideline on Air Quality Models (EPA-450/2-78-027R, July, 1986), its revisions, or any superseding EPA document, and approved by the Department. Where an air quality impact model specified in the Guideline on Air Quality Models is inappropriate, the model may be modified or another model substituted. Any substitution or modification of a model must be approved by the Department. Notification shall be given by the Department of such a substitution or modification and the opportunity for public comment provided for in fulfilling the public notice requirements in subsection B of 20.2.74.400 NMAC. The Department will seek EPA approval of such substitutions or modifications.

2.2 Air pollutants

Emissions of Sulfur Dioxide (SO_2), Particulate matter with an aerodynamic diameter of less than or equal to 10 micrometers (PM_{10}), Particulate matter with an aerodynamic diameter of less than or equal to 2.5 micrometers ($PM_{2.5}$), Carbon Monoxide (CO), Nitrogen Dioxide (NO_2), Lead (Pb), Hydrogen sulfide (H_2S), and air toxics as listed in 20.2.72 NMAC are pollutants that may require modeling. Ozone and Volatile Organic Compound (VOC) emissions do not currently require a modeling analysis for a PSD minor source. If NO_X or VOCs are subject to PSD review, you should contact NMED and the EPA Regional Office to determine current ozone modeling requirements.

2.3 Modeling Exemptions and Reductions

2.3.1 Modeling waivers

In some cases, the demonstration that ambient air quality standards and PSD increments will not be violated can be satisfied with a discussion of previous modeling. If emissions have been modeled using current modeling procedures and air quality standards, and this modeling is still valid for the current standards, then the modeling waiver form may be submitted to request approval of a modeling waiver. The Bureau will determine on a case-by-case basis if the modeling waiver can be granted. The waiver discussion and written waiver approval should be included in the modeling section of the application.

The Bureau has performed generic modeling to demonstrate that the following small sources do not need modeling. The application must include a modeling waiver form to document the basis of the waiver. Permitting staff must approve the total emission rates during the permitting process for any waiver to be valid.

Table 1. Very small emission rate modeling waiver requirements

Pollutant	If all emissions come from stacks 20 feet or greater in height and there are no horizontal stacks or raincaps (lb/hr)	If not all emissions come from stacks 20 feet or greater in height, or there are horizontal stacks, raincaps, volume, or area sources (lb/hr)
CO	50	2
H_2S (Pecos-Permian Basin)	0.1	0.02
H_2S (Not in Pecos-Permian Basin)	0.01	0.002
Lead	Waiver not available.	Waiver not available.
NO_2	2	0.025
PM2.5	0.3	0.015
PM10	1.0	0.05
SO_2	2	0.025
Reduced sulfur (Pecos-Permian Basin)	0.033	Waiver not available.
Reduced sulfur (Not in Pecos-Permian Basin)	Waiver not available.	Waiver not available.

2.3.2 General Construction Permits (GCPs)

General Construction Permits do not require modeling. General modeling was performed in the development of these permits.

2.3.3 Streamlined Compressor Station Modeling Requirements

Compressor stations may be eligible for streamlined permits under the authority of **20.2.72.300-399 NMAC**. Streamlined permits have reduced modeling analysis requirements.

Streamlined Compressor Station Location Requirements

Restrictions preventing use of streamlined permits in certain locations are listed in **20.2.72.301 NMAC**. Those restrictions dealing with location are described below.

According to **20.2.72.301.B.4 NMAC**, the facility cannot co-locate with petroleum refineries, chemical manufacturing plants, bulk gasoline terminals, natural gas processing plants, or at any facility containing sources in addition to IC engines and/or turbines for which an air quality permit is required through state or federal air quality regulations.

20.2.72.301.B.5 NMAC restricts the location of streamlined permit in areas predicted by air quality monitoring or modeling to have more than 80% of state or federal ambient air quality standards or PSD increments consumed. Table 2, below, is a list of these areas. This restriction means that any streamlined permit applicant wishing to locate in a nonattainment area or those areas listed in Table 2 must demonstrate, using air dispersion modeling, that the entire facility will not produce any concentrations above significance levels.

Table 2. Areas Where Streamlined Permits Are Restricted

County	Latitude	Longitude	Radius (m)
San Juan	36.73120	-107.9608189	3000
San Juan	36.48296	-108.1200487	1000

* Locations within 150 meters of a facility that emits 25 tons per year of NO_X are restricted areas for streamlined compressor station permits unless modeling is performed.

20.2.72.301.B.6 NMAC prohibits the location of streamline permit from use in areas if the nearest property boundary will be located less than:
(a) 1 kilometer (km) from a school, residence, office building, or occupied structure. Buildings and structures within the immediate industrial complex of the source are not included.
(b) 3 km from the property boundary of any state park, Class II wilderness area, Class II national wildlife refuge, national historic park, state recreation area, or community with a population of more than twenty thousand people.

Table 3. List of state parks, Class I areas, Class II wilderness areas, Class II national wildlife refuges, national historic parks, and state recreation areas

County	Name	Type	Min. Distance (km)
Bernalillo	Sandia Mountain Wilderness	State Wilderness	3
Catron	Gila Wilderness	Class I Area	30
Catron	Gila Cliff Dwelling	National Monuments	3
Catron	Datil Well	Recreation Sites	3
Chaves	Bottomless Lake	Class II State Parks	3
Chaves	Salt Creek Wilderness Area	Class I Area	30
Chaves	Bitter Lake National W.R.	Class II Wildlife Refuge	3
Cibola	Bluewater Lake	Class II State Parks	3
Cibola	El Malpais	National Monuments	3
Cibola	El Morro	National Monuments	3
Colfax	Cimarron Canyon	Class II State Parks	3
Colfax	Maxwell National W.R.	Class II Wildlife Refuge	3
Colfax	Capulin	National Monuments	3
DeBaca	Sumner Lake	Class II State Parks	3
DeBaca	Ft. Sumner	State Monuments	3
Dona Ana	Leesburg Dam	Class II State Parks	3
Dona Ana	Aguirre Springs	Recreation Sites	3
Dona Ana	Ft. Seldon	State Monuments	3
Eddy	Carlsbad Caverns National Park	Class I Area	30
Eddy	Living Desert	Class II State Parks	3
Grant	Gila Wilderness	Class I Area	30
Grant	City of Rocks	Class II State Parks	3
Guadalupe	Santa Rosa Lake	Class II State Parks	3
Harding	Chicosa Lakes	Class II State Parks	3
Harding	Kiowa National Grasslands	National Grasslands	3
Lea	Harry McAdams	Class II State Parks	3
Lincoln	White Mountain Wilderness	Class I Area	30
Lincoln	Valley of Fires	Class II State Parks	3
Lincoln	Lincoln	State Monuments	3

County	Name	Type	Min. Distance (km)
Luna	Pancho Villa	Class II State Parks	3
Luna	Rock Hound	Class II State Parks	3
McKinley	Red Rock	Class II State Parks	3
Mora	Coyote Creek	Class II State Parks	3
Mora	Ft. Union	National Monuments	3
Otero	Oliver Lee	Class II State Parks	3
Otero	White Sands	National Monuments	3
Otero	Three Rivers Petro	Recreation Sites	3
Quay	Ute Lake	Class II State Parks	3
Rio Arriba	San Pedro Parks Wilderness	Class I Area	30
Rio Arriba	El Vado Lake	Class II State Parks	3
Rio Arriba	Heron Lake	Class II State Parks	3
Rio Arriba	Navajo Lake (Sims)	Class II State Parks	3
Rio Arriba	Chama River Canyon Wilderness	State Wilderness	3
Roosevelt	Oasis	Class II State Parks	3
Roosevelt	Grulla National W. R.	Class II Wildlife Refuge	3
San Juan	Navajo (Pine)	Class II State Parks	3
San Juan	Chaco Canyon	National Historic Park	3
San Juan	Aztec Ruins	National Monuments	3
San Juan	Angel Peak (National)	Recreation Area	3
San Miguel	Conchas Lake	Class II State Parks	3
San Miguel	Storey Lake	Class II State Parks	3
San Miguel	Villanueva	Class II State Parks	3
San Miguel	Las Vegas National W. R.	Class II Wildlife Refuge	3
San Miguel	Pecos	National Monuments	3
Sandoval	Bandelier Wilderness	Class I Area	30
Sandoval	Coronado	Class II State Parks	3
Sandoval	Rio Grande Gorge/Fenton Lake	Class II State Parks	3
Sandoval	Bandelier	National Monuments	3
Sandoval	Sandia Crest (State)	Recreation Area	3
Sandoval	Coronado	State Monuments	3
Sandoval	Jemez	State Monuments	3
Sandoval	Sandia Mountain Wilderness	State Wilderness	3
Santa Fe	Hyde Memorial	Class II State Parks	3
Sierra	Caballo Lake	Class II State Parks	3
Sierra	Elephant Butte Lake	Class II State Parks	3
Sierra	Percha Dam	Class II State Parks	3
Socorro	Bosque del Apache Wilderness	Class I Area	30
Socorro	Sevillita National W.R.	Class II Wildlife Refuge	3
Taos	Pecos Wilderness	Class I Area	30
Taos	Wheeler Park Wilderness	Class I Area	30
Taos	Kit Carson	Class II State Parks	3
Taos	Rio Grande Gorge	Recreation Sites	3
Taos	Latir Peak Wilderness	State Wilderness	3
Torrance	Manzano Mountain	Class II State Parks	3
Torrance	Grand Guivira	National Monuments	3

County	Name	Type	Min. Distance (km)
Torrance	Quarai at Salinas	National Monuments	3
Torrance	Abo at Salinas	State Monuments	3
Torrance	Manzano Mountain Wilderness	State Wilderness	3
Union	Clayton Lake	Class II State Parks	3
Valencia	Sen. Willie Chavez	Class II State Parks	3
Valencia	Manzano Mountain Wilderness	State Wilderness	3

(c) 10 km from the boundary of any community with a population of more than forty-thousand people, or
(d) 30 km from the boundary of any Class I area;

20.2.72.301.B.7 NMAC prohibits the location of streamline permit in Bernalillo County or within 15 km of the Bernalillo County line.

Streamlined Compressor Station Modeling and Public Notice Requirements

Modeling and public notice requirements for streamlined compressor station permits depend on the amount of emissions from the facility. Refer to the table below, using the maximum of the Potential to Emit (PTE) of each regulated contaminant from all sources at the facility to determine applicability. The potential to emit for nitrogen dioxide shall be based on total oxides of nitrogen. The effects of building downwash shall be included in modeling if there are buildings at the site.

Table 4. Streamlined Permit Applicability Requirements for facilities with less than 200 tons/year PTE

Applicable Regulation	PTE (TPY)	Modeling Requirements (from 20.2.72.301 D NMAC)
20.2.72.301 D (1)	<40	• None
20.2.72.301 D (2)	<100	• The impact on ambient air from all sources at the facility shall be less than the ambient significance levels.
20.2.72.301 D (3)	<200	• Air quality impacts must be less than 50% of all applicable NAAQS, NMAAQS and PSD increments. • There shall be no adjacent sources emitting the same air contaminant(s) as the source within 2.5 km of the modeled NO_2 impact area. • The sum of all potential emissions for NO_X from all adjacent sources within 15 km of the NO_X ROI must be less than 740 tons/year. • The sum of all potential emissions for NO_X from all adjacent sources within 25 km of the NO_X ROI must be less than 1540 tons/year.

There are other criteria that must be met for streamlined permits for compressor stations. Please refer to **20.2.72.300-399 NMAC** for more information.

2.3.4 Minor NSR Exempt Equipment

Exempt equipment under 20.7.72.202 NMAC do not need to be included in modeling for 20.2.72 NMAC permits. The exemption does not exclude them from modeling requirements under other types of permits, such as 20.2.70 NMAC or 20.2.74 NMAC.

2.4 Levels of Protection

2.4.1 Significance Levels

Modeling significance levels are thresholds below which the source is not considered to contribute to any predicted exceedance of air quality standards or PSD increments. The definition of ‘source’ can apply to the whole facility or to the modifications at the facility. For a new facility or an unpermitted facility, NMED considers the entire facility to be the ‘source’. For other cases, ‘source’ includes only the new equipment or new emissions increases described in the current application. Equipment that replaces other equipment is part of the new equipment.

Example of source to model for permitting:
The entire facility was modeled for annual NO_2 and 1-hour and 8-hour CO in 1999 but was never modeled for 1-hour NO_2. The facility applies to replace a widget. If this widget emits only NO_2 and CO, then modeling review is applicable for these pollutants. For CO and for NO_2, the applicant may model only the replacement widget. If the impacts from the widget alone are below significance levels, then modeling is done for that pollutant/averaging period. If the impacts from the widget alone are above significance levels, then the entire facility plus nearby sources must be modeled for comparison with air quality standards and PSD increments.

Significance levels are listed in **20.2.72.500 NMAC** and are repeated in the sections below. Always use the maximum predicted concentration from the source for radius of impact/significance level determination. Even if the form of the standard allows it to be exceeded several times per period, that fraction is based on cumulative concentration and cannot be related to partial concentrations. If multiple years of meteorological data are used, then the average of those concentrations is compared with the significance level, except for $PM_{2.5}$ and 1-hour SO_2, for which the maximum across multiple years is compared with the significance level.

Use of the $PM_{2.5}$ significant ambient concentration level or significant monitoring concentration for PSD major modifications or new PSD major sources is not allowed. This significant ambient concentration level may still be used for minor source permitting.

2.4.2 Air Quality Standards

Air quality standards are maximum allowable concentrations that are designed to protect the most sensitive individuals from harm from airborne pollutants. National Ambient Air Quality Standards (NAAQS) and New Mexico Ambient Air Quality Standards (NMAAQS) are explained below. Unless otherwise noted, standards are not to be exceeded.

2.4.3 Prevention of Significant Deterioration (PSD) Increments

To prevent relatively clean areas from degrading to levels just barely in compliance with the air quality standards, limits on the change have been established in the form of PSD increments. Compliance demonstrations for PSD increments demonstrate that the deterioration is less than the allowable increment.

List of State air quality standards:
http://www.nmcpr.state.nm.us/nmac/parts/title20/20.002.0003.htm

2.5 Concentration Conversions

Many of the air quality standards are written in the form of parts per million (ppm) or parts per billion (ppb), but the models generally give output in units of micrograms per cubic meter ($\mu g/m^3$). EPA has verbally communicated to NMED that AERMOD output is expressed at Standard Temperature and Pressure (STP) conditions. Therefore, most air quality standards can be compared to modeled concentration without corrections for elevation (and associated low pressure). If a need for elevation correction arises, a method to adjust for elevation is listed below.

2.5.1 Gaseous Conversion Factor for Elevation and Temperature Correction

The following equation calculates the conversion from $\mu g/m^3$ to ppm, with corrections for temperature and pressure (elevation):

$$ppm = 4.553 \times 10^{-5} \times \frac{C \times T}{M_w} \times 10^{Z \times 1.598 \times 10^{-5}}$$

or, rearranged to calculate $\mu g/m^3$:

$$C = ppm \text{ x } M_W /(T \text{ x } (4.553 \text{ E } -5) \text{ x } (10^{Z \text{ x } 1.598 \text{ E } -5}))$$

where:

C = component concentration in $\mu g/m^3$.
T = average summer morning temperature in Rankin at site (typically 530 R).
M_w = molecular weight of component.
Z = site elevation, in feet.

2.5.2 Gaseous Conversion Factor at Standard Temperature and Pressure (STP) Conditions

Federal standards are expressed as mass per unit volume or ppm or ppb under standard temperature and pressure.

> “40 CFR 50.3 Reference conditions.
> All measurements of air quality that are expressed as mass per unit volume (e.g., micrograms per cubic meter) other than for particulate matter (PM2.5) standards contained in §§ 50.7 and 50.13 and lead standards contained in § 50.16 shall be corrected to a reference temperature of 25 (deg) C and a reference pressure of 760 millimeters of mercury (1,013.2 millibars).”

If a monitored or modeled concentration has been adjusted to STP, then the following equation calculates the conversion from ppm to $\mu g/m^3$ for NAAQS:

$$C = ppm \text{ x } M_w \text{ x } 40.8727$$

or, rearranged to calculate ppm:

$$\text{ppm} = C / (M_w \times 40.8727)$$

where:

C = component concentration in µg/m^3.
M_w = molecular weight of component.

$$p = p_0 \cdot \left(1 - \frac{L \cdot h}{T_0}\right)^{\frac{g \cdot M}{R \cdot L}} \approx p_0 \cdot \exp\left(-\frac{g \cdot M \cdot h}{R \cdot T_0}\right),$$

Parameter	**Description**	**Value**
p_0	sea level standard atmospheric pressure	101325 Pa
L	temperature lapse rate	0.0065 K/m
T_0	sea level standard temperature	288.15 K
g	Earth-surface gravitational acceleration	9.80665 m/s^2
M	molar mass of dry air	0.0289644 kg/mol
R	universal gas constant	8.31447 J/(mol•K)

$$[PM10]_{STP} = [PM10]_{modeled} (P_{standard})(T_{measured})/((P_{calculated\ by\ elevation})(T_{standard}))$$

2.6 Modeling the Standards and Increments

Unless otherwise specified, the discussion of the standards assumes one year of representative meteorological data is used. For multiple years of data, some pollutants use the average of the values predicted for each year as the design value. Others (including PM2.5, CO, and Pb) use the maximum value from the multiple years of data. Verify the form of the standard in regulations and EPA memos if multiple years of meteorological data are being used. Background concentrations are averaged over three years unless otherwise specified.

In cases where all the emissions of the pollutant in question are emitted from permitted sources, the nearby sources may be modeled instead of adding the background concentration. CO, NO_2, and SO_2 may use this substitution if they are over 10 km from the center of Albuquerque and El Paso. To use this substitution, include all nearby sources.

2.6.1 Carbon Monoxide (CO) Standards

Table 5A: Carbon Monoxide Air Quality Standards

Averaging Period	Significance Level ($\mu g/m^3$)	NAAQS (ppm)	NAAQS ($\mu g/m^3$)	NMAAQS (ppm)	NMAAQS ($\mu g/m^3$)
8-hour	500	9	10,303.6	8.7	9,960.1
1-hour	2,000	35	40,069.6	13.1	14,997.5

2.6.1.1 Design value of CO standard.

CO NAAQS are not to be exceeded more than once per year. NMAAQS are not to be exceeded. Demonstration of compliance with CO NMAAQS automatically demonstrates compliance with NAAQS.

2.6.1.2 Modeling for the CO design value.

Tier 1, 1-hour NMAAQS: Model the entire facility to determine the high 1-hour concentration. Add the high 1-hour background concentration to the high 1-hour predicted concentration to determine the total design concentration for comparison to the 1-hour NMAAQS.

Tier 1, 8-hour NMAAQS: Model the entire facility to determine the high 8-hour concentration. Add the high 8-hour background concentration to the high 8-hour predicted concentration to determine the total design concentration for comparison to the 8-hour NMAAQS.

Optionally, all nearby sources may be modeled instead of adding a background concentration, if the facility is over 10 km from the center of Albuquerque and El Paso.

Tier 2: Hourly background concentrations may be added instead of the maximum concentrations for each averaging period.

2.6.2 Hydrogen sulfide (H_2S) Standards

Table 5B: Hydrogen Sulfide Air Quality Standards

Averaging Period	Significance Level ($\mu g/m^3$)	NMAAQS (ppm)	NMAAQS ($\mu g/m^3$)	Notes
1-hour	1.0	0.010	13.9	For the state, except for the Pecos-Permian Basin Intrastate AQCR. Not to be exceeded more than once per year.
1/2-hour	5.0	0.10	139.3	For the Pecos-Permian Basin Intrastate AQCR
1/2-hour	5.0	0.030	41.8	for within 5-miles of the corporate limits of municipalities within the Pecos-Permian Basin AQCR

Design value of standard: For modeling ½-hour H_2S NMAAQS, use the 1-hour averaging time because the models cannot resolve less than one-hour increments.

Model the entire facility and any nearby sources and compare the high 1-hour concentration to the standard for that region. No background concentration is added.

2.6.3 Lead (Pb) Standards

Table 5C: Lead Air Quality Standards

Averaging Period	Significance Level (μg/m^3)	NAAQS (μg/m^3)
Quarterly	0.03	0.15

Design value of standard: For modeling quarterly lead averages, use the monthly averaging period as a conservative approach, unless the model being used has a quarterly averaging period or post-processing is desired to calculate quarterly values. Model the entire facility without surrounding sources and compare the high month concentration to the standard. No background concentration is added.

2.6.4 Nitrogen Dioxide (NO_2) Standards

Table 5D: NO_2 Air Quality Standards

Averaging Period	Significance Level (μg/m^3)	NAAQS (ppb)	NAAQS (μg/m^3)	NMAAQS (ppb)	NMAAQS (μg/m^3)	Class II PSD Increment (μg/m^3)	Class I PSD Significance Level (μg/m^3)	Class I PSD Increment (μg/m^3)
annual	1.0	53	99.66	50	94.02	25	0.1[8]	2.5
24-hour	5.0			100	188.03			
1-hour	7.52[1]	100	188.03					

[1] EPA proposed significance level of 4 ppb corrected to a reference temperature of 25°C and a reference pressure of 760 millimeters of mercury.

2.6.4.1 Design value of NO_2 standard

Demonstration of compliance with 1-hour standard is automatically a demonstration of compliance with the 24-hour NMAAQS. Otherwise, the 24-hour NO_2 standard is compared with the highest 24-hour average calculated by the model.

The annual NMAAQS design value is determined by modeling the entire facility and adding the annual background concentration. The total is compared to the standard. Optionally, to determine the total design value, the facility and all nearby sources may be modeled instead of adding a background concentration if the facility is over 10 km from the center of Albuquerque and El Paso.

The annual NO_2 PSD increment is compared with the annual average calculated by the model.

The 1-hour NO_2 standard is compared with the 3-year average of the 98th-percentile of the annual distribution of daily maximum 1-hour concentrations. If one year of on-site meteorological data is used, the 98th-percentile value associated with the 1-year period of meteorological data modeled is the design value. Each day of modeling, the maximum 1-hour concentration is determined for each receptor. The high-eighth-high value at each receptor is calculated, and the maximum of these is compared with the standard. If multiple years are modeled, the maximum value is averaged over the span of years before comparing with standards.

2.6.4.2 NO_2 Reactivity

Combustion processes emit nitrogen oxides in the forms of nitrogen oxide (NO) and nitrogen dioxide (NO_2). Only the concentration of NO_2 is regulated by air quality standards; however, emissions of nitrogen oxides ($NO_X = NO + NO_2$) must be modeled to estimate total NO_2 concentrations because nitrogen oxides change form in the atmosphere.

Two key reactions are most important in determining the equilibrium (or quasi-equilibrium) ratio of NO_2 to NO.

$$NO + O_3 \rightarrow NO_2 + O_2$$

$$NO_2 + h\nu \text{ (energy)} \rightarrow NO + O$$

Many other reactions participate in the determination of the atmospheric concentration of NO_2. As the plume travels away from the stack, more and more ozone diffuses into the plume, enabling the relatively quick reaction to form NO_2.

2.6.4.3 Estimating NO_2 concentrations

The Bureau has approved techniques, described below, for estimating NO_2 concentrations from NO_X point sources. Note that NO_2 emissions reported by the emissions inventory are actually NO_X emissions.

Tier 1, Total Conversion Technique: 100% conversion
This technique assumes all the NO_X is converted to NO_2. This simple technique is suitable for small facilities where compliance with standards is not a problem.

Tier 2, Ambient Ratio Method 2 (ARM2) Technique
ARM2 method is included as an option in AERMOD. This method is approved without the need for EPA approval. 0.5 is the national default for minimum ambient ratio. A minimum ambient ratio as low as 0.2 may be used by providing evidence that the in-stack ratio of the modeled emission units is equal to or lower than the minimum ambient ratio used. The default maximum ratio is 0.9.

Tier 3, Ozone Reaction Techniques
Two methods account for the ozone that mixes into the plumes and encourages NO_2 formation: Ozone Limiting Method (OLM) and Plume Volume Molar Ratio Method (PVMRM). Both these techniques are accepted and are built into AERMOD.
OLM assumes an NO_2 plume and an NO plume are each dispersing. The in-stack ratio of NO_2/NO_X is used to determine the amount of nitrogen dioxide initially in each plume. The concentration of NO at each receptor is assumed to react stoichiometrically with the background ozone concentration at that time to form NO_2. Contributions from both plumes are added to get the NO_2 concentration at that time.

PVMRM works similarly to OLM but uses the total volume of the plume by the time it reaches the receptor to calculate how much ozone is available for reaction. Both methods result in greater conversion with greater distance from the source but use different approximations for determining how much ozone has dispersed into the plume.

Both methods require additional information.
For the equilibrium NO_2/NO_X ratio, the value of 0.9 is approved.

For the in-stack NO_2/NO_X ratio, values lower than 0.5 must be justified with data. Combustion involving excess oxygen results in higher in-stack NO_2/NO_X ratios than do stoichiometric reactions. The facility may use an in-stack ratio of 0.5 without justification. Surrounding sources, if required, may be modeled with an in-stack ratio of 0.3 without justification.

Recent ozone data representative of the area should be used. See the section on background concentrations for more information.

Special techniques are required to model PSD increment with OLM or PVMRM if increment-expanding sources are being modeled. No negative emission rates can be used. See *ADDENDUM, USER'S GUIDE FOR THE AMS/EPA REGULATORY MODEL – AERMOD (EPA-454/B-03-001, September 2004),* Pg. 25, for more details on the PSDCREDIT option. **(http://www.rflee.com/RFL_Pages/AERMOD_USERGUIDE_ADDENDUM_06341.pdf)**

Combined-Plume Option vs. Individual-Plume Option

AERMOD provides two options for calculating ozone-limited NO_2 concentrations, the "plume-by-plume" (INDVDL) calculation, and the combined plume (SRCGRP) calculation. The Bureau has accepted a general demonstration that if two plumes are impacting the same receptor at the same time, then the two plumes have merged. If the plumes do not impact the same receptor at the same time, then the plumes have not merged, but both options will calculate the same concentration for that hour. Therefore, the Bureau will accept either INDVL or SRCGP option without additional demonstrations.

2.6.4.4 Modeling for the 1-hour NO_2 design value

Model the entire facility and add the 98th percentile 1-hour background concentration to compare to the design value. Optionally, all nearby sources may be modeled instead of adding a background concentration if the facility is over 10 km from the center of Albuquerque and El Paso, Texas. Refined hourly background concentrations may be used instead of the maximum 1-hour concentration as described in the section on background concentrations.

Before attempting to calculate the design value, first locate the areas with highest overall concentrations. Place a few receptors in these areas and re-run the model in these areas. The maximums will occur in nearly the same places.

Maximum modeled concentration may also be used as a conservative approximation of the design value.

"The highest of the average 8th-highest (98th-percentile) concentrations across all receptors, based on the length of the meteorological data period, represents the modeled 1-hour NO_2 design value based on the form of the standard."

2.6.4.5 Modeling for the annual NO_2 NMAAQS design value

Model the entire facility and add the annual background concentration to compare to the design value. Optionally, all nearby sources may be modeled instead of adding a background concentration if the facility is over 10 km from the center of Albuquerque and El Paso, Texas. (Use of hourly background concentrations does not affect the result for an annual average).

2.6.4.6 Modeling for the annual NO_2 PSD increment design value

Model all increment-consuming parts of the facility and increment-consuming nearby sources of the facility (or nearby sources of the Class I area for Class I analysis). Compare the result to the design value. All sources (not just increment affecting sources) will need to be modeled in order to take credit for increment expanding sources using OLM or PVMRM. See the AERMOD User's Guide Addendum for more details.

2.6.5 Ozone (O_3) Standards

Ozone is normally only modeled for regional compliance demonstrations and does not need to be modeled for air quality permits. However, permit applicants for PSD applications that apply to NO_X or VOCs should contact NMED and the EPA Regional Office to determine how to complete the ozone ambient impact analysis.

Table 5E: O_3 Air Quality Standards

Averaging Period	**Significance Level** ($\mu g/m^3$)	**NAAQS (ppm)**	**NAAQS** ($\mu g/m^3$)
8-hour	1.96 [2]	0.07[1]	137.3

[1] To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.07 ppm.
[2] 1.0 ppb, Guidance on Significant Impact Levels for Ozone and Fine Particles in the Prevention of Significant Deterioration Permitting Program, EPA, April 17, 2018

Ozone concentrations may be estimated using the following method derived from the MERP guidance[2].

$[O3] = ((NO_X \text{ emission rate (tons/year) }/184) + (\text{VOC emission rate (tons/year) }/1049)) \times 1.96\ \mu g/m^3$

> "Simulation of ozone formation and transport is a highly complex and resource intensive exercise. Control agencies with jurisdiction over areas with ozone problems are encouraged to use photochemical grid models, such as the Models-3/Community Multi-scale Air Quality (CMAQ) modeling system, to evaluate the relationship between precursor species and ozone." --68234 Federal Register / Vol. 70, No. 216 / Wednesday, November 9, 2005 / Rules and Regulations

In accordance with this guidance, NMED performs ozone modeling on a regional scale as need arises, rather than requiring permit applicants to quantify their contribution to a regional ozone concentration. Comprehensive ozone modeling is too resource intensive to attach this expense to a typical permit application, and screening modeling on an affordable scale currently cannot quantify a source's impacts to ambient ozone concentrations.

Regional ozone modeling for the Four Corners area was done in 2009 (see http://www.nmenv.state.nm.us/aqb/4C/Modeling.html) and the Air Quality Bureau is continuing to analyze ozone in the region.

2.6.6 Particulate matter less than 2.5 micrometers in aerodynamic diameter ($PM_{2.5}$) Standards

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[2] Guidance on the Development of Modeled Emission Rates for Precursors (MERPS) as a Tier 1 Demonstration Tool for Ozone and $PM_{2.5}$ under the PSD Permitting Program, Richard A. Wayland, EPA, December 2, 2016.

Table 5F: $PM_{2.5}$ Air Quality Standards[3]

Averaging Period	Significance Level [4] ($\mu g/m^3$)	NAAQS ($\mu g/m^3$)	Class II PSD Increment[3] ($\mu g/m^3$)	Class I PSD Significance Level ($\mu g/m^3$)	Class I PSD Increment[3] ($\mu g/m^3$)
annual	0.2	12 [1]	4	0.05	1
24-hour	1.2	35 [2]	9	0.27	2

[1] To attain this standard, the 3-year average of the annual arithmetic mean $PM_{2.5}$ concentrations from single or multiple community-oriented monitors must not exceed 12.0 ug/m^3.
[2] To attain this standard, the 3-year average of the 98th percentile of 24-hour concentrations at each population-oriented monitor within an area must not exceed 35 ug/m^3.
[3] For any period other than an annual period, the applicable maximum allowable increase may be exceeded during one such period per year at any one location.
[4] Guidance on Significant Impact Levels for Ozone and Fine Particles in the Prevention of Significant Deterioration Permitting Program, EPA, April 17, 2018.

$PM_{2.5}$ secondary formation concentrations may be estimated using the following method derived from the MERP guidance[4].

$$[PM_{2.5}]_{annual} =$$
$$((NO_X \text{ emission rate (tons/year) } /3184) + (SO_2 \text{ emission rate (tons/year) } /2289)) \times 0.2\ \mu g/m^3$$

$$[PM_{2.5}]_{24\text{-}hour} =$$
$$((NO_X \text{ emission rate (tons/year) } /1155) + (SO_2 \text{ emission rate (tons/year) } /225)) \times 1.2\ \mu g/m^3$$

Secondary formation from the project should be added to the modeled value. Refined factors for certain geographic areas may be developed using the MERP guidance.

2.6.6.1 $PM_{2.5}$ design value

The 24-hour design value is the 98th percentile of the combined concentrations from all sources. The annual design value is the annual average.

2.6.6.2 Modeling for the 24-hour $PM_{2.5}$ design value

AERMOD and current emissions inventories currently do not account for secondary formation of $PM_{2.5}$ in the atmosphere. Sources that emit at least 40 tons per year of NO_X or at least 40 tons per year of SO_2 are

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[3] Prevention of Significant Deterioration (PSD) for Particulate Matter Less Than 2.5 Micrometers ($PM_{2.5}$) – Increments, Significant Impact Levels (SILs) and Significant Monitoring Concentration (SMC), ENVIRONMENTAL PROTECTION AGENCY
40 CFR Parts 51 and 52, RIN 2060-AO24 http://www.epa.gov/nsr/documents/20100929finalrule.pdf
[4] Guidance on the Development of Modeled Emission Rates for Precursors (MERPS) as a Tier 1 Demonstration Tool for Ozone and PM2.5 under the PSD Permitting Program, Richard A. Wayland, EPA, December 2, 2016.

considered to emit significant amounts of precursors. Sources with significant increases of $PM_{2.5}$ precursors must qualitatively and/or quantitatively account for secondary formation of $PM_{2.5}$.[5]

Two tiers of modeling are available for $PM_{2.5}$ modeling. Both tiers include modeling the facility and nearby sources and adding secondary formation and a background concentration to that. Particulate sources typically have impacts in the immediate vicinity of the source that are not represented in background monitors, so double-counting of background concentrations is expected to be limited.

Add the design value of the modeled direct $PM_{2.5}$ to the design value of the secondary $PM_{2.5}$ and the design value of the background $PM_{2.5}$.

Tier 1: To the modeled concentration(s), add the secondary $PM_{2.5}$ and the 98th percentile 24-hour monitored background concentration.
Tier 2: Add the secondary $PM_{2.5}$ and the monthly or quarterly maximum background concentrations to daily modeled concentrations. Compare the high-eighth-high combined concentration with the 24-hour standard. If multiple years of meteorological data are used, then the high-eighth-high combined concentration is compared with the standard.

2.6.6.3 Modeling for the 24-hour $PM_{2.5}$ PSD increment design value

Model the high-second-high concentration of all increment-consuming sources at the facility and at nearby sources. Calculate secondary formation from NO_X and SO_2 increases after the appropriate baseline date and add that to the modeled concentration. Compare the total with the 24-hour PSD increment.

2.6.6.4 Modeling for the annual $PM_{2.5}$ PSD increment design value

Model all increment-consuming sources at the facility and at nearby sources. Calculate secondary formation from NO_X and SO_2 increases after the appropriate baseline date and add that to the modeled concentration. Compare the total predicted annual average concentration with the allowable increment.

2.6.7 Particulate matter less than 10 micrometers in aerodynamic diameter (PM_{10}) Standards

Table 5G: PM_{10} Air Quality Standards

Averaging Period	Significance Level (µg/m^3)	NAAQS (µg/m^3)	PSD Increment[2] Class II (µg/m^3)	PSD Class I Significance Level (µg/m^3)	PSD Class I Increment[2] (µg/m^3)
annual	1.0		17	0.2[1]	4
24-hour	5.0	150	30	0.3[1]	8

[1] EPA proposed significance level
[2] For any period other than an annual period, the applicable maximum allowable increase may be exceeded during one such period per year at any one location.

2.6.7.1 Modeling for the 24-hour PM_{10} NAAQS design value

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[5] Guidance for PM2.5 Permit Modeling, Stephen D. Page, May 20, 2014. http://www.epa.gov/ttn/scram/guidance/guide/Guidance_for_PM25_Permit_Modeling.pdf

If PM2.5 emission rates are modeled as equal to PM10 emission rates, then the PM2.5 NAAQS demonstration will satisfy the requirement for demonstration of compliance with PM10 NAAQS. However, PM10 PSD increment demonstration is not necessarily satisfied by any PM2.5 modeling.

The 24-hour NAAQS is not to be exceeded more than once per year.
Use high second high and a single year of representative meteorological data. This is approximately equivalent to the high fourth high specified in the multi-year analysis.
"…[W]hen n years are modeled, the (n+1)th highest concentration over the n-year period is the design value, since this represents an average or expected exceedance rate of one per year."
http://www.epa.gov/ttn/scram/guidance/guide/appw_05.pdf

Two tiers of modeling are available for PM_{10} NAAQS modeling. Both tiers include modeling the facility and nearby sources and adding a background concentration to that. Particulate sources typically have impacts in the immediate vicinity of the source that are not represented in background monitors, so double-counting of background concentrations is expected to be limited.

Tier 1, option 1: Use highest predicted concentration (instead of the high second high) and a single year of representative meteorological data. To the modeled concentration, add the high second high 24-hour monitored background concentration.

Tier 1, option 2: Use high second high predicted concentration and a single year of representative meteorological data. To the modeled concentration, add the highest 24-hour monitored background concentration.

Tier 2: Add monthly maximum background concentrations to daily modeled concentrations. The high-second-high combined concentration may be compared with the 24-hour standard.

2.6.7.2 Modeling for the 24-hour PM_{10} PSD increment design value

Model all increment-consuming sources at the facility and at nearby sources. Compare the high-second-high predicted concentration with the allowable increment.

2.6.7.3 Modeling for the annual PM_{10} PSD increment design value

Model all increment-consuming sources at the facility and at nearby sources. Compare the predicted annual average concentration with the allowable increment.

2.6.8 Sulfur Dioxide (SO_2) Standards

Table 5I: SO_2 Air Quality Standards

Averaging Period	Significance Level (µg/m^3)	NAAQS (ppb)	NAAQS (µg/m^3)	NMAAQS (ppb)	NMAAQS (µg/m^3)	PSD Class II Increment[3] (µg/m^3)	PSD Class I Significance Level (µg/m^3)	PSD Class I Increment[3] (µg/m^3)
annual	1.0			20	52.4	20	0.1[2]	2
24-hour	5.0			100	261.9	91	0.2[2]	5
3-hour	25.0	500	1309.3			512	1.0[2]	25
1-hour	7.8[1]	75	196.4					

[1] EPA proposed 1-hour significance level of 3 ppb corrected to a reference temperature of 25°C and a reference pressure of 760 millimeters of mercury.

[2] EPA proposed significance level.
[3] For any period other than an annual period, the applicable maximum allowable increase may be exceeded during one such period per year at any one location.

2.6.8.1 SO_2 design value

In NMAC, the SO_2 standards for the area within 3.5 miles of the Chino Mines Company smelter furnace stack at Hurley are set equal to the federal standards. However, since this stack no longer exists, the distance is irrelevant. The NMAAQS listed in table 5I apply for the entire state.
Demonstration of compliance with 1-hour standard will also demonstrate compliance with the other standards, but not necessarily the PSD increments.

The form is the 3-year average of the 99th percentile of the annual distribution of daily maximum 1-hour average concentrations.

2.6.8.2 Modeling for the 1-hour SO_2 NAAQS

The standard is calculated similarly to the NO_2 1-hour standard instructions in section 2.6.4.4, but the fourth highest is used in place of the eighth highest (and 99th percentile is substituted for 98th percentile). All sulfur oxides are assumed to be in the form of SO_2. If multiple years are modeled, the resulting high-fourth-high values at each receptor are averaged over the years modeled and the maximum average value is compared with the standard.

Tier 1: Add the 99th percentile 1-hour background concentration to 99th percentile modeling for the entire facility (without neighboring sources) and compare the total with the 1-hour NAAQS. Optionally, to determine the total design value, the facility and all nearby sources may be modeled instead of adding a background concentration if the facility is over 10 km from the center of Albuquerque and El Paso.

Tier 2: Add the hourly 1-hour background concentrations (as described in the background concentration section) to each hour of the modeling results and compare the 99th percentile of the totals with the 1-hour NAAQS. Optionally, to determine the total design value, the facility and all nearby sources may be modeled instead of adding a background concentration if the facility is over 10 km from the center of Albuquerque and El Paso.

2.6.8.3 Modeling for the 3-hour SO_2 PSD increment

Model the increment consuming emissions at the facility and at nearby sources and compare the high-second-high 3-hour average with the allowable PSD increment.

2.6.8.4 Modeling for the 24-hour SO_2 PSD increment

Model the increment consuming emissions at the facility and at nearby sources and compare the high-second-high 24-hour average with the allowable PSD increment.

2.6.8.5 Modeling for the annual SO_2 PSD increment

Model the increment consuming emissions at the facility and at nearby sources and compare the predicted annual average with the allowable PSD increment.

2.6.9 Total Reduced Sulfur Except For Hydrogen Sulfide Standards

Table 5J: Total Reduced Sulfur except for H_2S Air Quality Standards

Averaging Period	NMAAQS (ppm)	Notes
1/2-hour	0.003	for the state, except for the Pecos-Permian Basin Intrastate AQCR
1/2-hour	0.010	for the Pecos-Permian Basin Intrastate AQCR
1/2-hour	0.003	For within corporate limits of municipalities within the Pecos-Permian Basin Intrastate Air Quality Control Region.
1/2-hour	0.003	For within five miles of the corporate limits of municipalities having a population of greater than twenty thousand and within the Pecos-Permian Basin Intrastate Air Quality Control Region

2.6.9.1 Total Reduced Sulfur design value

EPA test methods suggest that reduced sulfur compounds in some cases consist primarily of carbon disulfide (CS_2), carbonyl sulfide (COS), and hydrogen sulfide (H_2S). To calculate the parts per million of reduced sulfur, use the average molecular weight in the sample. For example, 1-heptanethiol ($CH_3[CH_2]6SH$) has a molecular weight of 132.3.

For modeling ½-hour total reduced sulfur NMAAQS, use the 1-hour averaging time because the models cannot resolve less than one hour increments.

2.6.9.2 Modeling the Total Reduced Sulfur ½-hour NMAAQS

Model the entire facility and compare the 1-hour predicted concentration with the ½-hour NMAAQS. Surrounding sources and background concentrations are not added.

Table 6A. Air Quality Standard Summary (Without Notes).

Pollutant	Avg. Period	Sig. Lev. (µg/m^3)	Class I Sig. Lev. (µg/m^3)	NAAQS (µg/m^3)	NMAAQS (µg/m^3 unless noted)	PSD Increment Class I (µg/m^3)	PSD Increment Class II (µg/m^3)
CO	8-hour	500		10,303.6	9,960.1		
	1-hour	2,000		40,069.6	14,997.5		
H_2S	1-hour	1.0			13.9		
	1/2-hour	5.0			139.3		
	1/2-hour	5.0			41.8		
Pb	Quarterly	0.03		0.15			
NO_2	annual	1.0	0.1	99.66	94.02	2.5	25
	24-hour	5.0			188.03		
	1-hour	7.52		188.03			
O_3	8-hour	1.96		137.3			
$PM_{2.5}$	annual	0.2	0.05	12		1	4
	24-hour	1.2	0.27	35		2	9
PM_{10}	annual	1.0	0.2			4	17
	24-hour	5.0	0.3	150		8	30
SO_2	annual	1.0	0.1		52.4	2	20
	24-hour	5.0	0.2		261.9	5	91
	3-hour	25.0	1.0	1309.3		25	512
	1-hour	7.8		196.4			
Reduced S	1/2-hour				3 ppb		
	1/2-hour				10 ppb		

Table 6B. Standards for which Modeling is not Required.

Standard not Modeled	Surrogate that Demonstrates Compliance
CO 8-hour NAAQS	CO 8-hour NMAAQS
CO 1-hour NAAQS	CO 1-hour NMAAQS
NO_2 annual NAAQS	NO_2 annual NMAAQS
NO_2 24-hour NMAAQS	NO_2 1-hour NAAQS
O_3 8-hour	Regional modeling
SO_2 annual NMAAQS	SO_2 1-hour NAAQS
SO_2 24-hour NMAAQS	SO_2 1-hour NAAQS
SO_2 3-hour NAAQS	SO_2 1-hour NAAQS

Table 6C. Modeling the Design Value Summary (Default Modeling).

Averaging Period	Add Nearby Sources?	Add Background Concentration?	Modeled Concentration
CO 8-hour NMAAQS	No* (Yes)	Yes* (high 8 hour) (No)	high 8 hour
CO 1-hour NMAAQS	No* (Yes)	Yes* (high 1 hour) (No)	high 1 hour
H_2S 1-hour or ½-hour NMAAQS	Yes	No	high 1 hour
Pb Quarterly NMAAQS	No	No	high month
NO_2 annual NMAAQS	No* (Yes)	Yes* (annual average) (No)	annual average
NO_2 annual PSD increment	Yes	No	annual average
NO_2 1-hour NAAQS	No* (Yes)	Yes* (1-hr 98th percentile) (No)	98th-percentile 1 hour
$PM_{2.5}$ annual NAAQS	Yes	Yes (annual average)	annual average
$PM_{2.5}$ annual PSD increment	Yes	No	annual average
$PM_{2.5}$ 24-hour NAAQS	Yes	Yes (24-hr 98th percentile)	98th-percentile 24 hour
$PM_{2.5}$ 24-hour PSD increment	Yes	No	high 24 hour
PM_{10} annual PSD increment	Yes	No	annual average
PM_{10} 24-hour NAAQS	Yes	Yes (high 24 hour)	high second high 24 hour
PM_{10} 24-hour PSD increment	Yes	No	high second high 24 hour
SO_2 annual PSD increment	Yes	No	annual average
SO_2 24-hour PSD increment	Yes	No	high second high 24 hour
SO_2 3-hour PSD increment	Yes	No	high second high 3 hour
SO_2 1-hour NAAQS	No* (Yes)	Yes* (high 1 hour) (No)	99th-percentile 1 hour
Reduced S ½-hour NMAAQS	No	No	high 1 hour

* Standards marked with an asterisk normally offer the choice to either model nearby sources or add a representative background concentration.

2.7 PSD Increment Modeling

2.7.1 Air Quality Control Regions and PSD Baseline Dates

Any facility that is required to provide an air dispersion modeling analysis with its construction permit application is required to submit a PSD increment consumption analysis unless none of its sources consume PSD increment. Table 7 serves as a tool to determine which sources to include in PSD increment modeling.

Table 7: PSD Increment Consumption and Expansion

Sources that do not consume PSD increment	• Temporary emissions (sources involved in a project that will be completed in a year or less). • Any facility or modification to a facility constructed before the PSD major source baseline date. • Any minor source constructed before the PSD minor source baseline date.
Sources that consume PSD increment	• Any new emissions or increase in emissions after the PSD Minor Source Baseline date (for that AQCR and pollutant). • Any new emissions or increase in emissions at a PSD Major source that occurs after the Major Source Baseline Date.
Sources that expand PSD increment	• A permanent reduction in actual emissions from a baseline source.

Notes:

- EPA memos written before the publication of the Draft NSR Workshop Manual indicate that PSD regulations were not intended to apply to temporary pilot projects. The memo clearly indicated that the pilot project did not need a PSD permit.
- If a minor source facility once existed but shut down before the minor source baseline date, then it would not be considered to be part of the baseline.
- Haul road emissions are treated the same way other sources of emissions are treated.
- An increase in emissions due to increased utilization of a facility, such as de-bottlenecking, are treated as any other increase in emissions.
- The Bureau interprets temporary emissions to mean emissions at the location that will occur for less than one year or emissions of standby or emergency equipment that operates less than 500 hours per year. For example, if a series of three gravel crushers operate at a mine for more than one year, PSD increment modeling should be performed because the mining operations at the location are not temporary in nature, even though none of the of individual crushers remained on-site for an entire year.

Table 8: Minor Source Baseline Dates by Air Quality Control Region

AQCR	NO_2 Date	SO_2 Date	PM_{10} Date	$PM_{2.5}$ Date
12	8/10/1995	8/10/1995	8/10/1995	Not established
14	6/6/1989	8/7/1978	8/7/1978	Not established
152	3/26/1997	5/14/1981	3/26/1997	2/11/2013
153	8/2/1995	Not established	6/16/2000	Not established
154	Not established	Not established	Not established	Not established
155	3/16/1988	7/28/1978	2/20/1979	11/13/2013
156	Not established	8/4/1978	8/4/1978	Not established
157	Not established	Not established	Not established	Not established

Table 9: Major Source Baseline Dates and Trigger Dates

Pollutant	Major Source Baseline Date	Trigger Date
PM	January 6, 1975	August 7, 1977
SO_2	January 6, 1975	August 7, 1977
NO_2	February 8, 1988	February 8, 1988
$PM_{2.5}$	October 20, 2010	October 20, 2011

2.7.2 PSD Class I Areas

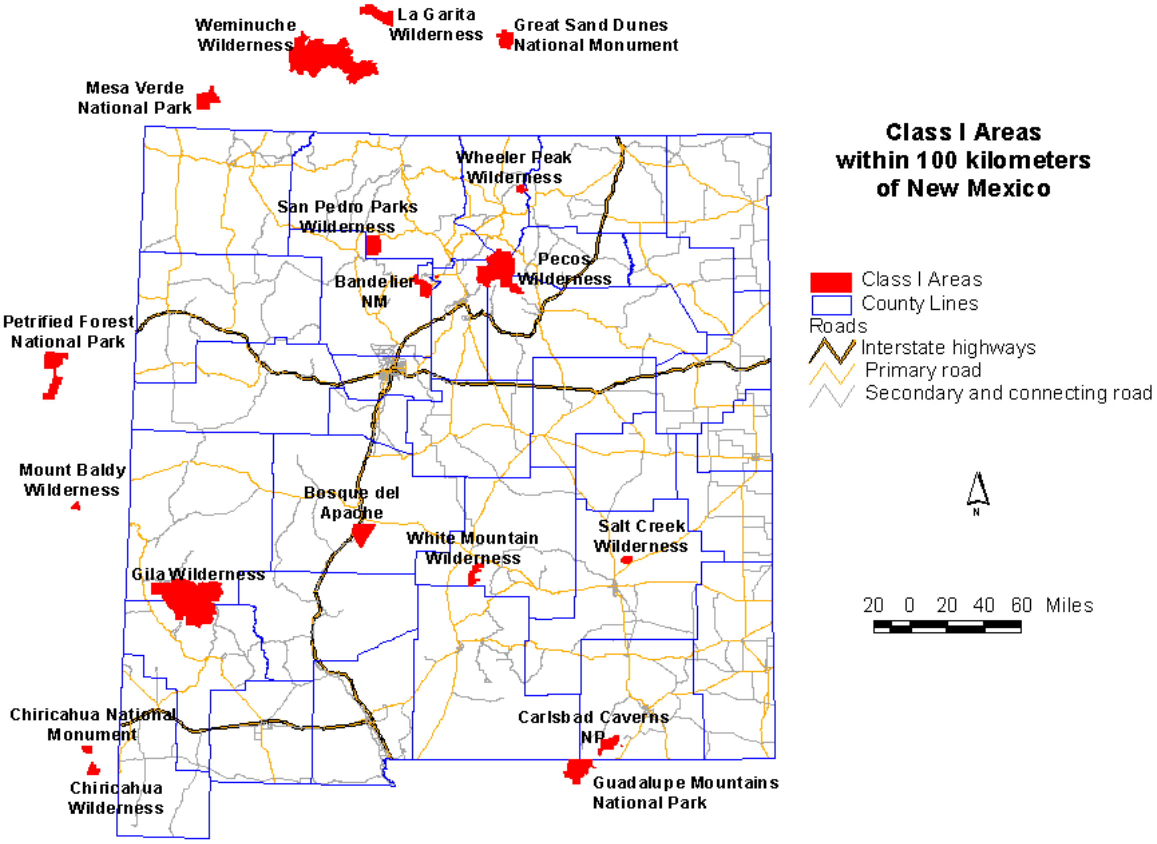

Figure 1: Class I areas

2.7.3 PSD Class I Area Proposed Significance Levels

The Environmental Protection Agency (EPA) has proposed significance levels for PSD Class I areas. No significance levels have been promulgated, but the Federal land managers (FLMs) are currently accepting the use of this value.

Table 10. Class I Prevention of Significant Deterioration Significance Levels

Pollutant	Averaging Period	Significance Level ($\mu g/m^3$)	PSD Class I Increment ($\mu g/m^3$)
Sulfur Dioxide (SO_2)	annual [a] 24-hour 3-hour	0.1 [b] 0.2 [b] 1.0 [b]	2 5 25
PM_{10}	annual [a] 24-hour	0.2 [b] 0.3 [b]	4 8
Nitrogen Dioxide (NO_2)	annual [a]	0.1 [b]	2.5
$PM_{2.5}$	annual 24-hour	0.06 0.07	1 2

[a] annual arithmetic mean

[b] EPA proposed significance level

2.8 New Mexico State Air Toxics Modeling

Modeling must be provided for any toxic air pollutant sources that may emit any toxic pollutant in excess of the emission levels specified in **20.2.72.502 NMAC -** Permits for Toxic Air Pollutants. Sources may use a correction factor based on release height for the purpose of determining whether modeling is required. Divide the emission rate for each release point by the correction factor for that release height on Table 11 and add the total values together to determine the total adjusted emission rate. If the total adjusted emission rate is higher than the emission rate in pounds per hour listed in **20.2.72.502 NMAC**, then modeling is required. The controlled emission rate (not the adjusted emission rate) of the toxic pollutant should be used for the dispersion modeling analysis.

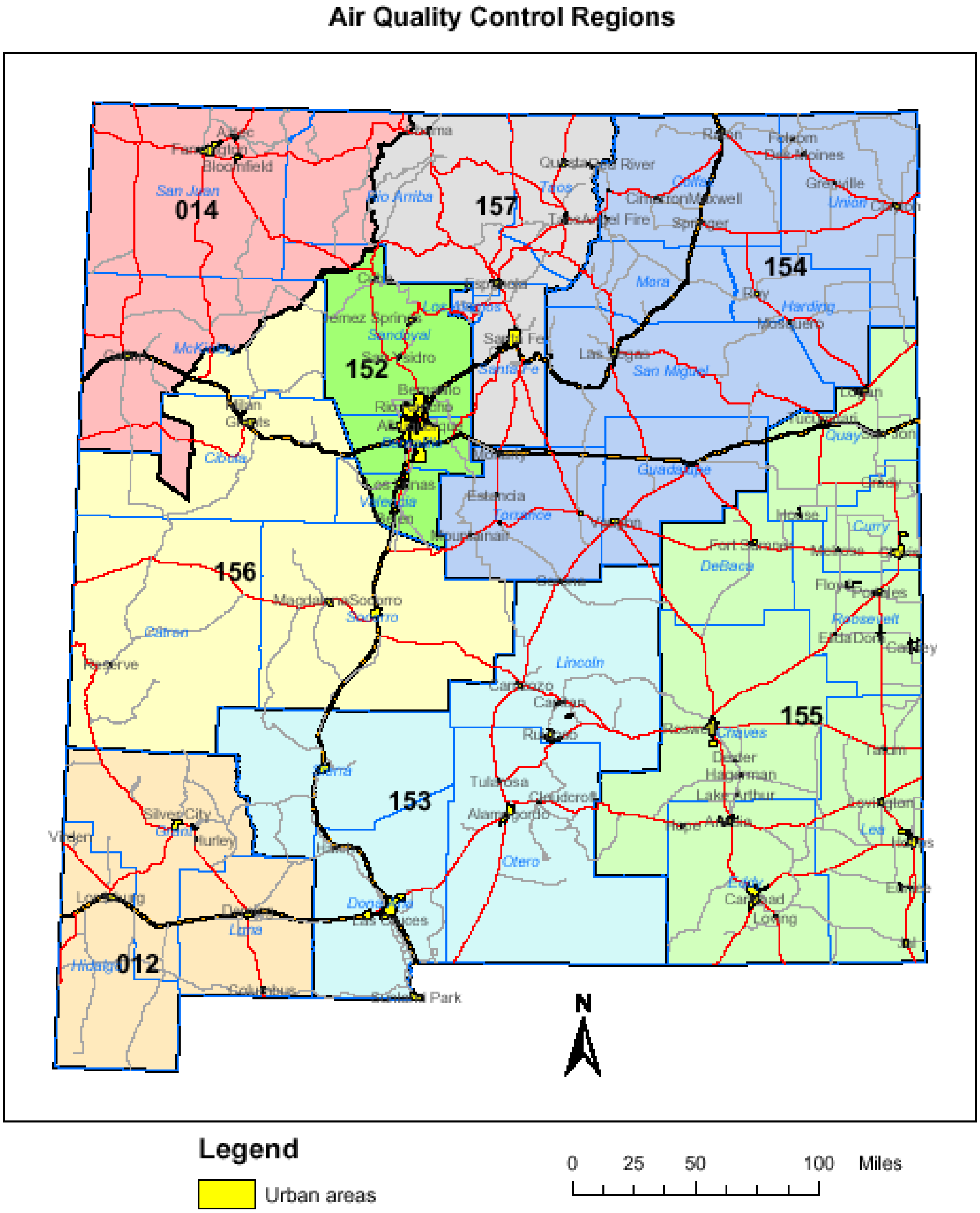

Figure 2: Air quality control regions (each AQCR has a different color)

Table 11: Stack Height Release Correction Factor (adapted from 20.2.72.502 NMAC)

Release Height in Meters	Correction Factor
0 to 9.9	1
10 to 19.9	5
20 to 29.9	19
30 to 39.9	41
40 to 49.9	71
50 to 59.9	108
60 to 69.9	152
70 to 79.9	202
80 to 89.9	255
90 to 99.9	317
100 to 109.9	378
110 to 119.9	451
120 to 129.9	533
130 to 139.9	617
140 to 149.9	690
150 to 159.9	781
160 to 169.9	837
170 to 179.9	902
180 to 189.9	1002
190 to 199.9	1066
200 or greater	1161

The table below lists a few of the commonly encountered State Air Toxics in New Mexico. This is not the complete list, which is too expansive to reprint here.

Table 12: A few common state air toxics and modeling thresholds (from 20.2.72.502 NMAC)

Pollutant	OEL (mg/m^3)	1% OEL (µg/m^3)	Emission Rate Screening Level (pounds/hour)
Ammonia	18	180	1.20
Asphalt (petroleum) fumes	5.00	50	0.333
Carbon black	3.50	35	0.233
Chromium metal	0.500	5.00	0.0333
Glutaraldehyde	0.700	7.0	0.0467
Nickel Metal	1.00	10.0	0.0667
Wood dust (certain hard woods as beech & oak)	1.00	10.0	0.0667
Wood dust (soft wood)	5.00	50.0	0.333

If modeling shows that the maximum eight-hour average concentration of each toxic pollutant is less than one one hundredth of its Occupational Exposure Level (OEL) listed in **20.2.72.502 NMAC**, then the analysis is finished. For a source of any known or suspected human carcinogens (per **20.2.72.502 NMAC**) which will cause an impact greater than one-one hundredth of the OEL, the source must demonstrate that best available control technology will be used to control the carcinogen. If modeling shows that the impact of a toxic which is not a known or suspected human carcinogen (per **20.2.72.502 NMAC**) is greater than one-one hundredth of the OEL, the application must contain a health assessment for the toxic pollutant that includes: source to potential receptor data and modeling, relevant environmental pathway and effects data, available health effects data, and an integrated assessment of the human health effects for projected exposures from the facility.

2.9 Hazardous Air Pollutants

Hazardous Air Pollutants (HAPs) do not require modeling, as they are regulated by means other than air quality standards. Sources should be aware of the Title V major source thresholds of 10 tons/year for any Hazardous Air Pollutants (HAP) and 25 tons/year for total HAPs, which will require an operating permit to be obtained from the department under **20.2.70 NMAC**- Operating Permits.

2.10 Nonattainment and Maintenance Areas

In nonattainment areas and for those sources outside of the nonattainment area that significantly contribute to concentrations in a nonattainment area, the modeling analysis required is a demonstration of an air quality benefit. Regular modeling is required in maintenance areas, however. Further information on nonattainment area modeling is in section 7.4, Nonattainment Area Requirements. Nonattainment areas are described at https://www.env.nm.gov/air-quality/nonattainment-areas/.

3.0 MODEL SELECTION

3.1 What dispersion models are available?

The Bureau accepts the use of EPA approved models for dispersion analysis. Commercial or parallel versions of these models are fine as long as they produce the same results. This section of the modeling guidelines is designed to describe the models that are available and provide some guidance on which situations are the most appropriate for which regulatory modeling situations.

Two types of models are currently in use for air dispersion modeling: probability density function (PDF) models, and puff models. Probability density function models apply a probability function from each emission release point to calculate the concentration at a receptor based on the location of the receptor, wind speed and direction, stability of the atmosphere, and other factors. The plume is assumed to extend all the way out to the most distant receptor, no matter how far that receptor is from the emission source. Because of this characteristic, PDF models suffer in accuracy when modeling distant concentrations or unstable conditions. SCREEN3, ISCST3, ISC_OLM, CTSCREEN, ISC-PRIME, and AERMOD are all PDF models. All but AERMOD use a Gaussian, or normal, distribution for their probability density function. AERMOD uses a PDF that varies depending on nearby terrain and other factors. Currently, AERMOD and CTSCREEN are EPA-approved models for near-field modeling. As of November 9, 2006, SCREEN3, ISCST3, and ISC_OLM are no longer considered EPA-approved models. The Federal Register notice detailing the promulgation of AERMOD is located at: http://www.epa.gov/scram001/guidance/guide/appw_05.pdf

CALPUFF is a puff model, meaning that it tracks puffs, or finite elements of pollution, after they are released from their source. This strategy makes the model ideal for tracking pollution over long distances or in conditions that are not stable, and also allows chemical reactions within the plume to be modeled. Unfortunately, puff models require large amounts of computing time. CALPUFF is an EPA-approved model for modeling long range transport and/or complex non-steady-state meteorological conditions.

3.2 EPA Modeling Conferences and Workshops

EPA Modeling Conference presented a wealth of information about recent regulatory modeling developments. The EPA web page with the details is http://www3.epa.gov/ttn/scram/conferenceindex.htm.

3.3 Models Most Commonly Used in New Mexico

Most analyses reviewed by the Bureau will begin with an AERMOD analysis, and possibly CALPUFF for Class I analyses. For dispersion modeling within 50 kilometers of the source, AERMOD should be used. CALPUFF should be used only for PSD Class I area analyses, per the Interagency Workgroup Air Quality Modeling (IWAQM) Phase II report, but may be approved for use on a case-by-case basis for other analyses.

3.3.1 AERMOD

- AERMOD is intended to be the standard regulatory model. The PRIME building downwash algorithm is used by the model. Both the Ozone Limiting Method (OLM) and the Plume Volume Molar Ratio Method (PVMRM) algorithms for nitrogen conversion are built into the model.
- AERMOD has greater accuracy in complex terrain than CTSCREEN.
- AERMOD is suggested for extremely complex terrain.

See the section on nitrogen oxides for more information and options.

3.3.2 CALPUFF

- CALPUFF is a puff model designed to calculate concentrations at distances up to and beyond 50 kilometers. The model is significantly more difficult to run than the other models discussed in these guidelines. Use of CALPUFF for NAAQS, NMAAQS, or PSD increment modeling must be approved by the Bureau before submitting the modeling.
- CALPUFF is required for additional impact analyses when Federal Land Managers require additional impact analyses for Class I areas near PSD major sources. Typically, CALPUFF light is used for this modeling.

3.3.3 CTSCREEN

- CTSCREEN is applicable only for modeling receptors above stack height.
- CTSCREEN is a difficult model to run because of the difficulty in obtaining hill contour profiles.
- CTSCREEN uses screening meteorology.
- AERMOD produced greater accuracy than CTDMPLUS (the full implementation of CTSCREEN) when modeling the data that was used to develop CTSCREEN/CTDMPLUS.
- CTSCREEN is typically used to model the terrain on top of a hill that did not pass when using AERMOD.

The following list can be used to correct 1-hour CTSCREEN concentrations to 3-hour, 24-hour and annual concentrations by multiplying by the appropriate conversion factor for the averaging period.

Table 13: CTSCREEN Correction factors for 1-hour concentration.

Averaging Period	Correction factor
3-hour	0.7
24-hour	0.15
Annual	0.03

3.3.4 AERSCREEN

- AERSCREEN is a screening version of AERMOD.

4.0 MODEL INPUTS AND ASSUMPTIONS

Models should be used with the technical options recommended in the Guideline on Air Quality Models (http://www.epa.gov/ttn/scram/guidance/guide/appw_05.pdf) except as noted in this document or approved by the Bureau.

Unless otherwise noted, information and procedures in this section refer to all of the models listed above.

4.1 Operating Scenarios

4.1.1 Emission Rates

All averaging periods shall be modeled using the maximum short-term emission rate allowed in the permit. The preferred method of modeling all averaging periods is to use maximum short-term emission rates and to use the hours of operation model input option to limit the facility's emissions.

4.1.2 Hours of Operation

If the facility is limited to operating certain hours of the day or has other operating restrictions, limiting the operating hours in the model can normally reduce the concentration produced by the model. Hours of operation can only be modeled by models that use actual meteorology, but not by screening models. Use screening models only to model facilities as if the maximum operating rate were emitting continuously.

4.1.3 Time Scenarios

Sometimes a facility has unusual operating times, for example, if the facility is allowed to operate 12 hours per day, but the hours are not specified. The facility may model as if it operates continuously, but as an option, the facility can model different time periods at the amount of time allowed per day as different operating scenarios, making sure that the maximums are modeled. In the 12 hour example, the facility might model three scenarios: 7AM to 7PM. 7PM to 7AM. And 5PM to 5AM. This way, all the hours of the day were modeled, and the modeler can be fairly certain that the maximum was modeled because the worst-case scenarios would occur when the calm blocks of time were modeled together. All scenarios should be modeled at maximum hourly emission rates.

4.1.4 Operating at Reduced Load

Some sources (like engines and boilers) can produce higher concentrations of pollution in ambient air when they are operating below maximum load than when they are at maximum load. The applicant shall analyze various feasible operating scenarios (100%, 75%, and 50% are typical) to determine the worst-case impacts, and then use that worst-case scenario for the entire modeling analysis. This requirement is in section 8.1 of Appendix W of EPA's Guideline.

4.1.5 Alternate Operating Scenario

If the permit application contains multiple operating scenarios (such as use of different fuels or different engines) then the applicant shall model each of the scenarios for the radius of impact analysis. Whichever scenario produces the greatest impacts on ambient air shall be used for the cumulative analysis, if required. If it is unclear which operating scenario produces the greatest impacts, each scenario shall be modeled for cumulative impact analysis.

4.1.6 Startup, Shutdown, Maintenance (SSM), and Other Short-term Emissions

If startup, shutdown, maintenance, or other temporary events have the potential for producing short-term impacts greater than the normal operating scenarios, then the applicant shall model each of the scenarios to demonstrate compliance with the ambient air quality standard.

If it is probable that an adjacent facility will have emissions higher than normal operation during the time the applicant's facility has increased emissions, then those emissions should also be accounted for in the modeling. Otherwise, model surrounding sources at their normal operating rate. Because of the short nature of the SSM emissions, modeling does not have to demonstrate compliance with annual standards or annual increment consumption. Highest hourly SSM emission rate should be modeled for NAAQS, NMAAQS and for increment consumption modeling.

Whichever scenario produces the greatest impacts on ambient air shall be used for the cumulative analysis, if required. If it is unclear which operating scenario produces the greatest impacts, each scenario shall be modeled for cumulative impact analysis.

4.2 Plume Depletion and Deposition

Dry plume depletion may be used to reduce concentrations of particulate matter. Appropriate particle characteristics for the specific type of source being modeled should be used. Check the web page for sample particle size distributions. Because of the length of time required to run a model with plume depletion, the Bureau recommends only applying plume depletion to receptors that are modeled to be above standards when the model is run without plume depletion.

The wet deposition option should not be used for the modeling analysis unless data are available and the use of wet deposition has been previously approved.

4.3 Meteorological Data.

4.3.1 Selecting Meteorological Data.

The meteorological data used in the modeling analysis should be representative of the meteorological conditions at the specific site of proposed construction or modification, or else use screening meteorological data, which contains worst-case data.

Representative, on-site data is obviously the best data to use; however, for many sources on-site data is not available. Bureau modeling staff can supply preferred meteorological data sets for various locations around the state. The National Weather Service also collects data throughout the country. These data sets are available through the National Climatic Data Center. It is mandatory that Bureau modeling staff approve the chosen meteorological data before the analysis is submitted. PSD permits contain more rigorous requirements relating to the collection of representative, on-site meteorological data. Either 1 year of representative data which serves as on-site data or 5 years of appropriate off-site data must be used. Please contact the Bureau as soon as possible if you anticipate the need to collect on-site meteorological or ambient monitoring data for a PSD permit.

Setback distance modeling for portable sources may require separate meteorological data than that used in the rest of the modeling for that facility. Preliminary analysis indicates that the Substation meteorological data set is appropriate for locations throughout the State. Contact the Bureau for guidance on relocation meteorological data selection.

The goal of modeling is to use site-specific meteorological data. In cases where the form of the standard allows the standard to be exceeded a number of times per year, this is based on site-specific data. If the equivalent of site-specific data is not available, then the highest concentration estimate should be considered the design value unless multiple years of data are used. (68238 Federal Register / Vol. 70, No. 216 / Wednesday, November 9, 2005 / Rules and Regulations)

For example, no meteorological monitoring stations are available near Raton, New Mexico, and there are terrain features that may make Raton meteorology different from other places. The Bureau will still recommend meteorological data to use for modeling in Raton, but the PM_{10} standard is not allowed to be exceeded at all because the meteorological data is not completely representative of the area.

For concentration monitoring data, proximity to the monitor is normally the driving factor for selection of a representative monitor. For meteorological data, the similarity of the terrain (including canyon and valley directions) is more important than finding the closest monitor. Unless otherwise noted, AQB staff will need the exact location of the facility to select or approve a set of meteorological data representative of the location. Staff will compare wind roses with prominent terrain features that influence drainage patterns or otherwise influence wind directions.

Processed meteorological data is available on the web page: https://www.env.nm.gov/air-quality/meteorological-data/.

4.4 Background Concentrations

> "Background concentrations should be determined for each critical (concentration) averaging time." (68242 Federal Register / Vol. 70, No. 216 / Wednesday, November 9, 2005 / Rules and Regulations)

The background concentrations listed below were derived from information downloaded from http://aqsdr1.epa.gov/aqsweb/aqstmp/airdata/download_files.html.

4.4.1 Uses of Background Concentrations

Background concentrations are added to the modeled concentrations or are used for stoichiometric modeling applications such as OLM or PVMRM. Normally, a background concentration associated with the averaging period being modeled is added after the model (with all facility and nearby sources) is completed. Sometimes this approach proves too conservative to demonstrate compliance with standards. If so, monthly, daily, or hourly concentration profiles can be developed using representative sets of monitoring data appropriate for the modeling domain. Adding refined background concentrations normally requires post-processing of hourly output files.

It is very important to use recent monitoring data, because concentration trends are likely to change over time (much more so than weather patterns). If hourly meteorological data does not match hourly monitoring data, then the following methods can be used to produce a concentration profile for the refined modeling exercise.

Choose the highest background for each period for the region that best describes the modeling domain, unless adequate justification can be made that a specific monitor is most representative. For rural areas that do not match the regional descriptions above, use a monitor from Eastern NM or Southwestern NM.

4.4.1.1 Refined background concentrations

Background concentrations may be refined to take into account patterns in daily and monthly fluctuations in concentration. Since background concentrations are added to the model after dispersion is complete, there is no point mathematically in determining refined background concentrations shorter than the averaging period of the air quality standard. 24-hour concentrations do not need 1-hour background concentrations (except for ozone limiting of NO_2 concentrations, which happens during dispersion).

4.4.1.2 Developing 24-hour refined background concentrations

Each of the 12 months is represented by the maximum 24-hour concentration occurring during that month. If three years of data are available, average the three values for each month and use the average for the background. If a given month has a low maximum concentration due to the small number of samples collected that month, then the concentration from that month is not used and the average of the maximums of the two other years will be used as the 24-hour background for that month.

Example: Roswell $PM_{2.5}$ (This example uses outdated data and should not be used for new modeling).

$PM_{2.5}$ has a 24-hour averaging period and an annual averaging period. The annual average uses the annual value in the standard background tables, but it is appropriate to use refined background concentrations for the 24-hour period. The Partisol sampler in Roswell is a Federal Reference Method sampler for $PM_{2.5}$. The filters are collected about every three days, so there is not data available for every day. Over three years of data are available, and 2007 through 2009 are presented in the following table.

January, 2007 had a maximum reported concentration of 10.0 $\mu g/m^3$. January 2008 and 2009 had maximum concentrations of 18.0 and 11.7, respectively. The average of these three values is 13.2. After the model has run, every day in January adds a background concentration of 13.2 $\mu g/m^3$. Care must be taken to identify the greatest sum of modeled concentration plus background, since background concentration varies each month – the highest modeled concentration may no longer be the highest when the background values are added.

Table 14: Roswell $PM_{2.5}$ Monitoring Data (2007-2009)

Year	Month	$PM_{2.5}$ concentration. ($\mu g/m^3$)											Max	3-year avg.
2007	1	2.33	3.67	9.50	6.25	10.00	6.25	4.67	5.58	7.25			10.00	**13.2**
2007	2	5.92	5.50	25.5	9.00	13.75	2.67	2.42	5.67	2.25			25.50	**14.7**
2007	3	1.67	2.92	4.42	4.17	3.42	12.25	8.00	9.29	2.67	5.58	2.67	12.25	**12.8**
2007	4	4.75	9.58	4.83	5.86	3.67	5.75	8.00	2.75	5.83	6.00		9.58	**9.2**
2007	5	4.58	3.42	4.00	8.33	6.08	4.00	3.75	4.33				8.33	**10.0**
2007	6	7.00	6.92	8.25	4.00	5.19	5.67	9.29	13.7	6.58			13.67	**11.5**
2007	7	8.58	8.28	8.17	5.75	7.92	8.67	7.33	7.28				8.67	**9.2**
2007	8	11.92	3.08	7.50	11.83	18.50	8.67	7.92	6.33	6.00	7.83		18.50	**13.2**
2007	9	11.75	4.00	4.75	6.75	9.17	4.08	4.08	3.17	4.42	4.08		11.75	**11.1**
2007	10	5.25	6.00	6.08	6.92	4.33	5.08						6.92	**7.0**
2007	11	7.75	7.58	8.75	7.25	5.42	8.33	7.83	7.25	18.58	8.33		18.58	**10.4**
2007	12	3.17	4.08	4.25	3.17	5.83	10.50	5.58	4.33	2.25			10.50	**10.8**
2008	1	5.3	8.2	3.6	4.4	3.0	4.9	18.0	13.4	4.2	2.6		18.0	
2008	2	2.2	3.8	3.3	3.3	7.4	3.5	9.3	4.6				9.3	
2008	3	6.8	3.7	14.8	4.9	5.8	5.8						14.8	
2008	4	3.7	5.5	10.7	2.9	6.7	6.2	5.2	9.5				10.7	
2008	5	6.8	7.4	4.3	5.2	11.6	6.2	6	5.3				11.6	
2008	6	6.3	7.1	4.8	5.2	6.3	14	4.9	4.9				14.0	
2008	7	6.7	6.4	4.8	4.0	7.0	6.1	9.2	9.2	9.8			9.8	
2008	8	6.5	6.7	9.2	3.6	5.6	4.3	5.2	7.8				9.2	
2008	9	7.6	7.6	2.3	4.8	5.0	8.8	8.8	11.1	8.9			11.1	
2008	10	7.2	2.8	4.6	4.8	3.2	4.3	7.9	3.5	4.0			7.9	
2008	11	5.5	6.2	4.1									6.2	
2008	12	3.8	4.6	7.8	5.2								7.8	
2009	1	5.2	3.7	1.8	11.7	10.0	5.6	4.1	7.3				11.7	
2009	2	5.8	5.6	9.3	3.4	8.1	9.0	4.2	5.4	4.7			9.3	
2009	3	4.1	6.0	11.4	2.8	4.1	3.8	11.3	6.2	9.7	4.0	4.2	11.4	
2009	4	7.2	4.4	6.2	1.8	4.8	1.8	3.1	6.6				7.2	
2009	5	6.4	3.2	10.0	6.7	3.9							10.0	
2009	6	6.4	3.9	4.7	5.0	6.7	5.3						6.7	
2009	7	4.8	8.9	4.5	5.7	6.0	8.6	9.2	5.8	8.5	8.1	8.4	9.2	
2009	8	8.4	10.5	7.6	5.0	6.1	11.8	7.0	4.3				11.8	
2009	9	7.9	3.9	4.9	5.3	10.3	1.7	6.5					10.3	
2009	10	2.2	6.2	1.9	1.9	3.0	3.6						6.2	
2009	11	6.2	5.3	6.1	2.8	5.5	5.0	6.3	2.6				6.3	
2009	12	14.2	5.5	4.3	7.7	4.9	5.3						14.2	

4.4.1.3 Developing 1-hour refined background concentrations

From the geographically nearest full set of monitoring data to the facility to be modeled, determine the maximum one-hour concentration that occurs during each hour of the day for each month. The result will be twelve different 24-hour profiles that will be repeated for the entire month that each represents. This profile can be used for all averaging periods. If three years of data are available, average the three values for each month and use the average for the background. POST files may be used to add hourly background concentrations to receptors.

Example: Determine the maximum concentration for hour 1 (midnight to 1AM) in January. Use this for hour 1 for each day in January. Determine the maximum concentration for hour 2 (1AM to 2AM) in January. Use this for hour 2 for each day in January. … Determine the maximum concentration for hour 24 (11PM to midnight) in December. Use this for hour 24 for each day in December. Complete the entire year in this manner, with hour and month-specific data.

4.4.1.4 Eliminating double-counting of emissions in background

In some cases the addition of a background concentration may result in double-counting of some of the emissions, if the reference monitor is very close to the modeling domain. This effect may be reduced by placing a receptor at the monitor location and modeling the sources in the model that existed at the time of the monitoring. The modeled concentration at the monitor may be subtracted from the background (with a minimum background of zero). The averaging period should be the same as the one used for the background calculation, and must be temporally correlated if the maximum monitored concentration is not being used.

4.4.2 CO Background Concentration

Ambient CO monitors to represent New Mexico are very limited. Concentrations near Sunland Park are best represented by monitors in El Paso. Monitors operated by Albuquerque should be conservative for the rest of New Mexico.

Table 15: Carbon Monoxide Background Concentration

Region	ID	Location	1-hour ($\mu g/m^3$)	8-hour ($\mu g/m^3$)	Latitude	Longitude	Notes
The rest of New Mexico	350010023	Del Norte High School	2203	1524	35.1343	-106.585	4700a San Mateo NE, Albuquerque, NM
Albuquerque	350010029	South Valley	2746	1566	35.01708	-106.657	201 Prosperity SE, Albuquerque, NM
Sunland Park	481410044	El Paso Chamizal	4677	2834	31.76569	-106.455	800 S San Marcial Street, El Paso, TX

Concentrations are the average of the maximum concentrations for 2015-2017.

4.4.3 H_2S Background Concentration

NMED has no H_2S monitors. The standards are generally designed to protect against noticeable changes in concentration above the background concentration for the region, and no background concentration is added.

4.4.4 Lead Background Concentration

Reformulation of gasoline and other control measures have virtually eliminated ambient lead concentrations. NMED has no lead monitors. Treat as zero background.

4.4.5 NO_2 Background Concentration

Note: No 24-hour averages were calculated. Compliance with 1-hour NAAQS automatically demonstrates compliance with 24-hour NMAAQS.

Table 16: NO_2 Background Concentration

Region	ID	Location	1-hour Background ($\mu g/m^3$)	1-hour 98th %ile ($\mu g/m^3$)	Annual Background ($\mu g/m^3$)	Latitude	Longitude	Address
4-Corners	1ZB, 350450009	Bloomfield	85.1	67.3	19.6	36.74222	-107.977	162 Hwy 544, Bloomfield NM 87413
4-Corners	1NL, 350450018	Navajo Dam	62.2	52.1	11.0	36.80973	-107.652	423 Hwy 539, Navajo Dam, NM 87419
4-Corners	350451233	Dine College	73.3	54.9	11.3	36.8071	-108.695	Dine College, GIS Lab
Albuquerque	350010023	Del Norte High School	94.2	83.8	20.2	35.1343	-106.585	4700A San Mateo NE
South Central	6ZM, 350130021	Sunland Park	100.4	85.7	12.5	31.79611	-106.584	5935A Valle Vista, Sunland Park, NM
South Central	6ZN, 350130022	US-Mexico Border Crossing	102.9	77.5	8.5	31.78778	-106.683	104-2 Santa Teresa International Blvd, NM
Eastern NM	5ZR, 350151005	Outside Carlsbad	60.3	38.7	5.0	32.38	-104.262	Holland St, SE of Water Tank, Carlsbad, NM
Eastern NM	5ZS, 350250008	Hobbs-Jefferson	83.2	64.2	8.1	32.72666	-103.123	2320 N. Jefferson St, Hobbs, NM
Southwestern NM[1]	7E, 350290003	Deming	62.052	53.277	6.966	32.2558	-107.723	310 Airport Road, Deming, NM88030

Annual background is the average of three annual averages of monitoring data from 2015 to 2017. The maximum 1-hour NO_2 concentrations from each of three years were averaged to determine the 1-hour background concentration, using monitoring data from 2015 to 2017

Refined 1-hour background profiles may be developed using the guidance described in “Refined Background Concentrations”, above.

[1] Based on 2013 -2015 averages.

4.4.6 Total Reduced Sulfur Background Concentration

NMED has no total reduced sulfur monitors. The standards are generally designed to protect against noticeable changes in concentration above the background concentration for the region, and no background concentration is added.

4.4.7 Ozone Background Concentration

Ozone background concentrations are required for NO_2 modeling using PVMRM or OLM.

Table 17: Ozone Background Concentration

Region	ID	Location	1-hour Background ($\mu g/m^3$)	Latitude	Longitude	Address
4-Corners	1ZB, 350450009	Bloomfield	146.1	36.74222	-107.977	162 Hwy 544, Bloomfield NM 87413
4-Corners	1NL, 350450018	Navajo Dam	156.9	36.80973	-107.652	423 Hwy 539, Navajo Dam, NM 87419
4-Corners[1]	350450020	Chaco Culture National Historical Park	144.8	36.03022	-107.910	1808 County Road 7950, Nageezi, NM 87037
4-Corners	1H, 350451005	Shiprock Substation	145.4	36.79667	-108.473	Usbr Shiprock Substation (Farmington)
4-Corners	350451233	Dine College	151.8	36.8071	-108.695	Dine College, GIS Lab
Albuquerque	2ZJ, 350431001	Highway Department, Bernalillo	148.6	35.29944	-106.548	Highway Dept. Yard Near Bernalillo
Albuquerque	2LL, 350610008	Los Lunas	140.4	34.8147	-106.74	1000 W. Main St, Los Lunas, NM 87031
Albuquerque	350010023	Del Norte High School	153.1	35.1343	-106.585	4700A San Mateo NE
Albuquerque	350010029	South Valley	145.4	35.01708	-106.657	201 Prosperity SE
Albuquerque	350011012	Foothills	152.4	35.1852	-106.508	8901 Lowell NE
South Central	6O, 350013008	La Union	161.3	31.93056	-106.631	St Lukes Episcopal Ch Rt 1 (La Union)
South Central	6ZK, 350130020	Chaparral Middle School	170.2	32.04111	-106.409	680 McCombs, Chaparral, NM
South Central	6ZM, 350130021	Desert View Elementary School	175.9	31.79611	-106.584	5935A Valle Vista, Sunland Park
South Central	6ZN, 350130022	US-Mexico Border Crossing	169.0	31.78778	-106.683	104-2 Santa Teresa International Blvd, NM
South Central	6ZQ, 350130023	NM Highway Dept. Yards In Las Cruces	149.9	32.3175	-106.768	750 N. Solano Drive, Las Cruces, NM
Southwestern NM[2]	7T, 350171003	Hurley Smelter	139.294	32.69194	-108.124	Chino Blvd near Hurley Park, Hurley, NM
Eastern NM	5ZS, 350025008	Hobbs-Jefferson	150.5	32.72666	-103.123	2320 N. Jefferson St, Hobbs, NM
Eastern NM	5ZR, 350151005	Outside Carlsbad	155.6	32.38	-104.262	Holland St, SE of Water Tank, Carlsbad, NM
Eastern NM	350153001	Carlsbad Caverns	145.4	32.1783	-104.441	Carlsbad Caverns National Park
North Central	350390026	Coyote	140.4	36.18774	-106.698	21 New Mexico 96, Coyote, NM, 87012
North Central	3SFA, 350490021	Santa Fe Airport	139.7	35.61975	-106.08	2001 Aviation Drive, Santa Fe, New Mexico 87507

[1] Based on 2017 only

[2] Based on 2013-2015 averages.

The hourly maximum ozone concentration from the nearest ozone monitor may be used for ozone limiting. Unless otherwise noted, the maximum 1-hour O_3 concentrations from each of three years were averaged to determine the 1-hour background concentration, using monitoring data from 2015 to 2017.

Refined 1-hour background profiles may be developed using the guidance described in "Refined Background Concentrations", above. Ozone files typically use the format, "(4I2,5X,F8.3)". Hourly concentrations use $\mu g/m^3$ to avoid elevation errors.

4.4.8 $PM_{2.5}$ Background Concentration

Table 18: $PM_{2.5}$ Background Concentration

Region	ID	Location	24-hour Background 100th%ile (µg/m^3)	24-hour Background 98th%ile (µg/m^3)	Annual Background (µg/m^3)	Latitude	Longitude	Address
Albuquerque	350010023	Del Norte High School	11.5	10.8	4.6	35.1343	-106.5852	4700A San Mateo NE
Albuquerque[1]	350010029	South Valley	22.6	18.20	7.43	35.01708	-106.6574	201 Prosperity SE
South Central[2]	6CM, 350130016	Anthony	18.4	17.0	7.6	32.00361	-106.5992	SE Corner Of Anthony Elem. School Yard
South Central	6ZM, 350130021	Sunland Park	25.9	24.3	7.3	31.79611	-106.5839	5935A Valle Vista, Sunland Park
South Central	6Q, 350130025	Las Cruces District Office of NMED	16.1	14.9	5.1	32.32194	-106.7678	2301 Entrada Del Sol, Las Cruces
Eastern NM	5ZS, 350250008	Hobbs-Jefferson	15.8	13.4	5.9	32.72666	-103.1229	2320 N. Jefferson St, Hobbs
4-Corners[1]	1FO, 350450019	Farmington Environment Department Office	14.13	11.77	4.19	36.77416	-108.165	3400 Messina Drive Suite 5000 Farmington
North Central[1]	3HM, 350490020	Santa Fe	16.55	9.45	4.32	35.67111	-105.9536	Runnels Bldg. 1190 St. Francis Dr.

[1] Based on 2013-2015 averages

[2] Based on average of 2013, 2014, and 2017

Concentrations are the average of three years of maximum data from 2015 to 2017. Some monitors may not represent background concentrations. Anomalously high values were eliminated before calculating aggregate concentrations. Use the highest 98th percentile background concentration from the region in which the facility is located, unless another monitor is more representative of the local area. Refined 24-hour background profiles may be developed using the guidance described in “Refined Background Concentrations”, above.

Monthly background concentrations for Southeastern New Mexico from Hobbs are listed below. These were collected from January 2015 to December 2018.

Table 18B: Hobbs Refined $PM_{2.5}$ Background Concentration

Month	**Monthly 24-hour Maximum** ($\mu g/m^3$)
1	**12.1**
2	**10.2**
3	**21.1**
4	**17.5**
5	**16.5**
6	**16.1**
7	**17.6**
8	**13.3**
9	**15.6**
10	**10.3**
11	**13.2**
12	**17.7**

4.4.9 PM_{10} Background Concentration

Table 19: PM_{10} Background Concentration

Region	ID	Location	Annual Background (µg/m^3)	24-hour Background Maximum (µg/m^3)	24-hour Background Second High (µg/m^3)	Latitude	Longitude	Address
Albuquerque	350010026	Jefferson	24.3	74.0	70.3	35.1443	-106.6047	3700 Singer
Albuquerque	350010029	South Valley	33.7	152.0	132.2	35.01708	-106.6574	201 Prosperity SE
4-Corners[1]	1ZB, 350450009	Bloomfield	13.0	55.0	50.0	36.74222	-107.977	162 Hwy 544, Bloomfield NM 87413
South Central	6CM, 350130016	Anthony	22.0	50.7	44.7	32.003611	-106.5992	SE Corner of Anthony Elem. School Yard
South Central	6ZK, 350130020	Chaparral Middle School	25.3	120.0	112.3	32.041111	-106.4092	680 McCombs, Chaparral
South Central[1]	6ZM, 350130021	Sunland Park	26.0	78.0	73.0	31.796111	-106.5839	5935A Valle Vista, Sunland Park
South Central	6WM, 350130024	Las Cruces City Well #46	15.3	94.7	83.3	32.278056	-106.8644	South of I-10 at Las Cruces Well #46
Southwestern[2]	7D, 350029001	Deming	16.2	56.5	46.5	32.267222	-107.7553	Post Office Pine St
Southwestern[2]	7E, 350029003	Deming Airport	22.7	128.7	109.3	32.2558	-107.7227	310 Airport Road, Deming
Eastern NM	5ZS, 350250008	Hobbs-Jefferson	24.0	100.7	37.3	32.726656	-103.1229	2320 N. Jefferson St, Hobbs
North Central[2]	3HM, 350490020	Santa Fe	9.0	23.0	20.7	35.671111	-105.9536	Runnels Bldg. 1190 St. Francis Dr.
North Central[2]	3ZD, 350055005	Taos	14.2	52.0	40.5	36.383333	-105.5833	Fire Station Santiago Road

Concentrations are averaged from 2015 to 2017. Some monitors, such as 350010026 and 350010029, are located near industrial sources or in disturbed areas and do not represent ambient background concentrations.

[1] Monitor 350450009 was missing 2015 data. Monitor 350130021 was missing 2016 data. These monitors used two year averages.

[2] Based on 2013-2015 averages

Refined 24-hour background profiles may be developed using the guidance described in "Refined Background Concentrations", above.

Anomalously high values were eliminated before calculating aggregate concentrations.

Monthly background concentrations for Southeastern New Mexico from Hobbs are listed below. These were collected from July 2011 to June 2014. The monitor was discontinued after June 2014.

Table 20: Hobbs Refined PM_{10} Background Concentration

Month	**Monthly 24-hour Maximum** (µg/m^3)
1	43.0
2	46.0
3	62.7
4	58.0
5	62.3
6	82.3
7	86.7
8	61.3
9	60.0
10	74.3
11	48.7
12	39.7

4.4.10 SO_2 Background Concentration

Table 21: SO_2 Background Concentrations

Region	ID	Location	1-hour Background (µg/m^3)	1-hour Background 99th Percentile (µg/m^3)	Annual (µg/m^3)	Latitude	Longitude	Address
Albuquerque	350010023	Del Norte High School	15.8	13.2	1.75	35.1343	-106.585	4700A San Mateo NE
Southwest New Mexico[1]	7T, 350171003	Hurley Smelter	6.11	1.75	0.0183	32.69194	-108.124	Chino Blvd Near Hurley Park, Hurley, NM
The rest of New Mexico	1ZB, 350450009	Bloomfield	8.84	5.31	0.219	36.74222	-107.977	162 Hwy 544, Bloomfield NM 87413
Between Farmington and Shiprock	1H, 350451005	Shiprock Substation	41.6	22.1	0.389	36.79667	-108.473	Usbr Shiprock Substation (Farmington)
4-Corners west of Shiprock	350451233	Dine College	37.3	19.5	1.48	36.8071	-108.695	Dine College, GIS Lab
Eastern New Mexico	483751025	Amarillo, 24th Ave	68.3	47.0	0.670	35.2367	-101.787	4205 NE 24th Ave, Amarillo TX

Background concentrations are from 2015 to 2017
[1] Based on 2013-2015 averages

Refined 1-hour background profiles may be developed using the guidance described in “Refined Background Concentrations”, above.

4.5 Location and Elevation

Important: Use the same UTM zone and datum for the entire facility. Facilities on the border between two UTM zones must convert all information into one zone or the other.

Make sure that the source location and parameters are the same as those listed in the application form!! This is the most common mistake we see.

4.5.1 Terrain Use

Terrain classifications are defined as follows:
- **Flat terrain** – Terrain with all elevations equal to the base of the source
- **Simple terrain** – Terrain with elevations below stack height
- **Complex terrain** – Terrain with elevations above stack height

- **Intermediate (Complex) terrain** – Terrain with elevations between stack height and plume height (a subset of complex terrain).

Flat terrain should be used if the source base is higher than all the surrounding terrain or if the facility consists primarily of non-buoyant fugitive sources. Simple and complex terrain should be used for all other scenarios.

4.5.2 Obtaining Elevation

Elevation data for receptors, sources, and buildings should be obtained from Digital Elevation Model (DEM) files or National Elevation Dataset (NED) files with a resolution of 30 meters or better. USGS DEMs are available for New Mexico in either 7.5-minute or 1-degree formats. It is strongly suggested that the 7.5-minute data be used in dispersion modeling rather than the coarse resolution 1-degree data. Keep in mind that the USGS DEMs can be in one of two horizontal datums. Older DEMs were commonly in NAD27 (North American Datum of 1927) while many of the latest versions in NAD83 (North American Datum of 1983). It is important to use the same source of data for all elevations. Even USGS 7.5-minute maps and USGS 7.5-minute DEM data may differ. Surrounding sources' elevations provided by the Bureau have been determined using 7.5-minute DEM data (NAD83), where available, and 1-degree DEM data elsewhere.

Elevations should be included for at least all receptors within 10 km of your facility or within your facility's ROI (whichever is smaller). Your source's elevation may be used for receptors beyond 10 km, but it may be wiser to use actual DEM elevations for the entire ROI because surrounding sources are provided with actual elevations.

4.6 Receptor Placement

4.6.1 Elevated Receptors on Buildings

Elevated receptors should be placed on nearby buildings at points of public access where elevated concentrations may be predicted. Use flagpole receptors in areas with multi-story buildings to model state and federal standards. In cases where nearby buildings have publicly accessible balconies, rooftops, or similar areas, the applicant should consult with the Bureau modeling staff to ensure proper receptor placement. PSD increment receptors are limited to locations at ground level.[6]

4.6.2 Ambient Air

Ambient air is defined as any location at or beyond the fence line of the facility. The fence line must restrict public access by a continuous physical barrier, such as a fence or a wall. If plant property is accessible to the public or if any residence is located within the restricted area, receptors should be located on-property.[7] Public access is interpreted to include housing, schools, hospitals, and similar areas that are frequented by family members of employees, but the remainder of the restricted area is excluded from public access if such family members do not have access to excluded areas. For example, receptors would not be placed in dormitories on military bases, but would be placed in family housing areas.

4.6.3 Receptor Grids

"Receptor sites for refined modeling should be utilized in sufficient detail to estimate the highest concentrations and possible violations of a NAAQS or a PSD increment. In designing a receptor network,

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[6] NSR Workshop Manual, page C.42

[7] NSR Workshop Manual, Page C.42

the emphasis should be placed on receptor resolution and location, not total number of receptors." (68238 Federal Register / Vol. 70, No. 216 / Wednesday, November 9, 2005 / Rules and Regulations)

The modeling domain can be defined using a Cartesian grid with 1000 meter spacing. Fine grids or fence line receptors with 50 to 100 meter spacing should fill any areas of the domain with potential to contain the highest concentration and/or any possible exceedances of NMAAQS, NAAQS, or PSD increment for the refined modeling. 50 meter spacing is recommended for fence line receptors for most sources, but 100 meters is recommended for expansive sources like coal mines, copper mines, or large military bases. (Grids with 50 meter spacing and 2 km side width are recommended for medium or large neighboring point sources. 50 meter spacing and 1 km width grids are recommended for hilltops or small neighboring sources.) Once these areas of potential high concentrations have been refined, the remaining receptors may be discarded.

For sources with an ROI greater than 50 kilometers, the grid should not extend beyond 50 km, as is noted in the NSR Workshop Manual.

4.6.4 PSD Class I Area Receptors

A modeling analysis of the PSD increment consumed at the nearest Class I areas must be performed by increment-consuming sources in AQCRs where the PSD minor source baseline date has been established, or in any AQCR where a new PSD-major source is to be installed. One receptor at the near boundary of the Class I area is normally sufficient for modeling to compare with Class I significance levels. 1000 meter spacing is recommended within the Class I areas for facilities with significant concentrations. If concentrations are above 75% of the PSD increment, then 50 to 100 meter spacing should be used near the hot spots. See Figure 1 for locations of Class I areas.

4.6.5 PSD Class II Area Receptors

Other than areas that are designated as PSD Class I areas, the entire state of New Mexico is a Class II area. The receptor grid for the PSD Class II increment analysis should be the same as the one for the cumulative run.

4.7 Building Downwash and Cavity Concentrations

Building downwash should be included in the analysis when stack height is less than good engineering practice (GEP) stack height and there are buildings, tanks, fans or other obstacles near the facility. All buildings and structures should be identified and analyzed for potential downwash effects. NMED requires the use of BPIP-Prime or equivalent for this analysis. GEP stack height should be determined as per 40 CFR 51.100. For receptors very near buildings, a cavity region analysis may be required. Modelers should consult with the Bureau modeling staff.

As summarized from 40 CFR 51.100:
GEP stack height is the greater of:
1) 65 meters, measured from the ground-level elevation at the base of the stack
or
2) H + 1.5L
Where
H = Height of nearby structure(s) measured from the ground-level elevation at the base of the stack.

L = The lesser of the height or the projected width (width seen by the stack) of nearby structures. Nearby structures can be as far as 5 times the lesser of the width or height dimension of the structure, but not greater than 0.8 km.
Stacks taller than GEP stack height should be modeled as if they were GEP stack height.

4.8 Neighboring Sources/Emission Inventory Requirements

> "The number of nearby sources to be explicitly modeled in the air quality analysis is expected to be few except in unusual situations. In most cases, the few nearby sources will be located within the first 10 to 20 km from the source(s) under consideration." (Federal Register / Vol. 82, No. 10 / Tuesday, January 17, 2017 / Rules and Regulations)

4.8.1 Neighboring Sources Data

The Emissions Inventory of neighboring sources is used as input data in air quality models. This data will be provided by the Bureau within a few days of request. E-mail the UTM coordinates of the location(s) to be modeled to the Bureau to request source data.

4.8.1.1 Determining which sources to include

This section functions as a definition for "nearby sources" as used in this document. The definition varies based on context, as illustrated below.

The contributions of distant sources are included in the background concentration. If the background concentration is added and includes all neighboring sources or a conservative approximation of them, then surrounding source modeling is not required for modeling of NAAQS or NMAAQS. For particulate matter or cases where the background concentration does not include all neighboring sources, then include all sources within 10 km of the facility in the model, and discard sources beyond 10 km from the facility. PSD increment is modeled, not monitored. (PSD increment may optionally add a background concentration instead of modeling the more distant sources.) For cases where background concentrations are not added, retain all sources within 25 km of the facility, plus sources emitting over 1000 pounds per hour within 50 km of the facility. For PSD Class I increment analysis, retain all sources within 25 km of the Class I area, plus sources emitting over 1000 pounds per hour within 50 km of the Class I area.

Table 22: Surrounding Source Retention Example for a Source Near Bloomfield.

Pollutant and averaging period	Neighboring source notes:
NO_2 1-hour NAAQS	Do not include surrounding sources. (Optionally, instead of adding background concentrations, include all sources within 25 km of the facility, plus sources emitting over 1000 pounds per hour within 50 km of the facility.)
$PM_{2.5}$ 24-hour NAAQS	Retain sources within 10 km of facility.
NO_2 annual Class II PSD increment	Retain sources within 25 km of the facility, plus sources emitting over 1000 pounds per hour within 50 km of the facility..
NO_2 annual Class I PSD increment	Retain sources within 25 km of Mesa Verde National Park, plus sources emitting over 1000 pounds per hour within 50 km of Mesa Verde.

4.8.1.2 Surrounding source format

The Bureau provides AERMOD input files with the surrounding sources (*.INP) and reference tables (*.XLS) to describe the sources in more detail. The AERMOD input files can be imported in GUI programs or edited manually. The Excel files are for reference only, and should not be used as the basis for modeling.

Sources numbered 0-49,999 belong in the NAAQS/NMAAQS analysis. Sources numbered 10,000 and above belong in the PSD increment analysis. (Notice overlap of two groups). Numbering in the reference tables may not include the 50,… or 10,… prefix for the counting numbers.

Unless otherwise noted, units of measure used in the surrounding sources files are the metric units associated with model input format. Emissions designated as NO_2 are actually total oxides of nitrogen (NO_X).

4.8.1.3 Handling errors in surrounding source files

Please contact the Bureau if you see suspicious data in the inventory. We know that there are errors in our database and we would like to correct them.

If you find a piece of equipment that has unusual stack parameters, document the error and corrected values in your modeling report. Please also report the error to Joe Kimbrell (Joseph.Kimbrell@state.nm.us) as well for database correction. Include MASTER_AI_ID, SUBJECT_ITEM_CATEGORY_CODE, and SUBJECT_ITEM_ID in the documentation.
Please document the reason the error is suspected.

The following parameters may be substituted for missing or invalid data. Determine the type of source that best matches the types below. For example, engines use the "other" category. Find the smallest emission rate in the table that is greater than or equal to the emission rate of the emission unit. That column contains the parameters that may be used for the parameters that are missing. (These parameters are based on modeling for general construction permits or on existing source data for control devices.)

Table 23: Missing Stack Parameter Substitutions for Turbines.

NO_2 Rate (lb/hr)	Height (m)	Temperature (K)	Velocity (m/s)	Diameter (m)
21.7	7	588	10	0.7
21	6	588	10	0.7
20	5	588	10	0.7
19	5	588	10	0.6
18	4.5	588	10	0.6
17	4.5	588	10	0.6
16	4.5	588	10	0.5
15	4.5	588	10	0.5
14	4.5	588	10	0.5
13	4	588	10	0.5
12	4	588	10	0.5

NO_2 Rate (lb/hr)	Height (m)	Temperature (K)	Velocity (m/s)	Diameter (m)
11	3.5	588	10	0.5
10	3.5	588	10	0.5
9	3.5	588	10	0.5
8	3.5	588	10	0.4
7	3	588	10	0.4
6	3	588	10	0.4
5	2.5	588	10	0.4
4	2.5	588	10	0.4
3	2	588	10	0.35
2	1.8	588	10	0.24
1	1.8	588	10	0.24

Table 24: Missing Stack Parameter Substitutions for Flares.

SO_2 Rate (lb/hr)	Height (m)	Temperature (K)	Velocity (m/s)	Diameter (m)
5000	18	1273	20	20.80618
4500	16	1273	20	19.73848
4000	14	1273	20	18.60962
3500	12	1273	20	17.4077
3000	9	1273	20	16.1164
2500	6	1273	20	14.71219
2100	6	1273	20	13.48395
2000	6	1273	20	13.15899
1900	6	1273	20	12.82579
1800	6	1273	20	12.48371
1700	6	1273	20	12.13198
1600	6	1273	20	11.76975
1500	6	1273	20	11.39602
1400	6	1273	20	11.0096
1300	6	1273	20	10.60911
1200	6	1273	20	10.19291
1100	6	1273	20	9.758965
1050	6	1273	20	9.534591
1000	6	1273	20	9.304808
950	6	1273	20	9.069204
900	6	1273	20	8.827315
850	6	1273	20	8.578609
800	6	1273	20	8.322474
750	6	1273	20	8.0582
700	6	1273	20	7.784961
650	6	1273	20	7.501776
600	6	1273	20	7.207473
550	6	1273	20	6.90063
500	6	1273	20	6.579493
450	6	1273	20	6.241855
400	6	1273	20	5.884877
350	6	1273	20	5.504798
300	6	1273	20	5.096453
250	6	1273	20	4.652404
200	6	1273	20	4.161237
150	6	1273	20	3.603737
100	6	1273	20	2.942439
90	6	1273	20	2.791442
80	6	1273	20	2.631797
70	6	1273	20	2.461821
60	6	1273	20	2.279203
50	6	1273	20	2.080618
40	6	1273	20	1.860962
30	6	1273	20	1.61164
29	6	1273	20	1.584552
28	6	1273	20	1.556992
27	6	1273	20	1.528936
26	6	1273	20	1.500355
25	6	1273	20	1.471219
24	6	1273	20	1.441495
23	6	1273	20	1.411144
22	6	1273	20	1.380126
21	6	1273	20	1.348395
20	6	1273	20	1.315899
19	4	1273	20	1.282579
18	4	1273	20	1.248371
17	4	1273	20	1.213199
16	4	1273	20	1.176975
15	4	1273	20	1.139602
14	4	1273	20	1.10096
13	4	1273	20	1.060911
12	4	1273	20	1.019291
11	4	1273	20	0.9758965
10	4	1273	20	0.9304808
9	3.5	1273	20	0.8827316
8	3.5	1273	20	0.8322473
7	3.5	1273	20	0.7784961
6	3.5	1273	20	0.7207473
5	3.5	1273	20	0.6579493
4	3	1273	20	0.5884877
3	3	1273	20	0.5096453
2	2.5	1273	20	0.4161237
1	2	1273	20	0.2942439

Table 25: Missing Stack Parameter Substitutions for Particulate Control Devices.

PM10 Rate (lb/hr)	Height (m)	Temperature (K)	Velocity (m/s)	Diameter (m)
22	19	0	28	4.6
21	18	0	27	4.6
20	17	0	26	4.4
19	16	0	25	4.2
18	15	0	24	4
17	14	0	23	3.8
16	14	0	22	3.6
15	13	0	21	3.4
14	13	0	20	3.2
13	12	0	19	3
12	12	0	18	2.8
11	11	0	17	2.6
10	11	0	16	2.4
9	10	0	15	2.2
8	10	0	14	2
7	10	0	13	1.8
6	9	0	12	1.6
5	9	0	11	1.4
4	9	0	10	1.2
3	9	0	9	1
2	9	0	8	0.8
1	9	0	7	0.6

Table 26: Missing Stack Parameter Substitutions for Other Point Sources.

NO_2 Rate (lb/hr)	Height (m)	Temperature (K)	Velocity (m/s)	Diameter (m)
21.7	7	730	28	0.3
21	6	730	28	0.3
20	5.5	730	28	0.3
19	4.5	730	28	0.3
18	4.5	730	27	0.3
17	4.5	730	27	0.3
16	4.5	730	27	0.25
15	4.5	730	27	0.25
14	4.5	700	22	0.25
13	4.5	700	22	0.25
12	4.5	700	22	0.2
11	4.5	700	22	0.2
10	4.5	700	22	0.2
9	4.5	700	20	0.2
8	4.5	700	18	0.2
7	4.5	700	14	0.2
6	4.5	650	14	0.2
5	4.5	500	5	0.2
4	4	500	5	0.1
3	3.5	500	5	0.1
2	3	500	5	0.0762
1	2	500	5	0.0762

For GCP 2, 3, and 5 permits with 95 tons/year of $PM_{2.5}$ emissions, use the following values:
TSP emission rate = 95 TPY
PM_{10} emission rate = 71.25 TPY (TSP X 0.75)
$PM_{2.5}$ emission rate = 17.875 TPY (PM_{10} X 0.25) = (TSP X 0.1875)

For volume sources with missing parameters:
Maximum release height = 10 m
Minimum release height = 1 m
Missing release height = PM10 Rate x 20 m/(lb/hr)
Initial vertical dimension = release height x 0.93
No limit to the maximum lateral dimension.
Lateral dimension = PM10Rate x 10 m/(lb/hr)
Minimum Lateral Dimension = 0.47 m

4.8.1.4 Refining Surrounding Sources

In some cases, it will be possible to use actual emissions to model surrounding sources instead of the maximum values allowed in the permit. If actual emission rates from the most recent two years is available, then the following optional technique may be used.

Annual averaging period: For the most recent two consecutive years of operation, if that period is representative of normal operation, the emission rate for each hour (in pounds per hour) is the total tons emitted for those two years divided by 8.76 (lb x year/ton x hour).

Other averaging periods: The unit is assumed to operate continuously unless there is a permit condition or physical limitation that prevents it from operating certain hours of the day or days of the year. If data is available for the most recent two years (Continuous Emissions Monitoring (CEM) data, for example) then a temporally representative level when operating may be used. For example, a generator that provides more power during peak hours could be modeled such that the maximum emission rate would be emitted during the peak hours of the day and the minimum operating emission rate would be emitted during the lowest-demand hours and the hours the unit would normally be off.[8]

4.8.2 Source Groups

It often saves considerable analysis time to set the model up to run with multiple source groups. The following groups are recommended.

- **Source alone group** – contains the sources at the facility that are used to compare with significance levels for the pollutant and averaging period being modeled. This group determines if the facility is above significance levels at the location and time.
- **Cumulative sources group** – contains all allowable emissions of the source and surrounding sources. This group is used to determine compliance with NAAQS and NMAAQS.
- **PSD sources group** – contains all sources that consume or expand PSD increment. This group is used to determine compliance with PSD increment regulations.

Impacts from different groups can be compared to determine if a source contributes significant concentrations if there is a problem complying with air quality standards.

4.8.3 Co-location with a GCP for aggregate processing facilities, asphalt plants, or concrete batch plants

At this time, General Construction Permits (GCPs) for aggregate processing facilities, asphalt plants, and concrete batch plants currently have the requirement that no visible emissions shall cross the fence line, which has been demonstrated to show compliance with all particulate matter air quality standards and PSD increments. NMED has allowed co-located facilities operating under a GCP to rely upon the GCP modeling demonstration for when co-located facilities operate at the same time, since all facilities at the location are required to have the same, no visible emissions, requirement at the fence line. However, if a source operating under a regular construction permit, and not a GCP, co-locates with a GCP source, it must show compliance with all particulate matter air quality standards through air dispersion modeling. The modeling for the source operating under a regular construction permit shall include all sources other than the co-located GCP sources. Gaseous pollutant modeling shall include the co-located GCP(s).

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[8] **Federal Register,** Vol. 82, No. 10, pg. **5220** / Tuesday, January 17, 2017 / Rules and Regulations

5.0 EMISSIONS SOURCE INPUTS

This section describes appropriate modeling for many types of sources. Additional guidance can be found in the User's Guide for the AMS/EPA Regulatory Model - AERMOD (EPA, 2004, http://www.epa.gov/scram001/dispersion_prefrec.htm).

5.1 Emission Sources

There are two general types of sources:

Sources that come from a stack or vent – stack sources, or point sources;
And sources that don't – fugitive sources.

5.2 Stack Emissions/Point Sources

All stacks should be modeled as point sources, as detailed below.

5.2.1 Vertical Stacks

Stacks that vent emissions vertically should be modeled as point sources with stack parameters that will simulate the manner in which emissions are released to the atmosphere:

Stack exit velocity, V_s = average upward velocity of emissions at the top of the stack;
Stack diameter, d_s = stack exit diameter;
Stack exit temperature, T_s = average temperature of emissions at the top of the stack;
Stack height, H_s = stack release height.

5.2.2 Stacks with Rain Caps and Horizontal Stacks

Stacks that vent emissions horizontally and/or have rain caps should be modeled as point sources with stack parameters that will simulate the manner in which emissions are released to the atmosphere:

Stack exit velocity, V_s = 0.001 m/s;
Stack diameter, d_s = 1m;
Stack exit temperature, T_s = 0 K, or optionally actual temperature for stacks with high temperature;
Stack height, H_s = release height.

AERMOD will set the temperature to ambient temperature if the stack exit temperature is set to 0 K. If the model being used does not do this, then set the temperature to ambient temperature or to a close approximation thereof.

If modeling only horizontal stacks that are not capped, turn stack tip downwash off, whether there are buildings or not. Stack tip downwash calculations are inappropriate for horizontal stacks. If only some stacks have rain caps or are horizontal and others release upward without caps, use stack tip downwash.

Optionally, for modeling only vertical stacks that are capped, turn stack tip downwash off and reduce the stack height by three times the actual stack diameter. The cap will probably force stack tip downwash most of the time. The maximum amount of the stack tip downwash (as calculated in ISC2) is three times the stack diameter. Reducing the stack height by this amount, while turning off the stack tip downwash option, causes the maximum stack tip downwash effect. (Joseph A. Tikvart, 1993)

AERMOD beta options using the POINTCAP and POINTHOR may also be used.

5.2.3 Flares

Both process and emergency flares should be modeled for comparisons with NAAQS and NMAAQS. If parts of the facility will be shut down when the flare operates then those emission units may be omitted from the flare modeling.

Flares should be treated as point sources with the following parameters:

Stack velocity = 20 m/s = 65.617 ft/s
Stack temperature = 1000°C = 1832°F
Stack height = height of the flare in meters
Effective stack diameter in meters= $D = \sqrt{10^{-6} q_n}$
where $q_n = q(1 - 0.048\sqrt{MW})$
and q is the gross heat release in cal/sec
MW is the weighted by volume average molecular weight of the mixture being burned.
(SCREEN3 Model User's Guide, 1995)

Flares in the surrounding sources inventory from the Bureau should already have an effective diameter calculated; so the parameters in the inventory can be entered directly into your model input "as is". There are other methods for analyzing impacts of flares; if you wish to use another method, check with the Bureau modeling staff first.

NOTE: The NAAQS cannot be violated, even during upset conditions. All emergency flares should be modeled to show compliance with the NAAQS short-term standards under upset conditions. Emergency flares should be modeled with surrounding sources, but not including neighboring emergency flares and other sources that operate less than 500 hours per year.

5.3 Fugitive Sources

5.3.1 Aggregate Handling

Aggregate handling emissions consist of three separate activities, namely: loading material to and from piles, transportation of material between work areas, and wind erosion of storage piles.

Loading material to and from piles should be modeled as volume sources representative of the loading or unloading operation. Emissions for loading and unloading are calculated using AP-42 Section 13.2.4. The loading and unloading each involve dropping the material onto a receiving surface, whether being dropped by a dump truck, a front-end loader, or a conveyor. Each drop should be modeled as described in Fugitive Equipment Sources, below.

Transportation of material between work areas should be modeled according to haul road methodology if vehicles are used to transport the material, or using transfer point methodology if conveyors are used to transport the material, as described in Fugitive Equipment Sources, below.

Modeling of wind erosion of storage piles is optional, as it says in AP42 not to use the equations for wind erosion in a steady state model.

For the following example facility, aggregate is handled 6 times:

1- a pile in front of the mine face is created,
2- a pile in front of the mine face is loaded into trucks or conveyors,

3- a pile in front of the processing equipment (crusher or HMA) is created,
4- loading the equipment (crusher or HMA),
5- a pile after the equipment, and
6- loading the truck

1 and 2 would not apply if on-site mining does not occur.
5 may be considered a transfer point (conveyor) instead of aggregate handling if controls are applied.
5 and 6 may not apply for HMA plant, as material is bound in asphalt.
6 would not apply if the waste pile is left on site.

5.3.2 Fugitive Equipment Sources

Emissions coming from equipment such as crushers, screens, or material transfer points should be modeled as volume sources. Emission rates are normally calculated using AP42 factors.

The release height (H) is the distance from the center of the volume to the surface of the ground. The base of each volume source must be square. For elongated sources, use a series of volume sources with square bases. Determine the apparent size of a volume source by estimating how large the plume would look to an observer. Consider the movement of the plume source during the course of an hour when determining the apparent size. For example, if the source of emissions is from disturbances on a pile, and the entire pile is disturbed at some point in the hour, then use the size of the pile as the apparent size instead of the area of the pile that would be disturbed at any one instant. The reason for this is that the model operates in one-hour blocks of time, so using instantaneous sizes could inaccurately target nearby receptors with elevated emission concentrations.

For a single volume source, divide the apparent length by 4.3 to determine the initial lateral dimension (σ_{Yo}) to input into the model. For a line source represented by a series of volume sources, divide the distance between the centers of adjacent sources by 2.15 to determine σ_{Yo}.

For a source on the ground, divide the vertical dimension of the source by 2.15 to determine the initial vertical dimension (σ_{Zo}) to input into the model. For a source on or connected to a building, divide the height of the building by 2.15 to determine the σ_{Zo}. For an isolated elevated source, divide the vertical dimension of the source by 4.3 to determine the σ_{Zo}.

Example sources are described in the table below. Some sources will vary from the characteristics listed in the table.

Table 27: Example Dimensions of Fugitive Sources

Source Type	**Height of Volume (m)**	**σ_{Zo} (m)**	**Release Height (m)**	**Width of Volume (m)**	**σ_{Yo} (m)**
Crusher	5	2.33	6	5	1.16
Screen	5	2.33	4	5	1.16
Transfer point	2	0.93	2	2	0.47
Elevated transfer point	4	0.93	4	2	0.47
High Elevated transfer point	4	0.93	8	2	0.47
Concrete truck loading	5	2.33	4	5	1.16

5.3.3 Haul Roads

Traffic carrying materials mined or processed at the facility must be modeled as part of the facility. Haul roads to be modeled include the portion of roads that are not publicly accessible. The Bureau recommends haul road modeling to be consistent with Regional/State/Local Haul Road Workgroup Recommendations, as described below. Haul road emissions should be modeled as a series of adjacent volume sources, except that area sources should be used for modeling haul roads where receptors located within source dimensions are important. A procedure to develop model input parameters follows. The applicant can use other procedures on a case-by-case basis but must demonstrate that those procedures would be appropriate.

Road Source Characterization: Follow the instructions described below.

Plume height:

The height of the volume (H) or plume height will be equal to 1.7 times the height of the vehicle generating the emissions. Use the same for top of plume height for area sources.
The initial vertical sigma (σ_{Zo}) is determined by dividing the height of the plume by 2.15.
The release height is determined by dividing the height of the volume by two. This point is in the center of the volume.

Table 28: Example Haul Road Vertical Dimensions

Vehicle size	Truck Height	Height of Volume	σ_{Zo}	Release Height
Large trucks	4 m (13.1 ft)	6.8 m (22.3 ft)	3.16 m (10.4 ft)	3.4 m (11.1 ft)
Small trucks	2 m (6.6 ft)	3.4 m (11.2 ft)	1.58 m (5.2 ft)	1.7 m (5.6 ft)

RH = H/2 = Release Height above the ground (m). It's the center of the volume source. Also use this for the source height of the area source, if using the area source alternative.
σ_{Zo} = H/2.15 = initial vertical dimension of the volume (m)

Road width:

The adjusted width of the road (W) is the actual width of the road plus 6 meters. The additional width represents turbulence caused by the vehicle as it moves along the road. This width will represent a side of the base of the volume. Use W for the width of the area source, if using the area source alternative.

The initial horizontal sigma (σ_{Yo}) for each volume is determined as follows:

- If the road is represented by a single volume, divide W by 4.3.
- If the road is represented by adjacent volumes, divide W by 2.15.
- If the road is represented by alternating volumes, divide the distance between the center point of one volume to the center point of the next volume by 2.15. $\sigma_{Yo} =$ 2W/2.15 This representation is only recommended for very long roads.
- If using area sources, the aspect ratio (i.e., length/width) should be less than 100 to 1. Subdivide the sources if they are too long.
- If using area sources, model each road segment as a straight line. Do not create a road segment with a bend in the road – divide the road into different segments when bends occur.

Road length:

The sum of the length of all volume sources should be about equal to the actual road length, unless the road is very long and half the segments are skipped to save time. The volume sources should be evenly spaced along the road and should be of equal size for a given road. It is acceptable to artificially end the haul road up to 50 meters before the intersection with a public road. The reduced length of the road is due to the observation that vehicles normally slow down or stop before exiting the property. All emissions from haul roads must be modeled, however. Emissions from the reduced road length are added to other road segments.

The two lateral dimensions (length and width) of a volume source should be equal. The number of volume sources, N, is determined by dividing the length of the road (optionally minus 50 meters) by W. The result is the maximum number of volume sources that could be used to represent the road. If N is very large, modeling time can be reduced by using alternating volume sources to reduce the number of sources.

Table 29: Example Haul Road Horizontal Dimensions

Vehicle size	Width of Volume	Length of Volume	σ_{Yo}
Large trucks	13 m (42.65 ft)	13 m (42.65 ft)	W/2.15 = 6.05 m (19.85 ft)
Small trucks	10 m (32.8 ft)	10 m (32.8 ft)	W/2.15 = 4.65 m (15.26 ft)

Road location:

The UTM coordinates for the volume source are in the center of the base of the volume. This location must be at least one meter from the nearest receptor.

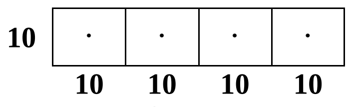
Emission Rate:

Divide the total emission rate equally among the individual volumes used to represent the road, unless there is a known spatial variation in emissions. Use the emissions calculated from the entire road length, even if you artificially end the road volume sources early before exiting the facility.

Example sources:

Use of the following modeling parameters should result in acceptable haul road modeling. Different facilities have different sized trucks, roads, and other variables. It is acceptable to use facility-specific parameters

Example One-Way Road Source



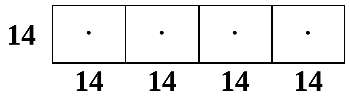
(looking from above)

Width = W = 10 m (32.8 ft)

σ_{Yo} = W/2.15 = 4.65 m (15.26 ft)

Figure 3: One-Way Road Source

Two-Way Road Source



(looking from above)

Width = W = 14 m (45.9 ft)

σ_{Yo} = W/2.15 = 6.51 m (21.4 ft)

Figure 4: Two-Way Road Source

Additional guidance can be found in Volume II of the User's Guide for ISC3 model (EPA, 1995).

5.3.4 Area Sources

Sources that have little plume rise may be modeled as area sources. Examples are: storage pile emissions, waste lagoon emissions, or gaseous emissions from landfills. Area source types include rectangle, circle, and irregularly shaped polygon. The model uses only the portion of the area source that is upwind of the receptor for calculating emissions for the hour, so it is safe to put receptors inside the area source without overly magnifying concentrations. The ISC input file uses emissions per area, but front-end programs for developing input files may calculate this for you based on total emissions from the source. For additional information, see the ISC User’s Guide (EPA, 1995d).

Extremely long or odd-shaped (like a giant “L”) area sources should be broken up into smaller area sources or modeled as a series of volume sources, because they may misrepresent emissions. Area sources, such as AREACIRC sources, may require many times as long to run the model as do volume or point sources in AERMOD.

5.3.5 Open Pits

The open pit source type should only be used to model open pits (not elevated trash dumpsters or anything else that somewhat resembles an open pit). The elevation of the pit entered into the model is the elevation of the top of the pit, which should be ground level.

The model calculates the effective depth of the pit by dividing the pit volume by the length and width of the pit. Release height above the base of the pit must be smaller than this value. Emissions from the bottom of the pit are expressed with a release height of zero.

Pit length should be less than 10 times the pit width. However, a pit cannot be sub-divided because the model needs to calculate mixing done throughout the pit. If the pit is irregular in shape, use the actual area of the top of the pit to calculate a rectangular shape with the same area.

Do not place receptors inside a pit.

The model input file requires pit emission rates to be expressed in mass per time per area [i.e., $g/(s \cdot m^2)$]. Model input front-end programs may convert actual emission rate into area-based emission rates automatically, however.

5.3.6 Landfill Offgas

Decomposition of landfill material can result in the release of gasses such as H_2S. If these gases are not collected using a negative pressure system and flared, then the area of the landfill that is releasing gas can be modeled as an area or a circular area source. If gas is collected by a negative pressure collection system and flared, then model the flare the same way other flares are modeled. Place large area sources in areas that have little effect from the negative pressure collection system. In either case, elevation of the source should be equal to that of the surface, and release height should be zero because they are released from the ground and are not significantly affected by turbulence caused by vehicles traveling over the off-gasses.

6.0 MODELING PROTOCOLS

6.1 Submittal of Modeling Protocol

A modeling protocol should be submitted prior to the performance of a dispersion modeling analysis. For PSD applications, a modeling protocol is mandatory, and must be sent to NMED/AQB for review and comment. Consultation with Bureau modeling staff regarding appropriate model options, meteorological data, background concentrations, and neighboring sources is recommended for minor sources also, and can be accomplished in writing or by phone. The applicant should allow two weeks for the Bureau to review and respond to the written protocol. To avoid delays caused by misinterpretation or misunderstanding, we strongly recommend consultation with our staff on the following topics:

a.) Choice of models;
b.) Model input options;
c.) Terrain classification (flat or simple and complex);
d.) Receptor grids;
e.) Source inventory data;
f.) Minor source baseline dates for modeling increment consumption;
g.) Nearby Class I areas;
h.) Appropriate meteorological data;
i.) Background concentrations;
j.) Setback distance calculation if a proposed facility is a portable fugitive source;
k.) Any possible sources of disagreement;

Important: Modeling that substantially deviates from guidelines may be rejected if it is not accompanied by a written approved modeling protocol.

The input data to the models will be unique to the source. Data will usually consist of 1) emission rates and stack parameters for the proposed source at maximum load capacity and at reduced load capacity; 2) emission parameters of sources in the area; 3) model options; 4) suitable meteorological data; 5) definition of source operation which creates the greatest air quality impacts if other than maximum load conditions; and 6) terrain information, if applicable. Very important: **The emission parameters used in the modeling analysis of the proposed source are normally the same as those in the permit application. Any difference between the two should be clearly documented and explained.** Failure to adhere to this rule may result in an incomplete analysis.

6.2 Protocol ingredients

The shortest acceptable modeling protocol would be a statement that the modeling guidelines will be followed and a statement of what meteorological data will be used. Ask the modeling section or check the web page for the latest sample protocols.

6.3 How to submit the protocol

E-mail the modeling protocol to the modeling manager: Sufi.Mustafa@state.nm.us

7.0 DISPERSION MODELING PROCEDURE

Note: The basic steps for performing the modeling are presented in sequential format. Sometimes, it will make sense to perform some of the steps out of order. The sequential modeling steps are designed as an aid to modeling, not a mandatory requirement.

It is important to have an approved modeling protocol before proceeding. Modeling that substantially deviates from guidelines may be rejected if it is not accompanied by a written approved modeling protocol.

7.1 Step 1: Determining the Radius of Impact

A facility's significance area is defined as all locations outside of its fence line where the source produces concentrations that are above the significance levels listed in Table 6. The source is deemed culpable for concentrations that exceed air quality standards or PSD increments that occur at a receptor if the source's contribution is above the significance level at the same time that the exceedance of air quality standards or PSD increments occurs.

The Bureau uses the Radius of Impact (ROI) to make sure the entire significance area is analyzed. The ROI is defined as the greatest distance from the center of the facility to the most distant receptor where concentrations are greater than significance levels.

An illustration of determining an ROI from modeling output is shown in Figure 5, below. Note that the entire ROI is completely contained within the receptor grid, as required.

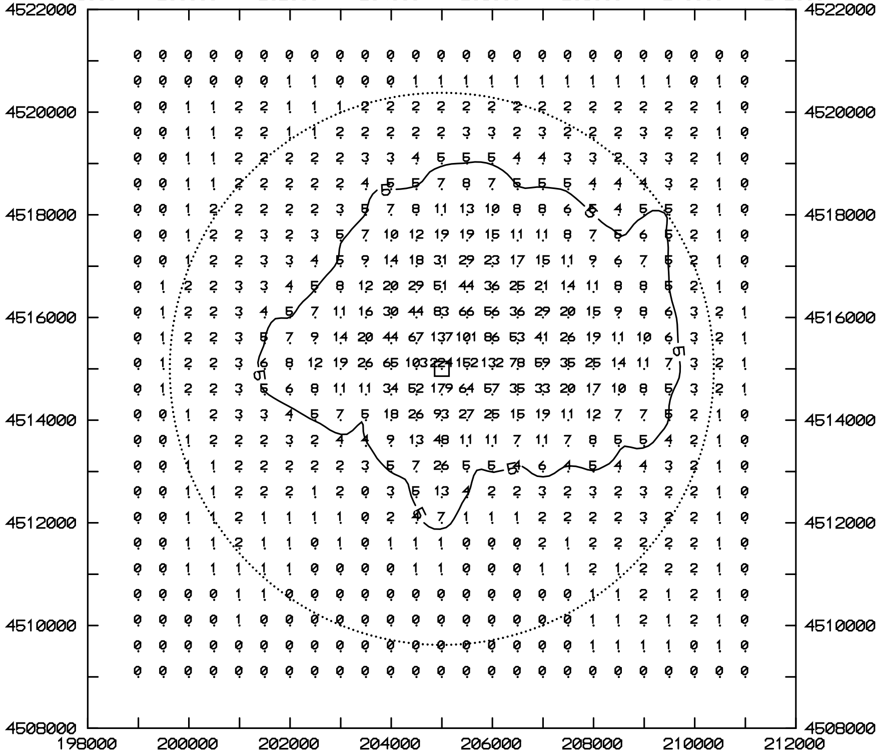


Figure 5. Plot of pollutant concentrations showing the 5 μg/m^3 significance level and the radius of impact (dashed line circle), determined from the greatest lineal extent of the significance level from the source.

7.1.1 Prepare the ROI analysis as follows:

I. Select the model that will be used for the analysis. It is usually quicker in the long run to use the same model for the radius of impact analysis as will be used for the refined analysis.
II. Model the entire source, as defined in section 2.4.1. Suggestion: Plot your sources to verify locations and identify typographical errors.
III. Set up the receptors as described above. Make sure the receptor grid extends far enough in every direction to capture the entire ROI, subject to the maximum radius of 50km.
IV. Optional step: Calculate the elevations of all sources, receptors, and buildings. This complex terrain analysis is optional for the ROI run, but it may save time to do it now.
V. Optional step: Add buildings and analyze them with BPIP or equivalent programs. This building downwash analysis is optional for the ROI run, but it may save time to do it now.
VI. Choose modeling options, as appropriate.
VII. Make sure that all sources and operating scenarios are modeled according to the guidelines in sections 4 and 5, above.
VIII. Run the model.

7.1.2 Analyze modeling results to determine ROI

I. Determine a radius of impact for each pollutant for each applicable averaging period. The largest ROI may be designated as the ROI for that pollutant, or each averaging period determined independently.
II. The ROI for NO_2 may be determined using Ambient Ratio Method 2 (ARM2).
III. Concentrations inside the facility's fence line can be ignored when determining the ROI.
IV. If no concentrations of a pollutant are above the significance levels for that pollutant, then the ROI for that pollutant is 0. Skip to Step 3 for that pollutant.
V. It is acceptable to scale impacts from one pollutant to determine impacts from another pollutant if several pollutants vent from the same stack and the ratios of emission rates and the averaging periods are the same.

Proceed to Step 2 for each pollutant with an ROI greater than zero.

7.2 Step 2: Refined Analysis

The entire area of significance must be included in the analyses for all averaging periods for each pollutant. If the ROI was determined using coarse grids, then add fine grid spacing to the potential areas of maximum concentration or concentrations above standards. If the ROI was determined using appropriate grid spacing, elevations, and building downwash (if applicable), then only the significant receptors need to be modeled for the refined analysis.

Once the ROI is determined for a specific source, neighboring sources need to be included and a cumulative impact analysis needs to be performed. As the ROI analysis is concerned with significance levels, the refined analysis is concerned with NAAQS, NMAAQS, and PSD Class I and Class II increments. The concentrations produced by the facility plus surrounding sources must be demonstrated to be below these levels in order to issue a permit under the regular permitting process.

7.2.1 Prepare the Refined Analysis as Follows:

I. If a screening model was used to determine ROI, the modeler may wish to use a refined model to reduce the area of significant impact. If so, return to *Step 1* and repeat the step with the new model.
II. Prepare a new modeling input file from the ROI file.

III. Fill the ROI with receptors with appropriate spacing (or discard receptors below significance levels if appropriate spacing was used for the ROI analysis).
IV. Add receptors near areas of high concentration if these areas are not contained within a fine grid. The modeling run must definitively demonstrate that the maximum impact has been identified. Concentrations should "fall off" from the center of the fine grid.
V. Add surrounding sources to the input file, if appropriate, as described in *Neighboring Sources/Emission Inventory Requirements*, above. Include $PM_{2.5}$ surrounding sources if particulate modeling is required. Suggestion: set up source groups so that impacts from the source alone, from the PSD increment consuming sources, and from all sources can be analyzed in a single run and compared with each other for determination of culpability.
VI. Building downwash analysis must be included in the refined analysis, if applicable.
VII. Terrain elevations must be included in the refined analysis, if applicable.

7.2.2 Analyze the Refined Modeling Results

I. Make sure the maximum impacts for each averaging period fall within a fine enough receptor grid to identify true maximums. Include fine grids near adjacent sources and in "hot spots".
II. Compare the highest short-term and annual impacts from all sources with NAAQS and NMAAQS.
III. Determine if there is an exceedance of PSD Class II increment within the area defined by the radius of impact by the group containing all PSD increment consuming sources.
IV. Determine if there is an exceedance of PSD Class I increment within any Class I area.
V. If the facility alone will violate any NAAQS, NMAAQS, or PSD increment, then the permit cannot be issued through the normal process. Please contact the Bureau for further information.
VI. If there are exceedances of the NMAAQS or NAAQS at any receptors within the ROI, the next step is to determine if the facility being modeled significantly contributes (see significance levels in Table 6) to the exceedance at those receptors during the same time period(s) that the exceedance occurs. If so, the permit cannot be issued through the normal process. See nonattainment area requirements, below.
VII. If no exceedances are found, or if the facility does not contribute amounts above significance levels to the exceedances, then the facility can be permitted per the modeling analysis.

7.2.3 NMAAQS and NAAQS

All sources are required to submit NMAAQS and NAAQS modeling. The total concentrations of all facilities and background sources are required to be below the NAAQS. The steps required for this analysis are outlined above.

7.2.4 PSD Class II increment

PSD Increment modeling applies to both minor and major sources. If the minor source baseline date has been established in the Air Quality Control Region (AQCR) in which the facility will be located, then PSD increment consumption modeling must be performed. If the minor source baseline date has not been established in that region, then only PSD major sources must perform this analysis.

Portable sources that are not located at a single location continuously for more than one year are not required to model PSD increment consumption.

The steps required for this analysis are outlined above.
The same significance levels that apply to NAAQS and NMAAQS standards are assumed to apply to PSD Class II increment as well.

7.2.5 PSD Class I increment

If a PSD Class II increment analysis is required and the proposed construction of a minor source is within 50 km of a Class I area (see Figure 1), then PSD increment consumption at the Class I area(s) must be determined and compared with the Class I PSD increment. If the proposed construction of a PSD major source is within 100 km of a Class I area, then PSD increment consumption at the Class I area(s) must be determined and compared with the Class I PSD increment. The PSD permit process requires a more thorough Class I analysis, which is described in *Step 6*.

See *Receptor Placement*, above, for receptor instructions.

Proceed with the Class I area analysis similarly to the other analyses described above. Class I significance levels apply for determining whether or not a facility contributes significantly to an exceedance in a PSD Class I area and for determining the Class I ROI.

7.3 Step 3: Portable Source Fence Line Distance Requirements for Initial Location and Relocation

Skip this step if the facility is not a portable source.

Portable sources should model fence line distance requirements for relocation purposes and for setback distances within the initial property. If the facility wants to be able to move equipment around within the property, or move to a new location, permit conditions will be required to ensure the facility continues to demonstrate compliance with air quality standards as it moves. For this modeling, use meteorological data that the Bureau has approved for relocation modeling, which may be different from that used for the rest of the modeling for the facility. Model the facility with a haul road length at least as long as the setback distance and a number of truck trips equal in number to the count at the original location. Surrounding sources may be ignored, but include co-located facilities if the desire is to be able to co-locate with other facilities at the new locations. To determine setback distance, draw a line connecting the concentrations where they drop off to the point that are just under the ambient air standard or PSD increment. Make sure to add background concentration before determining the isopleths for ambient air standards. From each point on the isopleth line, determine the distance to the nearest source (excluding haul road sources). The setback distance is the largest of these distances. Setback distance is typically rounded up to the nearest meter that is above the calculated value. An example setback distance determination is pictured in Figure 6, below.

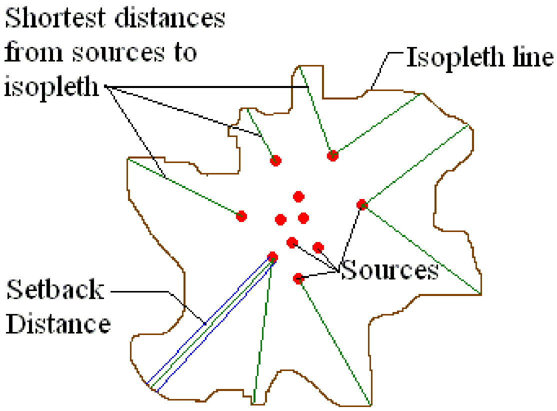


Figure 6: Setback Distance Calculation

Fine spacing is suggested within the property boundary for relocation requirement modeling.

If the applicant does not perform fence line distance modeling, relocation distance will be assumed to be the distance from the edge of a facility operations to the most distant point on the initial fence line. An irregular or elongated fence line shape can result in relocation requirements that require very large properties to be fenced off in order to relocate there without submitting modeling for each new location of the facility.

7.4 Step 4: Nonattainment Area Requirements

Skip this step if all modeled concentrations are below NAAQS, NMAAQS, and PSD Increments.

If the modeling analysis of a source predicts that the impact from any regulated air contaminant will exceed the significance level concentrations at any receptor which does not meet the NMAAQS or NAAQS, the source will be required to demonstrate a net air quality benefit and meet the requirements of 20.2.72.216 NMAC or 20.2.79 NMAC. The net air quality benefit is a reduction of at least 20% of the maximum modeled concentration from the facility or the emission sources being modified. The 20 percent reduction shall be calculated as the projected impact subtracted from the existing impact divided by the existing impact. The existing impact for the net air quality benefit must be based on the lowest enforceable emission rate, or the actual emission rate if a unit has no enforceable emission rate. The offsets used to meet the net air quality benefit must be quantifiable, enforceable, and permanent. For more information regarding nonattainment permit requirements, see **20.2.72.216 NMAC** and **20.2.79 NMAC** – Nonattainment Areas.

7.5 Step 5: Modeling for Toxic Air Pollutants

Skip this step if there are no toxics to model at this facility. See section 2, “New Mexico State Air Toxics Modeling”, to determine if modeling of toxics is required and for other details about toxics regulatory requirements.

I. Model the toxic air pollutants similar to the way the other pollutants were modeled, as described above in steps 1 and 2. Use an 8-hour averaging period, complex terrain, and building downwash.
II. No surrounding source inventory exists for the toxics, so model only your source.
III. Make sure a fine grid is used in the area of maximum concentration.
IV. If more than one toxic pollutant is being modeled and they use the same stacks at the same ratio of emission rates, it is allowable to scale the results of the first pollutants by the emission rate ratio to determine the concentration of the other toxics.

If modeling shows that the maximum eight-hour average concentration of all toxics is less than one percent of the Occupational Exposure Level (OEL) for that toxic, then the analysis of that toxic pollutant is finished. Report details about the maximum concentrations in the modeling report. Otherwise, perform BACT analysis or health assessments, as required. Contact the Bureau on how to proceed if the 1/100th of the OEL is exceeded.

7.6 Step 6: PSD Permit Application Modeling

Skip this step if the facility is not a PSD major source.

PSD sources and requirements are defined in NMAC 20.2.74.303 to 305. New PSD major sources and major modifications to PSD major sources must submit the following modeling requirements in addition to the NSR minor source modeling requirements. Minor modifications to PSD major sources

are only subject to NSR minor source modeling requirements listed above, as required under NMAC 20.2.72.

Due to a court ruling, the use of the $PM_{2.5}$ significant monitoring concentration for PSD major modifications or new PSD major sources is not allowed. This significant ambient concentration level may still be used for minor source and nonattainment permitting.

Sources subject to PSD requirements should consult with the Bureau to determine how to proceed in the application process. For PSD applications, a modeling protocol is required for review. Please refer to EPA's *New Source Review Workshop Manual.* The following items are required for PSD permit applications and supersede other modeling requirements in this document.

7.6.1 Meteorological Data

Applicants may need to collect one year of on-site meteorological and ambient data to satisfy PSD requirements. In some cases, it may be advantageous to begin collecting on-site meteorological and ambient data to ensure that it is available at a site that may become PSD in the future. A company considering a monitoring program is advised to consult with the Bureau as early as possible so that an acceptable data collection process, including instrument parameters, can be started. Generally, the following meteorological parameters will be measured: wind direction, wind speed, ambient air temperature, solar insolation, ΔT, and σ_θ. For further information on meteorological monitoring Refer to EPA's *Guideline on Air Quality Models* and *On-Site Meteorological Program Guidance for Regulatory Modeling Applications*. Refer to *Ambient Monitoring Guidelines for Prevention of Significant Deterioration (PSD)* for ambient monitoring guidance. In addition, a monitoring protocol and QA plan **must** be submitted and approved prior to beginning collection of data for a PSD application if these data are to be used for the analysis.

In the absence of actual on-site data, the Bureau may approve the use of off-site data that the Bureau believes mimics on-site data for that location or the Bureau may approve the use of data produced by the model MM5.

7.6.2 Ambient Air Quality Analysis

The ambient air quality analysis is the same as described above, with the exception of the following points.

- The PSD project is defined as the future potential emission rate minus the past actual emission rate.
- If the maximum ambient impact is less than EPA's significant concentration levels (see Table 6), then a full analysis is not required.
- Nearby sources must be considered. Discarding sources is discussed in the section on "neighboring sources data".
- A total air quality analysis must also be performed for each appropriate Class I area if the facility produces concentrations greater than the Class I significance levels in Table 6. All sources near the Class I area must be considered. The inventories for the analysis near the facility and the inventory for the analysis near Class I areas may be quite different because they are centered on different locations.
- If subject to 20.2.74.403 NMAC (Sources impacting Federal Class I Areas), an analysis of Air Quality Related Values must be included in the PSD application. If the facility will have no impact on the AQRV, then that must be stated in the application (NSR Workshop Manual, Chapter D).
- There may be additional analyses required by the Federal Land Managers (FLM) for Air Quality Related Values (AQRVs). See **F**ederal **L**and **M**anagers' **A**ir Quality Related Values Work

Group (FLAG) for more information at: http://www2.nature.nps.gov/air/Permits/flag/index.cfm

7.6.3 Additional Impact Analysis (NMAC 20.2.74.304)

The owner or operator of the proposed major stationary source or major modification shall provide an analysis of the impact that would occur as a result of the source or modification and general commercial, residential, industrial, and other growth associated with the source or modification. This analysis is in addition to the Class I analysis, but may use some of the same techniques that were used in the Class I analysis. The analysis required for a National Environmental Policy Act (NEPA) review may work to satisfy some requirements of this section.

- Visibility Analysis: A Class II Visibility Analysis is required to determine impact the facility will have upon Class II areas. Analyze the change in visibility of a nearby peak or mountain for this analysis. In the absence of nearby mountains, analyze the visibility of clear sky from nearby state or local parks.
- Soils analysis: What changes will occur to soil pH, toxicity, susceptibility to erosion, or other soil characteristics as a result of the project and indirect growth related to the project?
- Vegetation analysis: What changes will occur to type, abundance, vulnerability to parasites, or other vegetation characteristics as a result of the project and indirect growth related to the project? The owner or operator need not provide an analysis of the impact on vegetation having no significant commercial or recreational value.
- Growth analysis: The owner or operator shall also provide an analysis of the air quality impact projected for the area as a result of general commercial, residential, industrial, and other growth associated with the source or modification.

7.6.4 Increment Analysis

- If the facility produces ambient concentrations greater than the significance levels in Table 6, then the Class II PSD increment analysis for the facility must use the inventory of all increment consuming sources near the facility. Sources in other states should be obtained from the agency in the surrounding state.
- If there is a Class I area within 100 km of the facility (or any distance, if requested by the FLM), then receptors must be located at the Class I area.
- If the facility produces ambient concentrations greater than the Class I significance levels in Table 6 in a Class I area, then the increment analysis for the Class I areas should use the inventory of all increment consuming sources near the Class I area, including those sources in other states. Sources in other states should be obtained from the agency in the surrounding state.

7.6.5 Emission Inventories

- The most current inventory of sources must be used. It should contain all sources currently under review by the Bureau that would be located within the appropriate inventory area. The applicant should check with the modeling staff to ensure that the inventory is up to date.

7.6.6 BACT analysis

- The analysis must follow current EPA procedures and guidelines.

7.7 Step 7: Write Modeling Report

A narrative report describing the modeling performed for the facility is required to be submitted with the permit application using Universal Application form 4 (UA4). This report should be written to provide the public and the Bureau with sufficient information to determine that the proposed construction does not cause or contribute to exceedances of air quality standards. The report needs to contain enough information to allow a reviewer to determine that modeling was done in a manner consistent and defensible with respect to available modeling guidance. Do not include raw modeling output in the report, only summaries and descriptions of the output or input.

This outline may be used as a checklist to determine if the analysis is complete.

I. Applicant and consultant information
  a. Name of facility and company.
  b. Permit numbers currently registered for the facility.
  c. Contact name, phone number, and e-mail address for the Bureau to call in case of modeling questions.

II. Facility and operations description
  a. A narrative summary of the purpose of the proposed construction, modification, or revision.
  b. Brief physical description of the location.
  c. Duration of time that the facility will be located at this location.
  d. A map showing UTM coordinates and the location of the proposed facility, on-site buildings, emission points, and property boundaries. Include UTM zone and datum.

III. Modeling requirements description
  a. List of pollutants at this facility requiring NAAQS and/or NMAAQS modeling.
  b. AQCR facility is located in and resulting list of pollutants requiring PSD increment (Class I and II) modeling. Include distances to Class I areas in discussion.
  c. List of State Air Toxic pollutants requiring modeling.
  d. PSD, NSPS, and NESHAP applicability and any additional modeling requirements that result if those regulations are applicable to the facility.
  e. State whether or not the facility is in a federal Nonattainment area, and any special modeling requirements or exemptions due to this status.
  f. Any special modeling requirements, such as streamline permit requirements.

IV. Modeling inputs
  a. General modeling approach
    i. The models used and the justification for using each model.
    ii. Model options used and why they were considered appropriate to the application.
    iii. Ozone limiting model options discussion, if used for NO_2 impacts.
    iv. Background concentrations.
  b. Meteorological data
    i. A discussion of the meteorological data, including identification of the source of the data.
    ii. Discussion of how missing data were handled, how stability class was determined, and how the data were processed, if the Bureau did not provide the data.
  c. Receptor and terrain discussion
    i. Description of the spacing of the receptor grids.
    ii. List fence line coordinates and describe receptor spacing along fence.
    iii. PSD Class I area receptor description.
    iv. Flat and complex terrain discussion, including source of elevation data.
  d. Emission sources
    i. Description of sources at the facility, including:

            1. A cross-reference from the model input source numbers/names to the sources listed in the permit application for the proposed facility.
            2. Determination of sigma-Y and sigma-Z for fugitive sources.
            3. Description and list of PSD increment consuming sources, baseline sources, and retired baseline sources.
            4. Describe treatment of operating hours
            5. Particle size characteristics, if plume depletion is used.
            6. If the modeled stack parameters are different from the stack parameters in the application, an explanation must be provided as to what special cases are being analyzed and why.
            7. Partial operating loads analysis description.
            8. Flare calculations used to determine effective stack parameters.
            9. In-stack NO_2/NO_X ratio determination, if using OLM or PVMRM.
        ii. Surrounding sources:
            1. The date of the surrounding source retrieval.
            2. Details of any changes or corrections that were made to the surrounding sources.
            3. Description of adjacent sources eliminated from the inventory.
    e. Building downwash
        i. Dimensions of buildings

V. Modeling files description
    a. A list of all the file names in the accompanying CD and description of these files.
    b. Description of the scenarios represented by each file.

VI. Modeling results
    a. A discussion of the radius of impact determination.
    b. A summary of the modeling results including the maximum concentrations, location where the maximum concentration occurs, and comparison to the ambient standards.
    c. Source, cumulative, and increment impacts.
    d. Class I increment impact.
    e. A table showing concentrations and standards corrected for elevation.
    f. If ambient standards are exceeded because of surrounding sources, please include a culpability analysis for the source and show that the contribution from your source is less than the significance levels for the specific pollutant.
    g. Toxics modeling results, if needed.

VII. Summary/conclusions
    a. A statement that modeling requirements have been satisfied and that the permit can be issued.

Ask the modeling section or check the web page for a sample modeling reports. The modeling report documents details the standard format for the modeling report.

7.8 Step 8: Submit Modeling Analysis

Submit the following materials to the Bureau:

A CD containing the following:

I. An electronic copy (in MS Word format) of the modeling report.
II. Input and output files for all model runs. Include BEEST, ISC-View, or BREEZE files, if available.
III. Building downwash input and output files.

IV. Fence line coordinates.
V. Meteorological data, if not Bureau-supplied.
VI. A list of the surrounding sources at the time the facility was modeled.
VII. An electronic copy of the approved modeling protocol.

Do not include paper copies of modeling input and output files.

8.0 List of Abbreviations

Table 30: List of Abbreviations

ACRONYM	DESCRIPTION
AQB	Air Quality Bureau
AQCR	Air Quality Control Region
AQCR	Air Quality Control Regulation (CURRENTLY NOT USED)
AQRV	Air Quality Related Values
ARM2	Ambient Ratio Method 2
BACT	Best Available Control Technology
CO	Carbon monoxide
DEM	Digitized Elevation Model
EPA	Environmental Protection Agency
FLAG	**F**ederal **L**and **M**anagers' **A**ir Quality Related Values Work **G**roup
FEM	Federal Equivalent Method
FRM	Federal Reference Method
GEP	Good Engineering Practice
H_2S	Hydrogen sulfide
ISCST3	Industrial Source Complex Short Term Model version 3
NAAQS	National Ambient Air Quality Standards
NED	National Elevation Dataset
NO_2	Nitrogen dioxide
NO_X	Nitrogen oxides
NMAAQS	New Mexico Ambient Air Quality Standards
NMAC	New Mexico Administrative Code
O_3	Ozone
OEL	Occupational Exposure Level
OLM	Ozone limiting method
Pb	Lead
PDF	Probability density function
$PM_{2.5}$	Particulate matter equal to or under 2.5 μm in aerodynamic diameter
PM_{10}	Particulate matter equal to or under 10 μm in aerodynamic diameter
PPM	Parts per million (volume ratio)
PSD	Prevention of Significant Deterioration
PVMRM	Plume Volume Molar Ratio Method
ROI	Radius of Impact
SO_2	Sulfur dioxide
TSP	Total suspended particulates
UTM	Universal Trans Mercator
VOC	Volatile organic compounds

9.0 References

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EPA (1995). User's Guide for the Industrial Source Complex (ISC3) Dispersion Model, Volume I - User Instructions. EPA-454/B-95-003a. September 1995.

Joseph A. Tikvart (1993). “MEMORANDUM: Proposal for Calculating Plume Rise for Stacks with Horizontal Releases or Rain Caps for Cookson Pigment, Newark, New Jersey”, Joseph A. Tikvart (Model Clearinghouse), July 9, 1993.

SCREEN3 Model User’s Guide (1995). SCREEN3 Model User’s Guide, EPA-454/B-95-004, September, 1995. U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Emissions, Monitoring, and Analysis Division, Research Triangle Park, NC.

NSR Workshop Manual, Chapter D – Air Quality Related Values

Federal **L**and **M**anagers' **A**ir Quality Related Values Work **G**roup (FLAG) Phase I Report: http://www2.nature.nps.gov/air/Permits/flag/index.cfm–
New Mexico Administrative Code (NMAC)

EPA, 1995d*: User’s Guide for the Industrial Source Complex (ISC3) Dispersion Models*, EPA-454/B-95-003a, September, 1995. U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Emissions, Monitoring, and Analysis Division, Research Triangle Park, NC.

Texas 1999: ***Air Quality Modeling Guidelines***, TNRCC-New Source Review Permits Division, RG-25 (Revised), February 1999

“The Plume Volume Molar Ratio Method [(PVMRM)] for Determining NO_2/NOx Ratios in Modeling”, by Pat Hanrahan of the Oregon DEQ. The paper appeared in the November 1999 issue of the AWMA journal.

Links:

Environmental Protection Agency, 40 CFR Part 51, Revision to the Guideline on Air Quality Models Appendix W: http://www.epa.gov/ttn/scram/guidance/guide/appw_05.pdf

NSR Workshop Manual 1990 Draft: http://www.epa.gov/ttn/nsr/gen/wkshpman.pdf

Modeling Procedures for Demonstrating Compliance with PM2.5 NAAQS memo from Stephen Page, March 23, 2010:
http://www.epa.gov/ttn/scram/Official%20Signed%20Modeling%20Proc%20for%20Demo%20Compli%20w%20PM2.5.pdf

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Appendix A: Recent changes to the NM Modeling Guidelines

Note of changes made in 2019:

February 7, 2019: An error in summary Table 6C was corrected to make it match the full text in section 2.6.4.4.

Note of changes since 2016 version:

Source definition was changed to better match EPA definitions.
Original:

> Modeling significance levels are thresholds below which the source is not considered to contribute to any predicted exceedance of air quality standards or PSD increments. The definition of 'source' can apply to the whole facility or to the modifications at the facility. In cases where a particular averaging period has not been modeled for a pollutant, or was modeled, but predicted concentrations were above 95% of air quality standards or PSD increments, then NMED considers the entire facility to be the 'source' for those pollutants and periods. For other cases, 'source' includes only the modification described in the current application plus all contemporaneous emissions increases in the past 5 years since the entire facility was last modeled.

New:

> Modeling significance levels are thresholds below which the source is not considered to contribute to any predicted exceedance of air quality standards or PSD increments. The definition of 'source' can apply to the whole facility or to the modifications at the facility. For a new facility or an unpermitted facility, NMED considers the entire facility to be the 'source'. For other cases, 'source' includes only the new equipment or new emissions increases described in the current application. Equipment that replaces other equipment is part of the new equipment.

Meteorological data recommendations have changed to reflect recent data. AQB has processed new meteorological data and has retired some old data that may be out of date. The processed data is available on the meteorological data webpage (https://www.env.nm.gov/air-quality/meteorological-data/). At the time of this writing, Substation has replaced Bloomfield data for permitting sources to be located in unknown locations (portable source relocation modeling). This change was based on a comparison of modeling results for existing sets of meteorological data.

NO_2 conversion using Ambient Ratio Method (ARM) has been replaced with Ambient Ratio Method 2 (ARM2). EPA no longer mentions the use of ARM in Appendix W. Instead, that appendix described details about what ratios can be used for the ARM2 method, which is now built into AERMOD as a default option.

Title V sources that have not demonstrated compliance with NAAQS or PSD increments are required to model for these standards and increments or produce a compliance plan to come into compliance.

SO_2 background concentrations were added for the annual averaging period.

PM2.5 Class I significance levels were updated.

TSP standards were repealed November 30, 2018.

Background concentrations were updated to 2015-2017.

Areas Where Streamlined Permits Are Restricted were updated.

Secondary formation of ozone and PM2.5 were updated to reflect current Appendix W and MERP guidance.

Note of changes that were made in 2016:

1-hour NO_2 and SO_2 modeling is now required for all sizes of facilities with NO_2 or SO_2 emissions.

ARM2 method of NO_2 modeling has been added to the approved options.

AERMOD output is considered to be expressed at Standard Temperature and Pressure (STP), eliminating most of the need for concentration conversion.

Emission rates for the very small emission rate modeling waivers have changed.

The modeling report form, Universal Application 4 (UA4), is available.

Background concentrations have been updated to 2013-2015 monitoring results.

(Hobbs PM2.5 background concentration was corrected from the July 8, 2016 version).
(September 1, 2016: PM2.5 annual standard was corrected in Table 5F)

Errors in summary Tables 6A and 6C that did not match the instructions in the pollutant-specific standards sections were corrected.

NMED
EXHIBIT 4

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
RESEARCH TRIANGLE PARK, NC 27711

FEB 10 2020

OFFICE OF
AIR QUALITY PLANNING
AND STANDARDS

MEMORANDUM

SUBJECT: DRAFT Guidance for Ozone and Fine Particulate Matter Permit Modeling

FROM: Richard A. Wayland, Division Director Richard A. Wayland
Air Quality Assessment Division

TO: Regional Air Division Directors, Regions 1 – 10

The Environmental Protection Agency (EPA) is providing the attached *DRAFT Guidance for Ozone and Fine Particulate Matter Permit Modeling* to the state, local, and tribal air agencies, as well as the public, for consideration, review and comment. This guidance document reflects the EPA's recommendations for how a stationary source seeking a Prevention of Significant Deterioration (PSD) permit may demonstrate that it will not cause or contribute to a violation of the National Ambient Air Quality Standards (NAAQS) for ozone (O_3) and fine particulate matter ($PM_{2.5}$) and PSD increments for $PM_{2.5}$, as required under Section 165(a)(3) of the Clean Air Act (CAA) and 40 CFR sections 51.166(k) and 52.21(k).

This document does not substitute for provisions or regulations of the CAA, nor is it a regulation itself. As the term "guidance" suggests, it provides recommendations on how to implement the modeling requirements of a PSD compliance demonstration. Thus, it does not impose binding, enforceable requirements on any party, nor does it assure that the EPA will approve all instances of its application, as the guidance may not apply to a particular situation based upon the circumstances. Final decisions by the EPA regarding a particular PSD compliance demonstration will only be made based on the statute and applicable regulations, and will only be made following a final submission by air agencies and after notice and opportunity for public review and comment.

BACKGROUND

The EPA is providing this *DRAFT Guidance for Ozone and Fine Particulate Matter Permit Modeling* to fulfill an outstanding need for additional guidance on demonstrating compliance with the NAAQS for O_3 and $PM_{2.5}$ and PSD increments for $PM_{2.5}$. Because of the complex chemistry of secondary formation of O_3 and $PM_{2.5}$, the EPA's judgment in the past was that it was not technically sound to specify with "reasonable particularity" air quality models that must be used to assess the impacts of a single source on O_3 and secondary $PM_{2.5}$ concentrations. Instead, the EPA employed a case-by-case process for determining analytical techniques that

NMED Exhibit 4

should be used for these secondary pollutants. However, as discussed in the preamble of the 2017 revisions to the EPA's *Guideline on Air Quality Models*[1]:

> "…the EPA has determined that advances in chemical transport modeling science indicate it is now reasonable to provide more specific, generally-applicable guidance that identifies particular models or analytical techniques that may be used under specific circumstances for assessing the impacts of an individual or single source on ozone and secondary $PM_{2.5}$. For assessing secondary pollutant impacts from single sources, the degree of complexity required to appropriately assess potential impacts varies depending on the nature of the source, its emissions, and the background environment. In order to provide the user community flexibility in estimating single-source secondary pollutant impacts that allows for different approaches to credibly address these different areas, the EPA proposed a two-tiered demonstration approach for addressing single-source impacts on ozone and secondary $PM_{2.5}$."

This recommended two-tiered demonstration approach was promulgated as part of the 2017 *Guideline* revisions.

This draft guidance provides an update to the previous *Guidance for PM2.5 Permit Modeling*[2] to reflect the 2017 revisions to the *Guideline* and incorporate appropriate sections for O_3. As experience is gained with these types of PSD compliance demonstrations, the EPA expects to update this and related guidance and provide further specificity on procedures for assessing the impacts of a single source on O_3 and secondary $PM_{2.5}$ concentrations.

REVIEW AND COMMENT

The EPA is requesting that comments on the draft guidance be provided by **Friday, March 27, 2020**. This allows at least 45 days for consideration, review, and comment on the material presented in the draft guidance. Comments should be electronically submitted to Mr. George Bridgers of the EPA's Air Quality Modeling Group at *bridgers.george@epa.gov*.

Following the close of the comment period, the EPA will take into consideration all the feedback and comments submitted and will further engage with the regulatory air quality modeling community at the 2020 Regional, State, and Local Modelers' Workshop currently scheduled for May 5-7, 2020, at the Minneapolis Central Library in Minneapolis, MN. This workshop will allow for an open dialogue on further clarifications, potential amendments, and considerations for additions to the final guidance documentation to be released later this year.

---

[1] *Guideline on Air Quality Models*. 40 CFR part 51, Appendix W (82 FR 5182, Jan. 17, 2017). https://www3.epa.gov/ttn/scram/guidance/guide/appw_17.pdf. Also know as the "2017 *Guideline*."

[2] *Guidance for PM2.5 Modeling*. May 20, 2014. Publication No. EPA-454/B-14-001. Office of Air Quality Planning and Standards, Research Triangle Park, NC. https://www3.epa.gov/ttn/scram/guidance/guide/Guidance_for_PM25_Permit_Modeling.pdf.

The EPA will also conduct a webinar providing an overview of the *DRAFT Guidance for Ozone and Fine Particulate Matter Permit Modeling* allowing for an open exchange on the guidance documentation on Thursday, March 12th at 3pm EDT. Additional information on how to connect to the webinar is posted on the EPA's SCRAM website, https://www.epa.gov/scram, under the Recent Additions section and will be shared with the regulatory air quality modeling community through typical email distributions.

For convenience, the draft guidance document is available electronically on the EPA's SCRAM website at:
https://www3.epa.gov/ttn/scram/guidance/guide/Draft_Guidance_for_O3_PM25_Permit_Modeling.pdf.

If there are any questions regarding the draft guidance, please contact George Bridgers of EPA's Air Quality Modeling Group at (919) 541-5563 or *bridgers.george@epa.gov*.

cc: Air Program Managers, EPA Regions 1 – 10
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Attachment

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

DRAFT Guidance for Ozone and Fine Particulate Matter Permit Modeling

EPA-457/P-20-002
February 2020

DRAFT Guidance for Ozone and Fine Particulate Matter Permit Modeling

U.S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Air Quality Policy Division
Research Triangle Park, NC

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I. Introduction

The U.S. Environmental Protection Agency (EPA) is providing this “Guidance for Ozone and Fine Particulate Matter Permit Modeling” to fulfill a need for additional guidance on demonstrating compliance with the ozone (O_3) and fine particulate matter ($PM_{2.5}$) National Ambient Air Quality Standards (NAAQS) and the Prevention of Significant Deterioration (PSD) increments for $PM_{2.5}$. Because of the complex chemistry of secondary formation of O_3 and $PM_{2.5}$, the EPA's judgment in the past was that it was not technically sound to specify with “reasonable particularity” air quality models that must be used to assess the impacts of a single source on O_3 and secondary $PM_{2.5}$ concentrations. Instead, the EPA employed a case-by-case process for determining analytical techniques that should be used for these secondary pollutants. Under the former process, EPA recommended that the “[c]hoice of methods used to assess the impact of an individual source depends on the nature of the source and its emissions. Thus, model users should consult with the Regional Office to determine the most suitable approach on a case-by-case basis” (2005 *Guideline on Air Quality Models,* U.S. EPA, 2005; hereafter referred to as 2005 *Guideline*; sections 5.2.1.c and 5.2.2.1.c). As such, under the 2005 *Guideline*, the appropriate methods for assessing O_3 and secondary $PM_{2.5}$ impacts were determined as part of the normal consultation process with the appropriate permitting authority.

On January 4, 2012, the EPA granted a petition submitted on behalf of the Sierra Club on July 28, 2010 (U.S. EPA, 2012), which requested that the EPA initiate rulemaking regarding the establishment of air quality models for O_3 and $PM_{2.5}$ for use by all major sources applying for a PSD permit. In granting that petition, the EPA committed to engage in rulemaking to evaluate whether updates to the 2005 *Guideline* were warranted and, as appropriate, incorporate new analytical techniques or models for O_3 and secondarily formed $PM_{2.5}$. As discussed in the preamble of the 2017 revisions to the EPA's *Guideline on Air Quality Models* (U.S. EPA, 2017a; hereafter referred to as 2017 *Guideline*), "the EPA has determined that advances in chemical transport modeling science indicate it is now reasonable to provide more specific, generally-applicable guidance that identifies particular models or analytical techniques that may be used under specific circumstances for assessing the impacts of an individual or single source on ozone and secondary $PM_{2.5}$. For assessing secondary pollutant impacts from single sources, the degree of complexity required to appropriately assess potential impacts varies depending on the nature of the source, its emissions, and the background environment. In order to provide the user community flexibility in estimating single-source secondary pollutant impacts that allows for different approaches to credibly address these different areas, the EPA proposed a two-tiered demonstration approach for addressing single-source impacts on ozone and secondary $PM_{2.5}$." This recommended two-tiered demonstration approach was promulgated as part of the 2017 *Guideline* revisions.

As presented in section 5.2 of the 2017 *Guideline*, the first tier involves use of technically credible relationships between precursor emissions and a source's impacts. Such information may be published in the peer-reviewed literature; developed from modeling that was previously conducted for an area by a source, a governmental agency, or some other entity that is deemed sufficient; or generated by a peer-reviewed reduced form model. To assist permitting authorities, the EPA released the "Guidance on the Development of Modeled Emission Rates for Precursors (MERPs) as a Tier 1 Demonstration Tool for Ozone and $PM_{2.5}$ under the PSD Permitting Program" (U.S. EPA, 2019a; hereafter referred to as MERPs Guidance) that provides a framework to develop MERPs for consideration and use as a Tier 1 demonstration tool, as described in the preamble of the 2017 *Guideline*.

The second tier, also presented in section 5.2 of the 2017 *Guideline*, involves application of more sophisticated case-specific chemical transport models (CTMs), *e.g.*, photochemical grid models, to be determined in consultation with the EPA Regional Offices. The EPA provided guidance to permitting authorities on procedures for applying CTMs in the "Guidance on the Use of Models for Assessing the Impacts of Emissions from Single Sources on the Secondarily Formed Pollutants: Ozone and $PM_{2.5}$" (U.S. EPA, 2016a; hereafter Single-source Modeling Guidance). The Single-source Modeling Guidance is intended to inform that second tier approach by providing appropriate technical methods to assess O_3 and secondary $PM_{2.5}$ impacts associated with the precursor emissions from the new or modifying source. The appropriate tier for a given application should be selected in consultation with the appropriate permitting authority and be consistent with EPA guidance.

This guidance provides an update to the previous "Guidance for $PM_{2.5}$ Permit Modeling" (U.S. EPA, 2014a) to reflect the 2017 revisions to the *Guideline* and incorporate appropriate sections for O_3. As experience is gained with these types of PSD compliance demonstrations, the EPA expects to update this and related guidance and provide further specificity on procedures for assessing the impacts of a single source on O_3 and secondary $PM_{2.5}$ concentrations.

This guidance document is organized in three primary areas:

1. Guidance Overview – Section II provides a general overview of the steps that a permit applicant would take under the PSD program for demonstrating compliance with the O_3 NAAQS and/or the $PM_{2.5}$ NAAQS and PSD increments.
2. PSD Compliance Demonstrations for the O_3 and $PM_{2.5}$ NAAQS – Sections III and IV provide a detailed framework for conducting a source impact analysis and

a cumulative impact analysis, respectively, to appropriately address O_3 and $PM_{2.5}$ impacts from the proposed source[1] in determining whether it may cause or contribute to a NAAQS violation.

3. PSD Compliance Demonstrations for $PM_{2.5}$ Increments – Section V provides a detailed discussion of the assessment of primary and secondary $PM_{2.5}$ impacts of a new or modifying source with respect to the $PM_{2.5}$ increments.

This document recommends procedures for permit applicants and permitting authorities to follow to show that they have satisfied some of the criteria for obtaining or issuing a permit under applicable PSD regulations. This document is not a rule or regulation, and the guidance it contains may not apply to a particular situation based upon the individual facts and circumstances. This guidance does not change or substitute for any law, regulation, or any other legally binding requirement, may refer to regulatory provisions without repeating them in their entirety, and is not legally enforceable. The use of non-mandatory language such as “guidance,” “recommend,” “may,” “should,” and “can,” is intended to describe EPA policies and recommendations. Mandatory terminology such as “must” and “required” are intended to describe requirements under the terms of the CAA and EPA regulations, but this document does not establish or alter any legally binding requirements in and of itself.

This guidance does not create any rights or obligations enforceable by any party or impose binding, enforceable requirements on any PSD permit applicant, PSD permitting authority, EPA, or any other person. Since each permitting action will be considered on a case-by-case basis, this document does not limit or restrict any particular justifiable approach that

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[1] The term “proposed source” is used throughout this guidance document and should be taken to mean the “proposed source or modification” to which the compliance demonstration is being assessed.

permit applicants and permitting authorities may take to conduct the required compliance demonstrations. Each individual decision to issue a PSD permit must be supported by a record sufficient to demonstrate that the proposed construction and operation of a stationary source will not cause or contribute to a violation of the applicable NAAQS and PSD increments. While this document illustrates a particular approach that the EPA considers appropriate and acceptable as a general matter, permit applicants and permitting authorities should examine all relevant information regarding air quality in the area that may be affected by a proposed new or modified source and evaluate whether alternative or additional analysis may be necessary in a given case to demonstrate that the regulatory criteria for a PSD air quality analysis are satisfied. This document does not represent a conclusion or judgment by EPA that the technical approaches recommended in this document will be sufficient to make a successful compliance demonstration in every permit application or circumstance.

Permitting authorities retain the discretion to address particular issues discussed in this document in a different manner than the EPA recommends so long as the approach is adequately justified, supported by the permitting record and relevant technical literature, and consistent with the applicable requirements in the CAA and implementing regulations, including the terms of an approved State Implementation Plan (SIP). Furthermore, this guidance is not a final agency action and does not determine applicable legal requirements or the approvability of any particular permit application. To improve the quality of this guidance, the EPA is soliciting public comment and will consider the comments received.

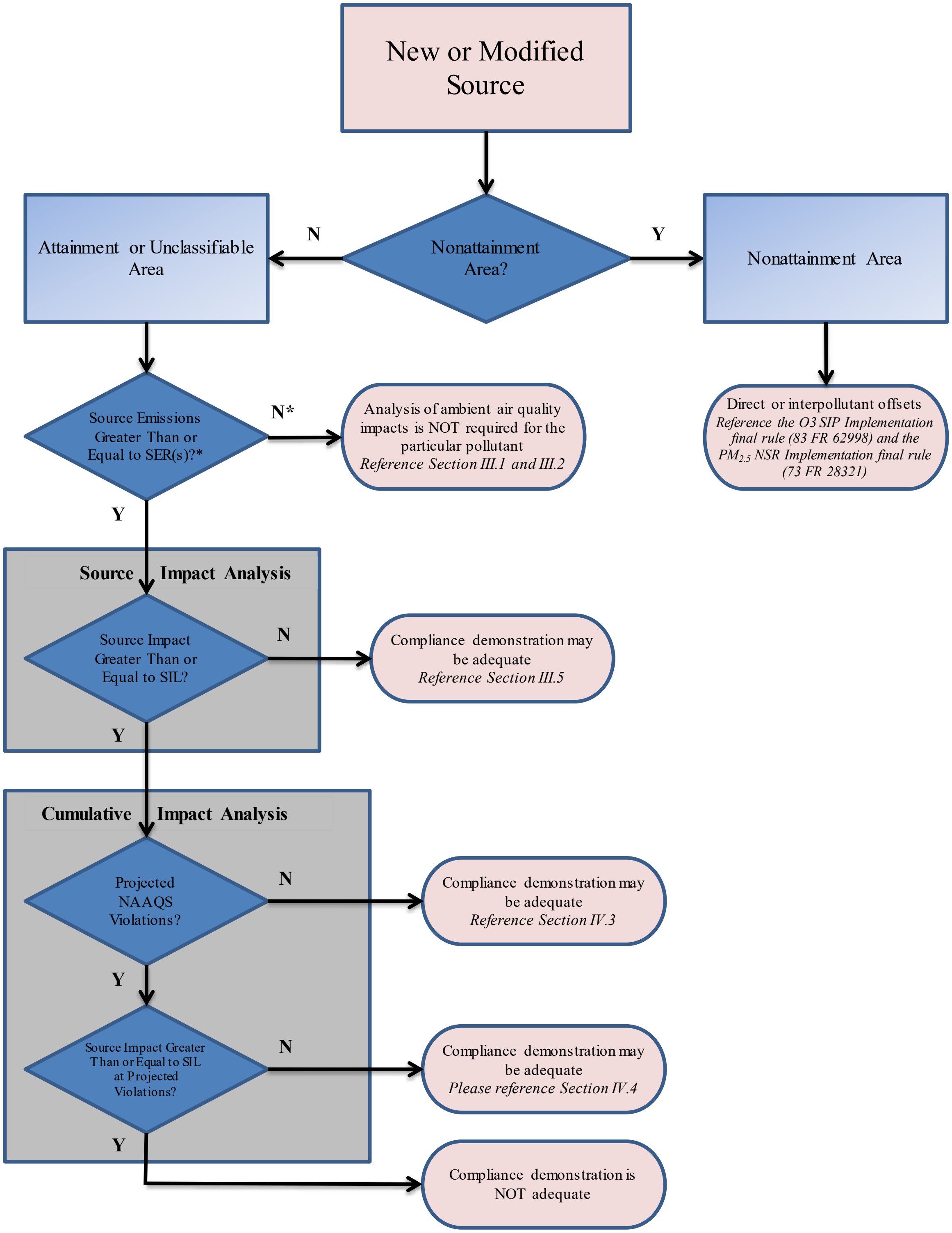
The EPA Regional Offices may seek clarification from the EPA's Office of Air Quality Planning and Standards (OAQPS) on issues and areas of concern in a modeling protocol or PSD compliance demonstration. Through these interactions and subsequent resolutions of specific issues, clarifications of preferred modeling procedures can become additional EPA guidance. This can happen in several ways: 1) the preferred procedures are published as regulations or guidelines; 2) the preferred procedures are formally transmitted as guidance to the Air Division Directors in the EPA Regional Offices; 3) the preferred procedures are formally transmitted as guidance to the EPA Regional Office modeling contacts; or 4) the preferred procedures are relied upon in decisions by the EPA's Model Clearinghouse that establish national precedent that the approach is technically sound. The Model Clearinghouse is the EPA focal point for the review of the technical adequacy of pollutant modeling to satisfy regulatory criteria and other NAAQS compliance demonstration techniques. Model Clearinghouse memoranda involving interpretation of modeling guidance for specific applications, as well as other clarification memoranda addressing modeling more generally, are available at the Support Center for Regulatory Atmospheric Modeling (SCRAM) website at: https://www.epa.gov/scram/air-quality-model-clearinghouse.

II. Guidance Overview

This guidance is appropriate for proposed new or modifying sources locating or located in an area classified as attainment or unclassifiable for O_3 and/or $PM_{2.5}$. It is intended to provide recommendations on how to conduct compliance demonstrations for the O_3 NAAQS and the $PM_{2.5}$ NAAQS and PSD increments under the PSD program following the progressive steps shown in Figure II-1 (for O_3 and $PM_{2.5}$ NAAQS) and Figure II-2 (for $PM_{2.5}$ increments). Since each permitting action is considered on a case-by-case basis, this guidance does not limit or restrict any particular justifiable approach that permit applicants and permitting authorities may take to conduct the required compliance demonstrations. Prospective permit applicants should recognize the importance of the consultation process with the appropriate permitting authority. This process will help identify the most appropriate analytical techniques to be used for conducting a compliance demonstration for the O_3 NAAQS and the $PM_{2.5}$ NAAQS and PSD increments.

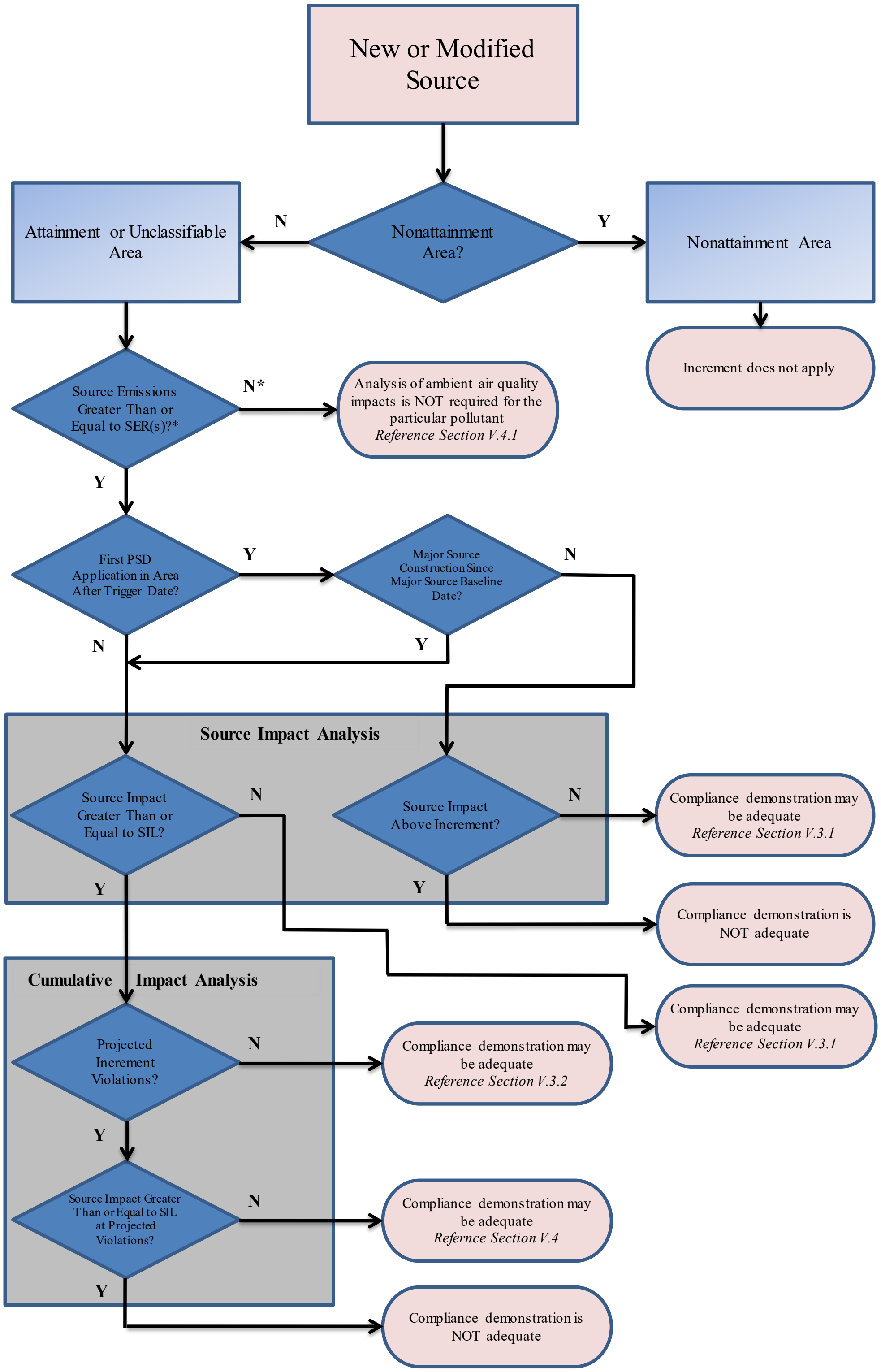
The EPA has historically supported the use of screening tools to help facilitate the implementation of the PSD program and streamline the permitting process in circumstances where proposed construction is projected to have an insignificant impact on air quality. These screening tools include significant emission rates (SERs) and significant impact levels (SILs). The use of these screening tools at each progressive step on the left side (attainment or unclassifiable areas) of Figure II-1 and Figure II-2 are described in more detail throughout Section II.

Figure II-1. Overview of O_3 and $PM_{2.5}$ NAAQS Compliance Demonstration for New or Modifying Sources under NSR/PSD Programs



* Any emissions rate or any net emissions increase associated with a major stationary source or major modification, which would construct within 10 kilometers of a Class I area, and have an impact on such area equal to or greater than 1 μg/m 3, (24-hour average) is considered significantand should proceed with an appropriate air quality assessment. *See* 40 CFR 52.21(b)(23)(iii).

Figure II-2. Overview of $PM_{2.5}$ PSD Increments Compliance Demonstration for New or Modifying Sources under NSR/PSD Programs



* Any emissions rate or any net emissions increase associated with a major stationary source or major modification, which would construct within 10 kilometers of a Class I area, and have an impact on such area equal to or greater than 1 μg/m 3, (24-hour average) is considered significantand should proceed with an appropriate air quality assessment. *See* 40 CFR 52.21(b)(23)(iii).

II.1 Significant Emissions Rates for O_3 and $PM_{2.5}$

O_3 and $PM_{2.5}$ are "regulated NSR pollutant[s]" as that term is defined in the PSD regulations.[2] Pursuant to that definition, ambient concentrations of O_3 are generally addressed through the regulation of its two precursors, nitrogen oxides (NO_X) and volatile organic compounds (VOC), while ambient concentrations of $PM_{2.5}$ are generally addressed through the regulation of direct $PM_{2.5}$ and its precursors NO_X and sulfur dioxide (SO_2).[3] "Significant," with respect to O_3 and $PM_{2.5}$, is defined in EPA regulations at 40 CFR 52.21(b)(23) in reference to a source's potential to emit (or in the case of a modification, the emissions increase[4] and net emissions increase) either direct emissions of the pollutant or emissions of a precursor pollutant. The regulations state that an increase in emissions of either O_3 precursor (NO_X or VOC) is significant if the increase of the particular precursor equals or exceeds 40 tons per year (tpy). For direct emissions of $PM_{2.5}$, the significance level is 10 tpy; for $PM_{2.5}$ precursor emissions, the significance level is 40 tpy for SO_2 and 40 tpy for NO_X.[5]

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[2] 40 CFR 52.21(b)(50).

[3] See 73 FR at 28333. The EPA's PSD regulations do not presumptively require VOC to be treated as precursors to $PM_{2.5}$ in the PSD program. However, a state or the EPA may demonstrate that VOC emissions in a specific area are a significant contributor to that area's ambient $PM_{2.5}$ concentrations and, thus, should be treated as a regulated NSR pollutant subject to the PSD permitting requirements. 40 CFR 52.21(b)(50)(i)(*b*)(*4*).

[4] While section 52.21(b)(23) explicitly defines "significant" for purposes of a net emissions increase or potential to emit, section 52.21(b)(40) defines "significant emissions increase" by reference to the definition of "significant" found in paragraph (b)(23).

[5] A significance rate for VOC as a $PM_{2.5}$ precursor is not defined in the PSD regulations. However, the EPA's final rulemaking action promulgating regulations for implementing the PSD permitting requirements for $PM_{2.5}$ and its precursors indicated that any state required to regulate VOC emissions as a $PM_{2.5}$ precursor "would be required to adopt the 40-tpy significant emissions rate unless it demonstrates that a more stringent significant emissions rate (lower rate) is more appropriate." 73 FR at 28333.

II.2 PSD Pollutant Applicability for O_3 and $PM_{2.5}$

The EPA’s PSD regulations apply specific permitting requirements (*e.g.*, Best Available Control Technology (BACT) and air quality analysis) to regulated New Source Review (NSR) pollutants that would be emitted in a significant amount by a proposed new or modified major stationary source.[6] For a new major stationary source, PSD permitting requirements apply to any regulated NSR pollutant for which the source would have the potential to emit a significant amount. For a modification at an existing major stationary source, PSD permitting requirements apply to any regulated NSR pollutant for which the modification would result in a significant emissions increase *and* a significant net emissions increase (*i.e.*, a “major modification”) of that pollutant.

The provisions at 40 CFR 52.21(m)(1) and (k)(1) comprise the preconstruction air quality analysis requirements of the PSD program and apply to each regulated NSR pollutant that the source or modification would emit in a significant amount. Paragraph (m)(1) provides that any PSD permit application shall contain an analysis of ambient air quality for each such pollutant, and paragraph (k)(1) provides that the owner or operator “shall demonstrate that allowable emission increases from the proposed source or modification . . . would not cause or contribute to air pollution in violation of [any NAAQS or PSD increment].”[7] EPA interprets the term “allowable emission increases” as it is used in paragraph (k)(1) to mean those emission increases authorized by the PSD permit, so that, consistent with paragraph (m)(1), the requirement applies to regulated NSR pollutants that would be emitted in a significant amount.

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[6] See 40 CFR 52.21(a)(2) for applicability procedures for new or modified major stationary sources.

[7] In accordance with CAA § 165(e)(2), one purpose of the monitoring requirements contained in 40 CFR 52.21(m) is to provide information relevant to the determination of whether emissions from a proposed source or modification will exceed a NAAQS or PSD increment. Therefore, EPA reads paragraphs (m) and (k) of 40 CFR 52.21 together.

With respect to the unique nature of the criteria pollutants O_3 and $PM_{2.5}$ emissions of individual O_3 and $PM_{2.5}$ precursors (*i.e.*, NO_X, VOC, SO_2, and direct $PM_{2.5}$ are not summed when determining a significant emissions increase for either criteria pollutant.[8] Only precursors of O_3 or $PM_{2.5}$ that would by themselves be emitted by the source in a significant amount are included in the air quality analysis.

II.3 Significant Impact Levels for O_3 and $PM_{2.5}$

The EPA has issued guidance recommending that permitting authorities consider the use of appropriate pollutant-specific concentration levels known as “significant impact levels” (earlier referred to as SILs) as a compliance demonstration tool for O_3 and $PM_{2.5}$ air quality assessments on case-by-case basis in PSD permitting actions (U.S. EPA 2018a). The “SILs Guidance” identified recommended SIL values for the O_3 and $PM_{2.5}$ NAAQS and the $PM_{2.5}$ PSD increments and included a policy document, as well as supporting technical and legal analyses, that EPA and other permitting authorities may use in case-by-case PSD permitting actions. As explained in the guidance, if a permitting authority chooses to use a recommended SIL value to support a PSD permitting decision, it should justify the values and their use in the administrative record for the permitting action and may choose to adopt EPA’s SILs Guidance, including the supporting technical and legal documents, in doing so.

The EPA’s recommended SIL values from the SILs Guidance for the O_3 and $PM_{2.5}$ NAAQS are presented in Table II-1 and for the $PM_{2.5}$ PSD increments in Table II-2. It is important to note that the $PM_{2.5}$ NAAQS has two averaging periods: 24-hour and annual. There

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[8] See 57 FR 55620, 55624 (Nov. 25, 1992); 80 FR 65292, 65441 (Oct. 26, 2015); see also 73 FR 28321, 28331 (May 16, 2008).

are no PSD increments established for O_3 and, thus, no O_3 increments SIL values. For a full discussion of the basis and purpose of the recommended O_3 and $PM_{2.5}$ SIL values, see the SILs Guidance and supporting documents (U.S. EPA 2018a).

Table II-1. EPA Recommended SIL Values for O_3 and $PM_{2.5}$ NAAQS

Criteria Pollutant (NAAQS Level)	NAAQS SIL Concentration
Ozone 8-hour (70 ppb)	1.0 ppb
$PM_{2.5}$ 24-hour (35 μg/m^3)	1.2 μg/m^3
$PM_{2.5}$ Annual (12 μg/m^3 or 15 μg/m^3)	0.2 μg/m^3

Table II-2. EPA Recommended SIL Values for $PM_{2.5}$ PSD Increments

Criteria Pollutant	PSD Increment SIL Concentration		
	Class I	Class II	Class III
$PM_{2.5}$ 24-hour	0.27 μg/m^3	1.2 μg/m^3	1.2 μg/m^3
$PM_{2.5}$ Annual	0.05 μg/m^3	0.2 μg/m^3	0.2 μg/m^3

As explained in the SILs Guidance, SILs are designed to have a role throughout the PSD air quality compliance demonstration. A permitting authority that chooses to use SILs would initially compare the modeled concentrations resulting from the proposed source's emissions increase to the appropriate SIL. This initial comparison is the "Source Impact Analysis." Where the proposed source's projected impacts on air quality concentrations are found at this first stage to be greater than or equal to the level of the applicable SIL, the analysis should then proceed to a second stage, which involves a cumulative assessment of the air quality in the affected area. The "Cumulative Impact Analysis" considers the combined impact of the proposed source or modification and other relevant sources in determining whether there would be a violation of any NAAQS or PSD increment in the affected area and, if so, whether the proposed source or modification would cause or contribute to such violation based on the applicable SIL.

II.4 Source Impact Analysis

As described in section 9.2.3 of the 2017 *Guideline*, the EPA's recommended procedure for conducting a PSD air quality assessment is a multi-stage approach. The first step is a source impact analysis that quantifies the air quality concentration increase expected to result from a new or modifying source's significant emissions increase as proposed in the PSD permit application.[9] The source impact analysis is used to assess the potential of a proposed new or modifying source to cause or contribute to a NAAQS or PSD increment violation.

In a source impact analysis, as illustrated in Figure II-1 and Figure II-2 and further explained in this guidance, a permitting authority compares the modeled concentrations resulting from the proposed source's emissions increase to an appropriate O_3 or $PM_{2.5}$ SIL. If the proposed source's maximum modeled impacts are found to be below the level of the O_3 or $PM_{2.5}$ SIL at every modeled receptor, the findings of the source impact analysis may be sufficient to demonstrate that the source will not cause or contribute to a violation of the O_3 NAAQS, $PM_{2.5}$ NAAQS, or the $PM_{2.5}$ PSD increment, as necessary to receive a PSD permit. On the other hand, where the proposed source's projected impacts on air quality concentrations are estimated to be greater than or equal to the level of an appropriate O_3 or $PM_{2.5}$ SIL at any modeled receptor, the demonstration should proceed to the next step of conducting a cumulative impact analysis.

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[9] This is consistent with EPA's overall approach for the use of screening techniques in air quality modeling. See 40 CFR part 51, Appendix W, sections 2.2 ("Levels of Sophistication of Air Quality Analyses and Models") and 4.2.1 ("Screening Models and Techniques"). In section 2.2.a, the *Guideline* observes that "[it] is desirable to begin an air quality analysis by using simplified and conservative methods followed, as appropriate, by more complex and refined methods. The purpose of this approach is to streamline the process and sufficiently address regulatory requirements by eliminating the need of more detailed modeling when it is not necessary in a specific regulatory application. For example, in the context of a PSD permit application, a simplified and conservative analysis may be sufficient where it shows the proposed construction clearly will not cause or contribute to ambient concentrations in excess of either the NAAQS or the PSD increments."

II.5 Cumulative Impact Analysis

This section provides an overview of cumulative impact analyses for O_3 and $PM_{2.5}$ NAAQS, as well as, PSD increments compliance. The cumulative impact analysis is illustrated in Figure II-1 and Figure II-2 and further explained in this guidance.

II.5.1 O_3 and $PM_{2.5}$ NAAQS Compliance

For either O_3 or $PM_{2.5}$, where the source impact analysis described in Section II.4 is insufficient to show that a proposed PSD source will not cause or contribute to a violation of the respective NAAQS, a cumulative impact analysis is then necessary to make the required NAAQS demonstration, as described in section 9.2.3 of the 2017 *Guideline*. A cumulative impact analysis should account for the combined impacts of the following:

1. Direct and/or precursor emissions that the new or modifying source would emit in significant amounts;[10]
2. Direct emissions from nearby sources (for primary $PM_{2.5}$ only), as appropriate; and
3. Monitored background levels that account for secondary impacts from regional background sources, secondary impacts from precursor emissions from nearby sources, and, in the case of primary $PM_{2.5}$, $PM_{2.5}$ impacts from direct emissions from background sources, nearby sources not explicitly modeled.[11]

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[10] For a new major stationary source, this includes any direct/precursor pollutant with the potential to emit greater than or equal to the SER and for a modification to an existing major stationary source any direct/precursor pollutant for which the modification results in a significant emissions increase and a significant net emissions increase.

[11] The emissions impact of any nearby source that has received a permit but is not yet operational should be included in the air quality assessment. In such cases, consultation with the appropriate permitting authority on the appropriate assessment approach is recommended.

Once all of these appropriate direct and/or precursor emissions impacts are taken into account, the estimated cumulative impact is then compared to the NAAQS to determine if there is a modeled violation. If not, then the NAAQS compliance demonstration is sufficient. If there are projected NAAQS violations, then the impacts of the emissions increase from the new or modifying source at those locations are compared to the appropriate SIL to determine whether that increase will cause or contribute to a violation of the NAAQS. Several aspects of the cumulative impact analysis for O_3 and $PM_{2.5}$ will be comparable to analyses conducted for other criteria pollutants, while other aspects will differ due to the issues identified earlier.

II.5.2 $PM_{2.5}$ PSD Increments Compliance

For $PM_{2.5}$, where the source impact analysis described in Section II.4 is insufficient to show that a source will not cause or contribute to a violation of any $PM_{2.5}$ PSD increment, a cumulative impact analysis is necessary to make the PSD increment demonstration, as described in section 9.2.3 of the 2017 *Guideline*. A cumulative impact analysis for an increment differs from the NAAQS cumulative impact analysis in that the increment assessment only accounts for the combined impact of the new or modifying source's emissions increase and certain previous emissions changes from sources (including the modifying source) that affect the PSD increment under the EPA's PSD regulations. A more complete description of the types of emissions that affect increment consumption and other aspects of the PSD increment system is contained in Section V.1 of this guidance document. The cumulative impacts are then compared to the appropriate $PM_{2.5}$ PSD increments to determine whether the new or modifying source emissions will cause or contribute to a violation of any $PM_{2.5}$ PSD increment.

For $PM_{2.5}$ PSD increments, since the requirement for calculating the amount of increment consumed was established relatively recently in comparison to the increments for other pollutants, a new or modified source being evaluated for $PM_{2.5}$ PSD increments compliance may still find that it is the first source, or one of only a few sources, with increment-consuming emissions in a particular attainment or unclassifiable area. As shown in Figure II-2, for such situations, a permitting authority may have sufficient reason (based on the approach for conducting source impact analysis described below) to conclude that the impacts of the new or modified source may be compared directly to the allowable increments, without the need for a cumulative modeling analysis. This would be the case where it can be shown that any other increment-consuming sources in the same baseline area, if any, do not have much or any overlapping impact with the proposed new or modified source.[12]

Another important consideration for $PM_{2.5}$ PSD increments is the differences in the EPA recommended SIL values for Class I and Class II / III areas, as presented in Table II-2. Given substantially smaller recommended SIL values for Class I areas, there is a greater likelihood that a proposed new or modifying source would cause or contribute to a PSD increment violation in a Class I area, even at distances beyond the nominal 50 km near-field application distance. Section 4.2 of the 2017 *Guideline* provides screening and compliance assessment approaches for near-field (50 km or less) and long-range transport (beyond 50 km) situations. The MERPs Guidance (*i.e.*, Tier 1 Assessment Approach) and the Single-source Modeling Guidance (*i.e.*, Tier 2 Assessment Approach) should be referenced for assessing secondary $PM_{2.5}$ impacts. There is also distance-weighted empirical relationship information (*i.e.*, precursor contributions to

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[12] The term "increment-consuming source," as used in this guidance, is intended to refer to any type of source whose emissions changes (increases or decreases) affects the amount of increment consumed or expanded.

secondary impacts by distance from source) provided within the MERPs Guidance that may be particularly useful for assessing secondary $PM_{2.5}$ impacts in long-range transport situations. Consultation with the appropriate permitting authority and the appropriate EPA Regional Office is highly recommended for any permit applicants demonstrating long-range Class I area increment compliance per the requirements of section 4.2.c.ii of the 2017 *Guideline*.

III. PSD Compliance Demonstrations for the O_3 and $PM_{2.5}$ NAAQS: Source Impact Analysis

This section provides details regarding the EPA's recommended approaches for conducting the source impact analysis as part of a PSD compliance demonstration for the O_3 and/or $PM_{2.5}$ NAAQS.

III.1 O_3 NAAQS

This section provides details regarding the EPA's recommended approaches for conducting the source impact analysis for the O_3 NAAQS associated with each of the two assessment cases presented in Table III-1. In each of the assessment cases, the analysis should begin by evaluating the impacts of each O_3 precursor (VOC and/or NO_X) that would be emitted in a significant amount, *i.e.*, equal to or greater than the respective SER (40 tpy).

Table III-1. EPA Recommended Approaches for Assessing O_3 Impacts by Assessment Case

Assessment Case	Description of Assessment Case		Secondary Impacts Approach*
Case 1: No Air Quality Analysis	NO_X emissions and VOC emissions < 40 tpy SER		N/A
Case 2*: Secondary Air Quality Impacts	NO_X emissions and/or VOC emissions ≥ 40 tpy SER		Include each precursor of O_3 emitted in a significant amount, see Section II.2. • **Tier 1 Approach** (*e.g.*, MERPs) • **Tier 2 Approach** (*e.g.*, Chemical Transport Modeling)

* In unique situations (*e.g.*, in parts of Alaska where photochemistry is not possible for portions of the year), it may be acceptable for the applicant to rely upon a qualitative approach to assess the secondary impacts. Any qualitative assessments should be justified on a case-by-case basis in consultation with the appropriate permitting authority and the appropriate EPA Regional Office.

For Case 1, a modeled O_3 NAAQS compliance demonstration is not required since neither O_3 precursor (NO_X or VOC) is proposed to be emitted in an amount equal to or greater than the applicable SER. For Case 2, where NO_X and/or VOC precursor emissions are greater than the applicable SER, the permit applicant would need to conduct a compliance demonstration for secondary O_3 impacts for the precursor(s) with emissions equal to or greater than the SER based on the two-tiered demonstration approach in EPA's 2017 *Guideline*.

III.2 $PM_{2.5}$ NAAQS

This section provides details regarding the EPA's recommended approaches for conducting the source impact analysis for the $PM_{2.5}$ NAAQS associated with each of the four assessment cases presented in Table III-2. In each of the assessment cases, the analysis should begin by evaluating the primary $PM_{2.5}$ impacts of direct emissions that would be emitted in a significant amount, *i.e.*, equal to or greater than the SER (10 tpy), and each precursor NO_X and/or SO_2 that would be emitted in a significant amount, *i.e.*, equal to or greater than the respective SER (40 tpy).

Table III-2. EPA Recommended Approaches for Assessing Primary and Secondary $PM_{2.5}$ Impacts by Assessment Case

Assessment Case	Description of Assessment Case	Primary Impacts Approach	Secondary Impacts Approach*
Case 1: No Air Quality Analysis	Direct $PM_{2.5}$ emissions < 10 tpy SER NO_X emissions and SO_2 emissions < 40 tpy SER	N/A	N/A
Case 2: Primary Air Quality Impacts Only	Direct $PM_{2.5}$ emissions ≥ 10 tpy SER NO_X emissions and SO_2 emissions < 40 tpy SER	**Appendix W preferred or approved alternative dispersion model**	N/A
Case 3*: Primary and Secondary Air Quality Impacts	Direct $PM_{2.5}$ emissions ≥ 10 tpy SER NO_X emissions and/or SO_2 emissions ≥ 40 tpy SER	**Appendix W preferred or approved alternative dispersion model**	Include each precursor of $PM_{2.5}$ emitted in a significant amount, see Section II.2. • **Tier 1 Approach** (*e.g.*, MERPs) • **Tier 2 Approach** (*e.g.*, Chemical Transport Modeling)
Case 4*: Secondary Air Quality Impacts Only	Direct $PM_{2.5}$ emissions < 10 tpy SER NO_X emissions and/or SO_2 emissions ≥ 40 tpy SER	N/A	Include each precursor of $PM_{2.5}$ emitted in a significant amount, see Section II.2. • **Tier 1 Approach** (*e.g.*, MERPs) • **Tier 2 Approach** (*e.g.*, Chemical Transport Modeling)

* In unique situations (*e.g.*, in parts of Alaska where photochemistry is not possible for portions of the year), it may be acceptable for the applicant to rely upon a qualitative approach to assess the secondary impacts. Any qualitative assessments should be justified on a case-by-case basis in consultation with the appropriate EPA Regional Office or other applicable permitting authority.

A $PM_{2.5}$ NAAQS compliance demonstration is not required for Case 1 since neither direct $PM_{2.5}$ emissions nor any $PM_{2.5}$ precursor (NO_X or SO_2) emissions is proposed to be emitted in a significant amount. Case 1 is the only assessment case that does not require a NAAQS compliance demonstration. Each of the remaining three assessment cases would include conducting a source impact analysis.

Case 2, where only direct $PM_{2.5}$ emissions are greater than or equal to the applicable SER: In this case, the permit applicant may be able to demonstrate that primary $PM_{2.5}$ impacts from the proposed increase in direct $PM_{2.5}$ emissions are below an appropriate SIL based on dispersion modeling using AERMOD or another appropriate preferred model listed in Appendix A of the 2017 *Guideline*, or an alternative model subject to the provisions of section 3.2 of the 2017 *Guideline*.

Case 3, where direct $PM_{2.5}$ emissions and NO_X and/or SO_2 precursor emissions are greater than or equal to the applicable SER: In this case, consistent with Case 2, the primary $PM_{2.5}$ impacts from direct $PM_{2.5}$ emissions can be estimated based on application of AERMOD or an approved alternative model. However, AERMOD does not account for secondary formation of $PM_{2.5}$ associated with the source's precursor emissions. Since the source also proposes to emit quantities of one or both $PM_{2.5}$ precursors in significant amounts, an assessment of their potential impact on secondary $PM_{2.5}$ is necessary. The assessment of NO_X and/or SO_2 precursor emission impacts on secondary $PM_{2.5}$ formation should be conducted based on the two-tiered demonstration approach in EPA's 2017 *Guideline*.

Case 4, where only NO_X and/or SO_2 precursor emissions are greater than or equal to the applicable SER: In this case, since direct $PM_{2.5}$ emissions are insignificant, *i.e.*, below the applicable SER, the analysis would only address the secondary $PM_{2.5}$ impacts from NO_X and/or SO_2 precursor emissions. Similar to Case 3, the assessment of the precursor emission impacts on secondary $PM_{2.5}$ formation for Case 4 would be conducted based on the two-tiered demonstration approach in EPA's 2017 *Guideline*.

III.3 Assessing Primary $PM_{2.5}$ Impacts

The assessment of primary $PM_{2.5}$ impacts from the proposed new or modifying source is generally the same for the $PM_{2.5}$ NAAQS and PSD increments. Section 4.2.3.5 of the 2017 *Guideline* identifies the AERMOD modeling system as the preferred model for addressing direct $PM_{2.5}$ emissions unless another preferred model listed in the *Guideline* is more appropriate, such as the Offshore and Coastal Dispersion Model (OCD), or the use of an alternative model is justified consistent with section 3.2 of the 2017 *Guideline*.

The AERMOD modeling system includes the following regulatory components:

- AERMOD: the dispersion model (U.S. EPA, 2019b);
- AERMAP: the terrain processor for AERMOD (U.S. EPA, 2018b); and
- AERMET: the meteorological data processor for AERMOD (U.S. EPA, 2019c).

Other components that may be used, depending on the application, are:

- BPIPPRIME: the building input processor (U.S. EPA, 2004);
- AERSURFACE: the surface characteristics processor for AERMET (U.S. EPA, 2008);
- AERSCREEN: a screening version of AERMOD (U.S. EPA, 2016b; U.S. EPA, 2011a); and
- AERMINUTE: a pre-processor to calculate hourly average winds from ASOS 2-minute observations (U.S. EPA, 2015).

Before applying AERMOD, the applicant should become familiar with the user’s guides associated with the modeling components listed above and the most recent version of the AERMOD Implementation Guide (U.S. EPA, 2019d). In addition to these documents, detailed guidance on the use of the AERMOD modeling system for estimating primary $PM_{2.5}$ impacts is provided in Appendix B. Because AERMOD is limited to modeling direct $PM_{2.5}$ emissions, additional or alternative approaches are used to provide an assessment of secondary $PM_{2.5}$ impacts from the proposed new or modifying source, as discussed in more detail in the following sections.

III.4 Assessing O_3 and Secondary $PM_{2.5}$ Impacts

This section provides more detail on the EPA's recommended approaches for assessing the impacts of precursor emissions on O_3 and/or secondary $PM_{2.5}$ formation.

III.4.1 Conceptual Model

Each NAAQS compliance demonstration is unique and may require multiple factors to be considered and assumptions to be thoroughly justified as a part of the technical assessment. A well-developed modeling protocol that includes a detailed conceptual description of the current air pollutant concentrations in the area (see Appendix A for examples of elements of a conceptual description) and of the nature of the emissions sources within proximity of the new or modifying emissions source is essential for determining the necessary components of an acceptable assessment of the impact from O_3 and/or secondary $PM_{2.5}$ formation.[13] With timely

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[13] For more detailed information on the development of such conceptual descriptions for an area, please refer to the following:

Chapter 10 of "Particulate Matter Assessment for Policy Makers: A NARSTO Assessment." P. McMurry, M. Shepherd, and J. Vickery, eds. Cambridge University Press, Cambridge, England (NARSTO, 2004).

Section 11, "How Do I Get Started? 'A Conceptual Description'" of "Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, $PM_{2.5}$, and Regional Haze." U.S. Environmental Protection Agency, Research Triangle Park, North Carolina (U.S. EPA, 2007a).

In addition, relevant regional examples include: "Conceptual Model of $PM_{2.5}$ Episodes in the Midwest," January 2009, Lake Michigan Air Directors Consortium; and "Conceptual Model of Particulate Matter Pollution in the California San Joaquin Valley," Document Number CP045-1-98, September 8, 1998.

and appropriate consultation between the applicant and the appropriate permitting authority, along with the submittal and subsequent approval, if required, of the modeling protocol by the appropriate permitting authority, many potential problems and unintended oversights in the technical assessment can be resolved early in the process or avoided all together.

In the development of an appropriate conceptual description to support an assessment, it is important to fully characterize the current O_3 and/or $PM_{2.5}$ concentrations in the region where the new or modifying source is to be located and not just the most current design values, which historically has been used as used as background concentrations in a cumulative modeling demonstration. For O_3, this characterization should take into consideration episodic high O_3 concentrations and any trends in the area. For $PM_{2.5}$, this characterization should take into consideration the seasonality and speciated composition of the current $PM_{2.5}$ concentrations and any long-term trends that may be occurring. It may also be important to describe the typical background concentrations of certain chemical species that participate in the photochemical reactions that form O_3 and secondary $PM_{2.5}$. It is possible that there are mitigating factors for secondary $PM_{2.5}$ formation given limitations of other chemical species important in the photochemical reactions, *e.g.*, minimal NH_3 in the ambient environment that could limit any precursor pollutant from readily reacting to form secondary $PM_{2.5}$. This understanding of the atmospheric environment will provide important insights on the potential for secondary formation and highlight aspects that will need to be accounted for in the source impact and/or cumulative impact assessment.

A good conceptual description will also characterize the meteorological conditions that are representative of the region and are associated with periods and/or seasons of higher and lower ambient O_3 and/or 24-hour $PM_{2.5}$ concentrations. For example, identification of meteorological phenomena that typically occur during periods of high daily 8-hour O_3 or 24-hour $PM_{2.5}$ concentrations, such as low-level temperature inversions, stagnant high pressure systems, low-level jets, etc., can be extremely important in understanding the importance, or lack thereof, of photochemistry and secondary $PM_{2.5}$ formation for the higher ambient O_3 and $PM_{2.5}$ concentrations. The analysis and understanding of meteorological conditions will also inform the assessment of high O_3 episodes and seasonal 24-hour $PM_{2.5}$ concentrations in the region.

III.4.2 Tier 1 Assessment Approach

As discussed in the section 5.2 of the 2017 *Guideline*, the EPA has determined that advances in chemical transport modeling science make it reasonable to provide more specific, generally-applicable guidance that identifies particular models or analytical techniques that may be appropriate for use under specific circumstances for assessing the impacts of an individual proposed source on O_3 and secondary $PM_{2.5}$ concentrations. There is not a preferred model or technique for estimating O_3 or secondary $PM_{2.5}$ for specific source impacts. Instead, for assessing secondary pollutant impacts from individual proposed sources, the degree of complexity required to appropriately assess potential single-source impacts varies depending on the nature of the source, its proposed emissions, and the background environment. In order to provide the user community flexibility in estimating single-source secondary pollutant impacts, which allows for different approaches to credibly address these different areas, the 2017 *Guideline* recommends a two-tiered demonstration approach for addressing single-source impacts on ambient concentrations of O_3 and secondary $PM_{2.5}$.

To inform a Tier 1 assessment,[14] the existing air quality model-based information that is used should be appropriate in terms of representing the type of source, its precursor emissions, and its geographic location, in addition to those elements of the conceptual description discussed above. The air quality modeling information may be available from past or current SIP attainment demonstration modeling, published modeling studies, or peer-reviewed literature with estimates of model responsiveness to precursor emissions in contexts that are relevant to the new or modifying source. The estimates of model responsiveness, such as impact on O_3 concentrations per ton of NO_X or impact on $PM_{2.5}$ concentrations per ton of SO_2 emissions, could then be used in conjunction with the precursor emissions estimates for the proposed new or modifying source to provide a quantitative estimate of the impact of such precursor emissions on the formation of O_3 and/or secondary $PM_{2.5}$ concentrations. The estimates of responsiveness should be technically credible in representing such impacts and it may be advisable for the estimate to reflect an upper bound of potential impacts.

To assist in the development of appropriate Tier 1 demonstration tools, the EPA developed the MERPs Guidance to provide a framework for permitting authorities to develop area-specific MERPs. The MERPs Guidance illustrates how permitting authorities may appropriately develop MERPs for specific areas and use them as a Tier 1 compliance demonstration tool for O_3 and secondary $PM_{2.5}$ under the PSD permitting program. The MERPs guidance also addresses the appropriate use of MERPs to reflect the combined ambient impacts

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[14] A Tier 1 assessment involves the use of technically credible relationships between precursor emissions and a source's secondary impacts, *e.g.*, as demonstrated in modeling for a source impact analysis, that may be published in the peer-reviewed literature, developed from modeling that was previously conducted for an area by a source, a governmental agency, or some other entity and that is deemed sufficient for evaluating a proposed source's impacts, or generated by a peer-reviewed reduced form model. In such cases, the EPA expects that existing air quality model-based information regarding the potential for NO_X and VOC precursor emissions to form O_3 and for SO_2 and NO_X precursor emissions to form secondary $PM_{2.5}$ concentrations may be used to establish an appropriate estimate of O_3 and/or secondary $PM_{2.5}$ impacts from the proposed new or modifying source.

across O_3 or $PM_{2.5}$ precursors and, in the case of $PM_{2.5}$, the combined primary and secondary ambient impacts. Such an approach includes flexibility with respect to the use of Tier 1 demonstration tools to generate information relevant for specific regions or areas and representative of secondary formation in a particular region or area.

Specifically, the MERPs Guidance provides information about how to use CTMs to estimate single-source impacts on O_3 and secondary $PM_{2.5}$ and how such model simulation results for specific areas can be used to develop empirical relationships between a source's O_3 and $PM_{2.5}$ precursor emissions and its secondary impacts that may be appropriate for use as a Tier 1 demonstration tool. It also provides results from EPA photochemical modeling of a set of more than 100 hypothetical sources across geographic areas and source types that may be used in developing MERPs as discussed in the guidance. This flexible and scientifically credible approach allows for the development of area-specific Tier 1 demonstration tools that better represent the chemical and physical characteristics and secondary pollutant formation within that region or area.

As discussed in the MERPs Guidance, the EPA's Single-source Modeling Guidance provides information to stakeholders about how to appropriately address the variety of chemical and physical characteristics regarding a project scenario and key receptor areas in conducting photochemical modeling to inform development of MERPs. The development of MERPs for O_3 and secondary $PM_{2.5}$ precursors is just one example of a suitable Tier 1 demonstration tool. The EPA will continue to engage with the modeling community to identify credible alternative approaches for estimating single-source secondary pollutant impacts, which provide flexibility and are less resource intensive for PSD permit demonstrations.

As an example, a Tier 1 assessment of secondary O_3 and $PM_{2.5}$ impacts was developed by a permit applicant, the Tennessee Valley Authority (TVA), for a major modification at their Gleason facility in Tennessee in 2018. The TVA and the Tennessee Department of Environment and Conservation (TDEC) worked closely with EPA Region 4 to ensure that the ambient impacts analysis was technically sound and consistent with applicable PSD regulations and EPA guidance. The PSD air quality modeling analysis was submitted to TDEC in late 2018 using an approach that was consistent with the EPA's MERPs Guidance to relate facility emissions to potential downwind impacts of secondary O_3 and $PM_{2.5}$. A more detailed discussion of the TVA's technical assessment is provided in Appendix C.

The National Association of Clean Air Agencies (NACAA) Workgroup final report (NACAA, 2011) provides details on potential approaches to quantify the secondary $PM_{2.5}$ impacts from a proposed new or modifying source that may be appropriate to inform a Tier 1 assessment of $PM_{2.5}$ impacts (see Appendix C and D of NACAA, 2011). One suggested method in the final report is to convert emissions of precursors into equivalent amounts of direct $PM_{2.5}$ emissions using "pollutant offset ratios" and then use a dispersion model to assess the impacts of the combination of direct $PM_{2.5}$ emissions and the equivalent direct $PM_{2.5}$ emissions. The "pollutant offset ratios" referenced in that final report were those put forth by the EPA in the 2008 "Implementation of the New Source Review (NSR) Program for Particulate Matter Less Than 2.5 Micrometers ($PM_{2.5}$)" final rule (73 Fed. Reg. 28321) concerning the development and adoption of interpollutant trading (offset) provisions for $PM_{2.5}$ under state nonattainment area NSR programs for $PM_{2.5}$.[15] The EPA's July 23, 2007, technical analysis titled "Details on

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[15] In the preamble to the 2008 final rule (73 FR 28321), the EPA included preferred or presumptive offset ratios, applicable to specific $PM_{2.5}$ precursors that state/local air agencies may adopt in conjunction with the new interpollutant offset provisions for $PM_{2.5}$, and for which the state could rely on the EPA's technical work to demonstrate the adequacy of the ratios for use in any $PM_{2.5}$ nonattainment area. In a July 21, 2011 memorandum, EPA changed its policy and stated that it no longer supported the ratios provided in the preamble to the 2008 final

Technical Assessment to Develop Interpollutant Trading Ratios for $PM_{2.5}$ Offsets," describes the method used to establish the original "preferred" precursor offset ratios (U.S. EPA, 2007b).

We do not support using the specific results from the EPA's 2007 technical assessment in this context without additional technical demonstration specific to the source(s) and area(s) for which the ratios would be applied. As described in the EPA's July 21, 2011 memorandum addressing reconsideration of the "preferred" interpollutant offset trading ratios included in the preamble to the 2008 final rule, the EPA acknowledged that existing models and techniques are adequate to "conduct local demonstrations leading to the development of area-specific ratios for $PM_{2.5}$ nonattainment areas" and provided a general framework for efforts that may be relevant in developing appropriate "pollutant offset ratios" for use in hybrid qualitative/quantitative assessment of secondary $PM_{2.5}$ impacts (U.S. EPA, 2011b). In the context of PSD compliance demonstrations, a similar general framework is embodied in the MERPs Guidance in which the EPA addresses how to conduct modeling to inform the development of a MERP for a particular area.

The EPA also notes that the NACAA Workgroup "considered, but rejected, other methods for assessing secondary $PM_{2.5}$ impacts, including use of a simple emissions divided by distance (Q/D) metric and use of AERMOD with 100 percent conversion of SO_2 and NO_X concentrations to $(NH_4)_2SO_4$ and $(NH_4)NO_3$." The EPA has reviewed the detailed discussion provided in Appendix E of the NACAA Workgroup final report and agrees with these conclusions.

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rule as presumptively approvable ratios for adoption in SIPs containing nonattainment NSR programs for $PM_{2.5}$. Memorandum from Gina McCarthy, Assistant Administrator, to Regional Air Division Directors, "Revised Policy to Address Reconsideration of Interpollutant Trading Provisions for Fine Particles ($PM_{2.5}$)" (U.S. EPA, 2011b).

III.4.3 Tier 2 Assessment Approach

As discussed in the 2017 *Guideline*, a Tier 2 assessment involves application of more sophisticated, case-specific CTMs in consultation with the appropriate permitting authority and conducted consistent with the recommendations in the most current version of the Single-source Modeling Guidance. Where it is necessary to estimate O_3 and/or secondary $PM_{2.5}$ impacts with case-specific air quality modeling, a candidate model should be selected for estimating single-source impacts on O_3 and/or secondarily formed $PM_{2.5}$ that meets the general criteria for an "alternative model" where there is no preferred model as outlined in section 3.2.2.e of the 2017 *Guideline*. The general criteria include:

i. The model has received a scientific peer review;
ii. The model can be demonstrated to be applicable to the problem on a theoretical basis;
iii. The databases that are necessary to perform the analysis are available and adequate;
iv. Appropriate performance evaluations of the model have shown that the model is not biased toward underestimates; and
iv. A protocol on methods and procedures to be followed has been established.

Section 3.2.2 further provides that the appropriate EPA Regional Office, in consultation with the EPA Model Clearinghouse, is authorized to approve a particular model and approach as an alternative model application.

Both Lagrangian puff models and photochemical grid models may be appropriate for this purpose where those models satisfy alternative model criteria in section 3.2.2 of the 2017 *Guideline*. That said, the EPA believes photochemical grid models are generally most appropriate for addressing O_3 and secondary $PM_{2.5}$ impacts because they provide a spatially and temporally dynamic realistic chemical and physical environment for plume growth and chemical transformation. Publicly available and documented Eulerian photochemical grid models such as the Comprehensive Air Quality Model with Extensions (CAMx) (Ramboll Environ, 2018) and the Community Multiscale Air Quality (CMAQ) (Byun and Schere, 2006) model treat emissions, chemical transformation, transport, and deposition using time and space variant meteorology. These modeling systems include primarily emitted species and secondarily formed pollutants such as O_3 and $PM_{2.5}$ (Chen et al., 2014; Civerolo et al., 2010; Russell, 2008; Tesche et al., 2006). In addition, these models have been used extensively to support O_3 and $PM_{2.5}$ SIPs and to explore relationships between inputs and air quality impacts in the United States and elsewhere (Cai et al., 2011; Civerolo et al., 2010; Hogrefe et al., 2011).

On August 4, 2017, the EPA released a memorandum (U.S. EPA, 2017b) providing information specific to how the CAMx and the CMAQ model systems were relevant for each of these elements. This memorandum provides an alternative model demonstration for the CAMx and CMAQ photochemical transports models establishing their fit for purpose in PSD compliance demonstrations for O_3 and $PM_{2.5}$ and in NAAQS attainment demonstrations for O_3, $PM_{2.5}$ and Regional Haze. The memorandum also provides for their general applicability for use in PSD compliance demonstrations; however, it does not replace the need for such demonstrations to provide model protocols describing model application choices or the evaluation of model inputs and baseline predictions against measurements relevant for their specific use by permit applicants and state, local, and tribal air agencies.

For those situations where a refined Tier 2 demonstration is necessary, the EPA has also provided the Single-source Modeling Guidance that provides recommended, credible procedures to estimate single-source secondary impacts from sources for permit related assessments. Extensive peer-reviewed literature demonstrates/documents that photochemical grid models have been applied for single-source impacts and that the models adequately represent secondary pollutant impacts from a specific facility, in comparison to near-source downwind in-plume measurements. The literature shows that these models can clearly differentiate impacts of a specific facility from those of other sources (Baker and Kelly, 2014; Zhou et al., 2012). Other peer-reviewed research has clearly shown that photochemical grid models are able to simulate impacts from single sources on secondarily-formed pollutants (Baker et al., 2015; Bergin et al., 2008; Kelly et al., 2015). Further, single-source secondary impacts have been provided in technical reports that further support the utility of these tools for single-source scientific and regulatory assessments (ENVIRON 2012a; ENVIRON 2012b; Yarwood et al., 2011). The EPA firmly believes that the peer-reviewed science clearly demonstrates that photochemical grid models can adequately assess single-source impacts. The EPA recognizes that ongoing evaluations in this area will lead to continual improvements in science and associated predictive capabilities of these models.

For the purposes of conducting a Tier 2 assessment, the application of a CTM will involve case-specific factors that should be part of the consultation process with the appropriate permitting authority and reflected in the agreed-upon modeling protocol. Consistent with the Single-source Modeling Guidance and section 9.2.1 of the 2017 *Guideline*, EPA recommends that the modeling protocols for this purpose should include the following elements:

1. Overview of Modeling/Analysis Project
    - Participating organizations
    - Schedule for completion of the project
    - Description of the conceptual model for the project source/receptor area
    - Identify how modeling and other analyses will be archived and documented
    - Identify specific deliverables to the appropriate permitting authority
2. Model and Modeling Inputs
    - Rationale for the selection of air quality, meteorological, and emissions models
    - Modeling domain
    - Horizontal and vertical resolution
    - Specification of initial and boundary conditions
    - Episode selection and rationale for episode selection
    - Rationale for and description of meteorological model setup
    - Basis for and development of emissions inputs
    - Methods used to quality assure emissions, meteorological, and other model inputs
3. Model Performance Evaluation
    - Describe ambient database(s)
    - Describe evaluation procedures and performance metrics

As stated previously, we expect that the EPA Regional Offices, with assistance from the OAQPS, may assist reviewing authorities, as necessary, to structure appropriate technical demonstrations leading to the development of appropriate chemical transport modeling applications for the purposes of estimating potential O_3 and/or secondary $PM_{2.5}$ impacts.

III.5 Comparison to the SIL

This section provides recommendations for source impact analyses where a permit applicant compares the proposed source's ambient O_3 or $PM_{2.5}$ impacts to an appropriate SIL as part of the required demonstration that a proposed source or modification will not cause or contribute to a violation of the O_3 or $PM_{2.5}$ NAAQS. These recommendations are also generally applicable for demonstrations that a proposed source or modification will not cause or contribute to a violation of the $PM_{2.5}$ PSD increments, see Section V.4. The EPA's recommended SIL values for O_3 and $PM_{2.5}$ NAAQS and $PM_{2.5}$ PSD increments are listed in Table II-1 and Table II-2. (U.S. EPA 2018a).

III.5.1 SIL Comparison for O_3

For Assessment Case 2, an analysis of secondary O_3 impacts would be conducted where the proposed source's precursor emissions of NO_X and/or VOC are equal to or greater than the respective SERs. The EPA recommends that the assessment of the precursor emission impacts on O_3 formation should be conducted based on the two-tiered demonstration approach as provided for specific to O_3 in section 5.3 of the 2017 *Guideline*. Under the Tier 1 approach, for source impact analyses, the highest of the multi-season (or episode) averages of the maximum modeled daily 8-hour O_3 concentrations predicted each season (or episode) should be compared to the appropriate O_3 SIL, since this metric represents the maximum potential daily 8-hour O_3 impact from the proposed source or modification. Under the Tier 2 approach, where a CTM is directly applied to estimate the source impacts, the comparison should be done at each receptor, *i.e.*, each modeled grid cell. If the source impact is less than the SIL, then the analysis is generally sufficient to support a finding that the source will not cause or contribute to a NAAQS violation.

However, if the source impact is equal to or greater than the SIL, then the analysis is insufficient to show that a source will not cause or contribute to a violation of the NAAQS and a cumulative impact assessment would be necessary.

III.5.2 SIL Comparison for $PM_{2.5}$

For Assessment Case 2, an analysis of primary $PM_{2.5}$ impacts would be conducted where the proposed source's direct $PM_{2.5}$ emissions are equal to or greater than the applicable SER (10 tpy). In such situations, the modeled estimates of ambient primary $PM_{2.5}$ concentrations due to direct emissions using the EPA preferred AERMOD dispersion model (or other acceptable preferred or approved alternative model) should be compared to an appropriate $PM_{2.5}$ SIL in the source impact analysis. The dispersion modeling methods here are similar to the methods used for other primary pollutants, including the use of maximum allowable emissions, following Table 8-2 of the 2017 *Guideline*. However, due to the form of the $PM_{2.5}$ NAAQS, we recommend that one of the following be compared to the SIL, depending on the meteorological data used in the analysis:

- The highest of the 5-year averages of the maximum modeled annual 24-hour $PM_{2.5}$ concentrations (for the 24-hour $PM_{2.5}$ NAAQS) or highest of the 5-year averages of the annual average $PM_{2.5}$ concentrations (for the annual $PM_{2.5}$ NAAQS) predicted each year at each receptor, based on 5 years of representative National Weather Service (NWS) data;
- The highest modeled 24-hour $PM_{2.5}$ concentration (for the 24-hour $PM_{2.5}$ NAAQS) or the highest modeled average $PM_{2.5}$ concentration (for the annual $PM_{2.5}$ NAAQS) predicted at each receptor based on 1 year of site-specific meteorological data; or the

highest of the multi-year averages of the maximum modeled annual 24-hour $PM_{2.5}$ concentration (for the 24-hour $PM_{2.5}$ NAAQS) or the highest of the multi-year averages of the maximum modeled annual average $PM_{2.5}$ concentrations (for the annual $PM_{2.5}$ NAAQS) predicted each year at each receptor, based on 2 or more years, up to 5 complete years, of available site-specific meteorological data; or

- The highest of the 3-year averages of the maximum modeled annual 24-hour $PM_{2.5}$ concentrations (for the 24-hour $PM_{2.5}$ NAAQS) or highest of the 3-year averages of the annual average $PM_{2.5}$ concentrations (for the annual $PM_{2.5}$ NAAQS) predicted each year at each receptor, based on 3 years of prognostic meteorological data.

These metrics represent the maximum potential 24-hour or annual $PM_{2.5}$ impacts from the proposed source or modification at any receptor, given the form of the NAAQS, and, therefore, provide an appropriate part of the basis for determining whether a cumulative modeling analysis would be needed. If the source impact is less than the SIL, then the analysis is generally sufficient to support a finding that the source will not cause or contribute to a NAAQS violation. However, if the source impact is equal to or greater than the SIL, then the analysis is insufficient to show that a source will not cause or contribute to a violation of the NAAQS and a cumulative impact assessment would be necessary to make the NAAQS compliance demonstration.

For Assessment Case 3, analyses of both primary and secondary $PM_{2.5}$ impacts are necessary because the proposed source's direct $PM_{2.5}$ emissions and emissions of at least one $PM_{2.5}$ precursor are equal to or greater than the respective SERs. In this case, both the primary and secondary $PM_{2.5}$ impacts from the proposed source or modification would be included in the comparison to the appropriate $PM_{2.5}$ SIL in the source impact analysis. As with Case 2, the ambient impacts due to direct $PM_{2.5}$ emissions would be estimated using the EPA preferred

AERMOD dispersion model (or other acceptable preferred or approved alternative model). For the assessment of the precursor emission impacts on $PM_{2.5}$ formation, the EPA recommends that this part of the assessment should be conducted based on the two-tiered demonstration approach as provided for specific to $PM_{2.5}$ in section 5.4 of the 2017 *Guideline*. However, the comparison to the SIL will depend on the type of assessment conducted for the secondary $PM_{2.5}$ impacts from the source.

In the SIL comparison for Case 3, the primary and secondary $PM_{2.5}$ impacts may be combined in various ways that may entail greater or lesser degrees of conservatism. For example, combining the peak estimated primary $PM_{2.5}$ impact with the peak estimated secondary $PM_{2.5}$ impact, unpaired in time and space, would tend to be a conservative estimate of combined impacts since, as noted above, peak impacts associated with a source's direct $PM_{2.5}$ and precursor emissions are not likely well-correlated in time or space. The conservatism associated with combining peak estimated primary and secondary impacts for comparison to a SIL makes this an appropriate initial approach to combining estimated primary and secondary $PM_{2.5}$ impacts.

Other approaches for combining primary and secondary $PM_{2.5}$ impacts for comparison to a SIL for Case 3 will vary based on the degree of temporal and spatial pairing of estimated primary and secondary $PM_{2.5}$ impacts. Full temporal and spatial pairing may not be feasible in many cases, given that the dispersion modeling and chemical transport modeling may be based on different data periods. Furthermore, full temporal and spatial pairing of primary and secondary $PM_{2.5}$ impacts may not be appropriate in many cases because photochemical grid modeling represents gridded concentration estimates whereas dispersion modeling produces estimates at discrete receptor locations and because of the limitations in the skill of both the dispersion model and the photochemical grid model to accurately predict impacts on a paired in time and space basis. As a result, consideration of some degree of temporal pairing of primary and secondary $PM_{2.5}$ impacts is most appropriate on a seasonal or monthly basis with considerations of spatial pairing that reflects the general lack of correlation between primary and secondary impacts, *i.e.*, primary impacts being higher near the source while secondary impacts being higher at some distance away from the source.

The permitting authority and the permit applicant should thoroughly discuss the details regarding combining modeled primary and secondary $PM_{2.5}$ impacts for Case 3 situations and should reach agreement during the initial review of the modeling protocol. The permitting authority should ensure that any approach for combining estimated primary and secondary $PM_{2.5}$ impacts for comparison to a SIL for Case 3 conforms to the recommendations described above for Case 2 regarding the form of the modeled estimate. Accordingly, the approach should be based on the highest of the multi-year averages of the maximum modeled 24-hour or annual $PM_{2.5}$ concentrations predicted each year at each receptor, which represents the maximum potential impact from the proposed source or modification.

For Assessment Case 4, an analysis of secondary $PM_{2.5}$ impacts would be conducted for the proposed source's precursor emissions that are equal to or greater than the respective SERs. For this source impact analysis, under the Tier 1 approach, the highest of the multi-year averages of the maximum predicted modeled 24-hour or annual $PM_{2.5}$ concentrations should be compared to the appropriate $PM_{2.5}$ SIL since these metrics represent the maximum potential impact from the proposed source or modification. Under the Tier 2 approach, where a CTM is directly applied to estimate the source impacts, the comparison should be done at each receptor, *i.e.*, each modeled grid cell.

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IV. PSD Compliance Demonstrations for the O_3 and $PM_{2.5}$ NAAQS: Cumulative Impact Analysis

Where the source impact analysis described in Section III is insufficient to show that a source will not cause or contribute to a violation of the O_3 or $PM_{2.5}$ NAAQS, a cumulative impact assessment will then be necessary to determine whether the source complies with the NAAQS. A cumulative assessment accounts for the combined impacts of the proposed new or modifying source's emissions, emissions from other nearby sources, and representative background levels of O_3 or $PM_{2.5}$ within the modeling domain. The cumulative impacts are then compared to the O_3 or $PM_{2.5}$ NAAQS to determine whether there is a modeled NAAQS violation. If not, then the NAAQS compliance demonstration is sufficient. If there are modeled violations, then the source impact at the location of these violations is compared to the appropriate SIL to determine if the proposed new or modifying source emissions will cause or contribute to a violation of the NAAQS. This section provides details on conducting an appropriate cumulative impact assessment for the O_3 and $PM_{2.5}$ NAAQS.

O_3

The cumulative impact assessment should include the following components of O_3 impacts, as appropriate, for comparison to the NAAQS:

- Proposed new or modifying source
    - Impacts on O_3 from each precursor (NO_X and/or VOC) that is proposed to be emitted in a significant amount, *i.e.*, equal to or greater than the respective SER (40 tpy)
- Nearby sources
    - Impacts on O_3 from precursors (NO_X and/or VOC) are typically accounted for through representative monitored background

- Monitored background level of O_3 that accounts for O_3 impacts from regional transport and from nearby sources[16]

$PM_{2.5}$

The cumulative impact assessment should include the following components of $PM_{2.5}$ impacts, as appropriate, for comparison to the NAAQS:

- Proposed new or modifying source
    - Primary impacts on $PM_{2.5}$, *i.e.*, from direct $PM_{2.5}$ emissions that are proposed to be emitted in a significant amount, *i.e.*, equal to or greater than the SER (10 tpy)
    - Secondary impacts on $PM_{2.5}$ from each precursor (NO_X and/or SO_2) that is proposed to be emitted in a significant amount, *i.e.*, equal to or greater than the respective SER (40 tpy)
- Nearby sources
    - Primary impacts on $PM_{2.5}$
    - Impacts on $PM_{2.5}$ from precursors (NO_X and/or SO_2) are typically accounted for through representative monitored background
- Monitored background level of $PM_{2.5}$ that accounts for secondary $PM_{2.5}$ impacts from regional transport and from nearby sources, and primary $PM_{2.5}$ impacts from background sources not included in the modeled inventory, *e.g.*, minor sources[17]

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[16] The emissions impact of any nearby source that has received a permit but is not yet operational should be included in the air quality assessment. In such cases, consultation with the appropriate permitting authority on the appropriate assessment approach is recommended.

[17] The emissions impact of any nearby source that has received a permit but is not yet operational should be included in the air quality assessment. In such cases, consultation with the appropriate permitting authority on the appropriate assessment approach is recommended

As with the source impact analysis, the primary impacts of direct $PM_{2.5}$ emissions from the proposed new or modifying source and nearby sources in a cumulative impact analysis should be estimated based on the AERMOD dispersion model (or other acceptable preferred or approved alternative model). In addition, EPA recommends that the estimate of secondary $PM_{2.5}$ impacts from the proposed new or modifying source should be conducted based on the two-tiered demonstration approach described in section 5.2 of the 2017 *Guideline*. As noted above, secondary impacts on $PM_{2.5}$ from regional transport, precursor emissions from nearby sources, and primary $PM_{2.5}$ impacts from background sources not included in the modeled inventory should be accounted for through representative monitored background concentrations.

IV.1 Modeling Inventory

Section 8 of the 2017 *Guideline* provides the current required and recommended approaches for characterizing source emissions and developing the O_3 and/or $PM_{2.5}$ modeling inventory for purposes of NAAQS compliance modeling in PSD air quality demonstrations. Section 8.2 and Table 8-2 of the 2017 *Guideline* address the appropriate emissions limit, operating level, and operating factor to be modeled, which is the maximum allowable emissions rate for the proposed new or modifying source in most cases and an allowable emissions rate adjusted for actual operations for any nearby sources. For applications that require the assessment of secondarily formed O_3 or $PM_{2.5}$ through case-specific chemical transport modeling, information regarding the development of the appropriate modeling inventory can be found in the Single-source Modeling Guidance.

Section 8.3.3 of the 2017 *Guideline* emphasizes the importance of professional judgment in the identification of nearby and other sources “that are not adequately represented by ambient monitoring data" that should be included in the modeled emission inventory and identifies "a significant concentration gradient in the vicinity of the [proposed] source" as a primary criterion for this selection. Additionally, the 2017 *Guideline* suggests that "the number of nearby sources to be explicitly modeled in the air quality analysis is expected to be few except in unusual situations" and that "[i]n most cases, the few nearby sources will be located within the first 10 to 20 km from the [proposed] source." The EPA also provided modeling guidance in March 2011 (U.S. EPA, 2011c) that includes a detailed discussion of the significant concentration gradient criterion. However, several application-specific factors should be considered when determining the appropriate inventory of nearby sources to include in the cumulative modeling analysis, including the potential influence of terrain characteristics on concentration gradients and the availability and adequacy of ambient monitoring data to account for impacts from nearby sources as well as other background sources.

Consistent with the 2017 revisions to the *Guideline*, the EPA cautions against the application of very prescriptive procedures for identifying which nearby sources should be included in the modeled emission inventory for NAAQS compliance demonstrations, such as the procedures described in Chapter C, Section IV.C.1 of the draft "New Source Review Workshop Manual" (U.S. EPA, 1990). Our main concern is that following such procedures in a literal and uncritical manner may, in many cases, increase the likelihood of double-counting modeled and monitored concentrations, resulting in cumulative impact assessments that are overly conservative and would unnecessarily complicate the permitting process. The identification of which sources to include in the modeled emissions inventory should be addressed in the modeling protocol and, as necessary, discussed in advance with the permitting authority.

Since modeling of direct $PM_{2.5}$ emissions has been limited and infrequent, the availability of an adequate direct $PM_{2.5}$ emission inventory for nearby sources may not exist in all cases. Recommendations for developing $PM_{2.5}$ emission inventories for use in PSD applications will be addressed separately, but existing SIP inventories for $PM_{2.5}$ or statewide PSD inventories of sources for refined modeling are expected to provide a useful starting point for this effort.

IV.2 Monitored Background

Section 8.3 of the 2017 *Guideline* provides recommendations for determination of monitored background concentrations to include in cumulative impact assessments for NAAQS compliance, which should account for impacts from existing sources that are not explicitly included in the modeled inventory and natural sources. From newly-acquired pre-construction monitoring data and/or existing representative air quality data gathered for purposes of a permitting analysis, permit applicants should assess and document what the background monitoring data represent to the extent possible, including any information that may be available from the state or other agency responsible for siting and maintaining the monitor.[18]

Determining the monitored background concentrations of O_3 and/or $PM_{2.5}$ to include in the cumulative impact assessment may entail different considerations from those for other criteria pollutants lacking secondary formation. An important aspect of the monitored background concentration for O_3 or $PM_{2.5}$ is that the ambient monitoring data should in most cases account for the impact of secondary formation of either pollutant from precursor emissions of existing sources impacting the modeling domain. Additionally, for $PM_{2.5}$, ambient monitoring

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[18] Please note in the case of an existing source seeking a permit for a modification, there is potential overlap across secondary impacts from monitored background and from precursor emission from the existing source. In such cases, recommendations for excluding monitored values when the source in question is impacting the monitor in section 8.3.2.b of the 2017 *Guideline* may need to be modified to avoid overcompensating in cases where the monitored concentrations are also intended to account for the existing source's impacts on secondary $PM_{2.5}$.

data should account for the component of the background levels of primary $PM_{2.5}$ from emissions of nearby sources that are not included in the modeled inventory. As with other criteria pollutants, consideration should also be given to the potential for some double-counting of the impacts from modeled emissions that may be also included in the background monitored concentrations. This should generally be of less importance than the representativeness of the monitor for secondary formation of O_3 and $PM_{2.5}$., unless the monitor is located relatively close to nearby sources of primary $PM_{2.5}$ that could be impacting the monitor. Also, due to the nature of O_3 and secondary $PM_{2.5}$, monitored background concentrations of O_3 and $PM_{2.5}$ are more likely to be homogeneous across the modeling domain in most cases compared to most other pollutants.

Depending on the nature of local $PM_{2.5}$ levels within the modeling domain, it may be appropriate to account for seasonal variations in monitored background $PM_{2.5}$ levels, which may not be correlated with seasonal patterns of the modeled primary $PM_{2.5}$ levels. For example, maximum modeled primary $PM_{2.5}$ impacts associated with low-level emission sources are likely to occur during winter months due to longer periods of stable atmospheric conditions, whereas maximum ambient levels of secondary $PM_{2.5}$ typically occur during spring and summer months due to high levels of sulfates (particularly in the eastern United States). The use of temporally-varying monitored background concentrations in a cumulative impact analysis is discussed in more detail in Section IV.3.

IV.3 Comparison to the NAAQS

As indicated in Figure II-1, the first step of a cumulative impact analysis consists of a comparison of the combined modeled and monitored concentrations, as discussed above, with the applicable NAAQS to determine if there are any projected violations of the O_3 and/or $PM_{2.5}$ NAAQS.

O_3

Ozone differs from other criteria pollutants because it is secondarily formed by NOx and VOC precursor emissions and there are not direct O_3 emissions to be considered in the NAAQS compliance demonstration. The O_3 design value that is representative for the area, rather than the overall maximum monitored background concentration, should generally be used as the monitored component of the cumulative analysis. The O_3 design value is based on the 3-year average of the annual fourth-highest daily maximum 8-hour average O_3 concentrations (80 FR 65292).

The EPA recommends that the modeled O_3 impacts should be added to the monitor-based design value for comparison to the NAAQS, as appropriate. The monitoring data should be representative in that it accounts for O_3 formation associated with existing sources both within and outside of the modeling domain. The EPA recommends that modeled O_3 impacts should be based on a Tier 1 or 2 assessment that accounts for the source's precursor emissions of NOx and/or VOC that are proposed to be emitted in a significant amount. The resulting cumulative O_3 concentrations would then be compared to the O_3 NAAQS (0.070 ppm).

$PM_{2.5}$

Combining the modeled and monitored concentrations of $PM_{2.5}$ for comparison to the 24-hour or annual $PM_{2.5}$ NAAQS entails considerations that differ from those for other criteria pollutants due to the issues identified at the end of Section IV.2. Based on assessment cases shown in Table III-2, the discussion below addresses comparisons to the NAAQS in the context of dispersion modeling of direct $PM_{2.5}$ emissions only (*i.e.*, Case 2) and for applications involving assessments of secondary $PM_{2.5}$ impacts (*i.e.*, Cases 3 and 4).

Given the importance of secondary formation of $PM_{2.5}$ and the potentially high background levels relative to the $PM_{2.5}$ NAAQS, greater emphasis is generally placed on the monitored background levels relative to the modeled inventory for $PM_{2.5}$ than for other pollutants. This is true for both $PM_{2.5}$ NAAQS and PSD increments assessments. Also, given the probabilistic form of the $PM_{2.5}$ NAAQS, careful consideration should be given to how the monitored and modeled concentrations are combined to estimate the cumulative impact levels.

The $PM_{2.5}$ design value that is representative for the area, rather than the overall maximum monitored background concentration, should generally be used as the monitored component of the cumulative analysis. The $PM_{2.5}$ design value for the annual averaging period is based on the 3-year average of the annual average $PM_{2.5}$ concentrations, while the $PM_{2.5}$ design value for the 24-hour averaging period is based on the 3-year average of the annual 98th percentile 24-hour average $PM_{2.5}$ concentrations (78 FR 3086). Details regarding the determination of the annual 98th percentile monitored 24-hour value based on the number of days sampled during the year are provided in the data interpretation procedures for the $PM_{2.5}$ NAAQS in Appendix N to 40 CFR part 50.

It should be noted here that although the monitored design values for the $PM_{2.5}$ standards are defined in terms of 3-year averages, this definition does not preempt or alter the 2017 *Guideline's* requirement for use of 5 years of representative NWS meteorological data, at least 1 year of site-specific data, or at least 3 years of prognostic meteorological data for purposes of modeling primary emissions of $PM_{2.5}$.[19] The 5-year average based on use of representative NWS meteorological data, the average across one or more (up to 5) complete years of available site-

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[19] See 40 CFR part 51, Appendix W, section 8.4.2.e.

specific data, or the average across 3 years of prognostic meteorological data serves as an unbiased estimate of the 3-year average for purposes of modeling demonstrations of compliance with the NAAQS. Modeling of "rolling 3-year averages," using years 1 through 3, years 2 through 4, and years 3 through 5 as recommended in the EPA's SIP Modeling Guidance, is not required.

For each case, the EPA recommends that the modeled design concentrations of primary $PM_{2.5}$ and/or the modeled secondary $PM_{2.5}$ impacts should be added to the monitor-based design value for comparison to the NAAQS, as appropriate. The primary $PM_{2.5}$ modeled design concentration should be based on:

- The 5-year average of the modeled annual 98th percentile 24-hour $PM_{2.5}$ concentrations (for the 24-hour $PM_{2.5}$ NAAQS) or 5-year average of the modeled annual average $PM_{2.5}$ concentration (for the annual $PM_{2.5}$ NAAQS) predicted each year at each receptor, based on 5 years of representative NWS data;
- The modeled 98th percentile 24-hour $PM_{2.5}$ concentrations (for the 24-hour $PM_{2.5}$ NAAQS) or modeled average $PM_{2.5}$ concentration (for the annual $PM_{2.5}$ NAAQS) predicted at each receptor based on 1 year of site-specific meteorological data, or the multi-year average of the modeled annual 98th percentile 24-hour $PM_{2.5}$ concentrations (for the 24-hour $PM_{2.5}$ NAAQS) or modeled annual average $PM_{2.5}$ concentration (for the annual $PM_{2.5}$ NAAQS) predicted each year at each receptor, based on 2 or more years, up to 5 complete years, of available site-specific meteorological data; or
- The 3-year average of the modeled annual 98th percentile 24-hour $PM_{2.5}$ concentrations (for the 24-hour $PM_{2.5}$ NAAQS) or 3-year average of the modeled

annual average $PM_{2.5}$ concentration (for the annual $PM_{2.5}$ NAAQS) predicted each year at each receptor, based on 3 years of prognostic meteorological data.

The EPA recommends that secondary $PM_{2.5}$ modeled impacts should be based on either a Tier 1 or 2 assessment accounting for the source's $PM_{2.5}$ precursor emissions of NOx and/or SO_2 that are proposed to be emitted in a significant amount. The resulting cumulative $PM_{2.5}$ concentrations would then be compared to the 24-hour $PM_{2.5}$ NAAQS (35 $\mu g/m^3$) and/or the annual $PM_{2.5}$ NAAQS (12 $\mu g/m^3$).

Specifically, for Case 2, where the source's direct $PM_{2.5}$ emissions are equal to or greater than the SER, the modeled design concentration should be based on AERMOD (or other acceptable preferred or approved alternative model) estimates of the proposed source's and other nearby sources' direct $PM_{2.5}$ emissions combined with the monitor-based design value. The monitor should be representative in that it accounts for secondary $PM_{2.5}$ formation associated with existing sources both within and outside of the modeling domain, in addition to the background levels of primary $PM_{2.5}$ associated with nearby and background sources that are not included in the modeled inventory.

For Case 3, where the source's direct $PM_{2.5}$ emissions and NO_X and/or SO_2 precursor emissions are proposed to be emitted in amounts equal to or greater than the respective SERs, the cumulative impact for comparison to the NAAQS should be based on the sum of the modeled design concentration for primary $PM_{2.5}$ impacts (from dispersion model estimates based on the proposed source's and other nearby source's direct $PM_{2.5}$ emissions), the modeled secondary $PM_{2.5}$ impacts (based on a Tier 1 or 2 assessment accounting for the proposed source's $PM_{2.5}$ precursor emissions), and the monitored design value (see Case 2 discussion above on monitor representativeness).

For Case 4, where the source's NO_X and/or SO_2 precursor emissions are proposed to be emitted in amounts equal to or greater than the respective SERs, the cumulative impact for comparison to the NAAQS should be based on the sum of the modeled secondary $PM_{2.5}$ impacts (based on a Tier 1 or 2 assessment accounting for the proposed source's $PM_{2.5}$ precursor emissions) and the monitor-based design value (see Case 2 discussion above on monitor representativeness).

The recommendations provided above constitute a First Level analysis for $PM_{2.5}$ NAAQS compliance demonstrations. For applications where impacts from primary $PM_{2.5}$ emissions are not temporally correlated with background $PM_{2.5}$ levels, combining the modeled and monitored levels as described above may be overly conservative in some situations. For example, there are areas of the country where background $PM_{2.5}$ levels are substantially higher on average during the summer months as compared to the winter months; however, the projected modeled impacts from the new or modified source may be substantially greater in the winter rather than in the summer. In such cases, a Second Level modeling analysis may be advisable to account for these temporal relationships. Such an analysis would involve combining the monitored and modeled $PM_{2.5}$ concentrations on a seasonal (or quarterly) basis, as appropriate. The use of a seasonally-varying monitored background component is likely to be a more important factor for the 24-hour $PM_{2.5}$ NAAQS analysis than for the annual $PM_{2.5}$ NAAQS. Careful evaluation of when model projections of $PM_{2.5}$ impacts and background $PM_{2.5}$ levels peak throughout the year is recommended before embarking on a Second Level modeling analysis. This is because the First Level approach may already adequately capture the temporal correlation. As a part of this process to determine the appropriate level of analysis, the permit applicant should consult with the appropriate permitting authority and then reflect the appropriate approach in their modeling protocol.

The AERMOD model provides several options for specifying the monitored background concentration for inclusion in the cumulative impact assessment. The options that are most relevant to $PM_{2.5}$ analyses include:

- For First Level 24-hour or annual $PM_{2.5}$ NAAQS analyses, an option to specify a single annual background concentration that is applied to each hour of the year, and
- For Second Level 24-hour $PM_{2.5}$ NAAQS analyses, an option to specify four seasonal background values that are combined with modeled concentrations on a seasonal basis.

The AERMOD model also allows the user to track the effect of background concentrations on the cumulative modeled design concentration.

For Second Level 24-hour $PM_{2.5}$ NAAQS modeling analyses, EPA recommends that the distribution of monitored data equal to and less than the annual 98th percentile be appropriately divided into seasons (or quarters) for each of the three years that are used to develop the monitored design value. This will result in data for each year of the multi-year data, which contains one season (or quarter) with the 98th percentile value and three seasons (quarters) with maximum values which are less than or equal to the 98th percentile value. The maximum concentration from each of the seasonal (or quarterly) subsets should then be averaged across these three years of monitoring data. The resulting average of seasonal (or quarterly) maximums should then be included as the four seasonal background values within the AERMOD model. Therefore, the monitored concentrations greater than the 98th percentile in each of the three years would not be included in the seasonal (or quarterly) subsets. These excluded monitored concentrations are the same values that are excluded when determining the monitored design value. An example of the calculations for a Second Level 24-hour $PM_{2.5}$ NAAQS modeling analysis is provided in Appendix D.

For a monitor with a daily (1-in-1 day monitor) sampling frequency and 100% data completeness, the highest seven monitored concentrations for each year would be excluded from the seasonal (or quarterly) subdivided datasets. Similarly, for a monitor with every third day (1-in-3 day monitor) sampling frequency and 100% data completeness, the highest two monitored concentrations for each year would be excluded from the seasonal (or quarterly) subdivided datasets. The monitored concentrations excluded from the subdivided datasets could primarily come from one or two seasons (or quarters) each year or could be evenly distributed across all four seasons (or quarters) each year. Additionally, the monitored concentrations not included in the subdivided datasets could shift seasonally (or quarterly) from one year to the next. Given the reason for considering a Second Level 24-hour analysis (*i.e.*, lack of temporal correlation between modeled and monitored concentrations), it is likely that the monitored data greater than the 98th percentile would be concentrated in one or two seasons as opposed to evenly distributed throughout the year. As mentioned earlier, see Appendix N of 40 CFR part 50 in determining the appropriate 98th percentile rank of the monitored data based on the monitor sampling frequency and valid number of days sampled during each year.

The EPA does not recommend a "paired sums" approach on an hour-by-hour basis because of the spatial and temporal variability throughout a typical modeling domain on an hourly basis and the complexities and limitations of hourly observations from the current $PM_{2.5}$ ambient monitoring network. The implicit assumption underlying this “paired sums’ approach is that the background monitored levels for each hour are spatially uniform and that the monitored values are fully representative of background levels at each receptor for each hour. Such an assumption does not account for the many factors that contribute to the temporal and spatial variability of ambient $PM_{2.5}$ concentrations across a typical modeling domain on an hourly basis.[20] Furthermore, the pairing of daily monitored background and 24-hour average modeled concentrations is not recommended except in rare cases of relatively isolated sources where the available 1-in-1 day monitor can be shown to be representative of the ambient concentration levels in the areas of maximum impact from the proposed new source. In most cases, the seasonal (or quarterly) pairing of monitored and modeled concentrations previously described in the Second Level approach should sufficiently address situations in which the impacts from primary $PM_{2.5}$ emissions are not temporally correlated with background $PM_{2.5}$ levels. Any monitor-model pairing approach aside from the First or Second Level methods should be justified on a case-by-case basis in consultation with the appropriate permitting authority and the appropriate EPA Regional Office.

IV.4 Determining Whether Proposed Source Causes or Contributes to Modeled Violations

If the cumulative impact assessment following these recommendations results in predicted modeled violations of the O_3 and/or $PM_{2.5}$ NAAQS, then the permit applicant will need

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[20] The complexity of the $PM_{2.5}$ ambient monitoring network presents special challenges with a "paired sum" approach that are not present with other NAAQS pollutants. The Federal Reference Method (FRM) $PM_{2.5}$ monitoring network is based on 24-hour samples that are taken on average every third day at the 1-in-3 day monitors. The frequency of daily or 1-in-1 day $PM_{2.5}$ monitors is steadily increasing but is relatively limited to the largest cities and metropolitan regions of the U.S. Various methods to "data fill" the 1-in-3 day monitoring database to create a pseudo-daily dataset have been explored in a few situations, but none of these data filling methods have been demonstrated to create a representative daily $PM_{2.5}$ dataset that the EPA would consider acceptable for inclusion in a $PM_{2.5}$ NAAQS compliance demonstration. The use of continuous $PM_{2.5}$ monitors, which are more limited in number compared to the FRM monitors and may require careful quality assurance of individual hourly measurements, may be an option but should be discussed in advance with the appropriate permitting authority.

to demonstrate that the proposed source's emissions do not cause or contribute to the modeled NAAQS violations. In the SILs Guidance, the EPA explained that the permitting authority may further evaluate whether the proposed source or modification will cause or contribute to predicted violations by comparing the proposed source's modeled impacts, paired in time and space with the predicted violations, to an appropriate SIL. The proposed source or modification would not be considered to cause or contribute to predicted violations of the O_3 or $PM_{2.5}$ NAAQS where the modeled impacts of the proposed source or modification at those particular times and locations are less than the appropriate O_3 or $PM_{2.5}$ NAAQS SIL. As explained in the SILs Guidance, a permitting authority that chooses to use an O_3 or $PM_{2.5}$ SIL value to support a PSD permitting decision should justify the value and its use in the administrative record for the permitting action.

A demonstration that a proposed source or modification does not cause or contribute to a predicted violation should be based on a comparison of the modeled concentrations (primary and secondary impacts) at the receptor location(s) showing the violation(s) of the O_3 or $PM_{2.5}$ NAAQS to the appropriate O_3 or $PM_{2.5}$ NAAQS SIL, *i.e.*,

- For a predicted violation of the O_3 NAAQS, the average of the predicted annual (or episodic) 98th percentile daily maximum 8-hour averaged O_3 concentrations at the affected receptor(s) should be compared to an appropriate O_3 NAAQS SIL, *e.g.*, SIL values recommended by EPA in the SILs Guidance (Table II-1).
- For a predicted violation of the annual $PM_{2.5}$ NAAQS, the average of the predicted annual concentrations at the affected receptor(s) should be compared to an appropriate $PM_{2.5}$ annual NAAQS SIL, *e.g.*, SIL values recommended by EPA in the SILs Guidance (Table II.1).

- For a predicted violation of the 24-hour $PM_{2.5}$ NAAQS, the average of the predicted annual 98th percentile 24-hour average concentrations at the affected receptor(s) should be compared to an appropriate $PM_{2.5}$ 24-hour NAAQS SIL, *e.g.*, SIL values recommended by EPA in the SILs Guidance (Table II-1).

V. PSD Compliance Demonstration for the $PM_{2.5}$ Increments

As summarized in Section II of this guidance, CAA section 165(a)(3) requires that proposed new and modified major stationary sources seeking a PSD permit must demonstrate that their proposed emissions increases will not cause or contribute to a violation of any NAAQS or PSD increments. Based on the flow diagram presented in Figure II-2, this section describes the EPA's recommendations for completing the required compliance demonstration for the PSD increments for $PM_{2.5}$.

V.1 Overview of the PSD Increment System

This section provides an overview of the PSD increment system by defining basic terms, such as increment, baseline concentration, baseline area, trigger date, minor source baseline date, and major source baseline date. This section also introduces and discusses the concepts of increment consumption and expansion.

V.1.1 PSD Increments and Baseline Concentration

The term "increment" generally refers to what the CAA calls the "maximum allowable increase over baseline concentrations" with respect to a criteria pollutant. The CAA section 169(4) defines "baseline concentration," generally, as "the ambient concentration levels which exist at the time of the first application for a [PSD] permit for an area subject to this part…."[21] Accordingly, an increment analysis is generally concerned with the emissions increases affecting

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[21] EPA's regulations at 40 CFR 52.21(b)(14)(ii) (and 51.166(b)(14)(ii)) provide that the triggering application is to be a complete PSD application. Hence, the term "complete application" will be used throughout this section with regard to the minor source baseline date and increment consumption.

air quality in a particular PSD area after the date that the first complete PSD application is submitted to the permitting authority.[22] When comparing the ambient impact of such total emissions increases against the increment value for a particular pollutant, a cumulative increase in the ambient concentration of that pollutant that is greater than the increment generally is considered “significant deterioration.” When the cumulative impact analysis identifies significant deterioration in this way, the permitting authority should determine whether the emissions increase from the proposed new source or modification will cause or contribute to the projected violation of the PSD increment.

Based on the statutory definition of baseline concentration, as described above, it is conceptually possible to measure whether there will be significant deterioration in at least two separate ways. The first way involves comparing a direct modeled projection of the change in air quality caused by all increment-consuming and expanding emissions to the increment in the area of concern (known as the baseline area, discussed below in Section V.1.2). The second approach is to make a determination of whether the current monitored ambient air quality concentration in the applicable baseline area, supplemented by the modeled impact of the proposed source, will exceed an allowable ambient air quality ceiling. This latter approach requires comparing such monitored concentration(s) to the sum of the increment and the baseline concentration for the baseline area.

Historically, because of the lack of monitoring data to adequately represent the baseline concentration combined with various other limitations associated with the use of ambient air

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[22] The EPA also considers emissions decreases occurring after the date of the first PSD application to affect increment consumption to the extent that such decreases cause an improvement of air quality in the area of concern. Thus, the concept of increment “expansion” is also discussed in this section.

quality monitoring data for measuring increment consumption,[23] the EPA has recommended that the required increment analysis be based exclusively on the first approach, which models the increment-related emissions increases or decreases to determine the resulting ambient air quality change and compares this value with the increments for a particular pollutant.

V.1.2 PSD Baseline Area and Key Baseline Dates

In order to determine whether a PSD increment would be violated as part of a PSD permit review, it is necessary to identify (1) the affected geographic area in which the increment will be tracked and (2) the key baseline dates after which emissions changes affect increment in that area. The relevant geographic area for determining the amount of increment consumed is known as the “baseline area.” The baseline area is established primarily on the basis of the location of the first major source to submit a complete PSD application after an established “trigger date” (see discussion of key dates below) and may be comprised of one or more areas that are designated as “attainment” or “unclassifiable” pursuant to CAA section 107(d) for a particular pollutant within a state. In accordance with the regulatory definition of baseline area at 40 CFR 52.21(b)(15), the area is an “intrastate area” and does not include any area in another state.[24] At a minimum, the baseline area is the attainment or unclassifiable area in which the first PSD applicant after the trigger date proposes to locate, but additional attainment or unclassifiable areas could be included in a particular baseline area when the proposed source’s modeled impact

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[23] The EPA described certain limitations associated with the use of ambient air quality monitoring data for measuring increment consumption in the preamble to its proposed PSD regulations in 1979. For example, the CAA provides that certain emissions changes should not be considered increment consuming. These limitations generally continue to apply to the extent that certain emissions changes detected by an ambient monitor are not considered to consume increment. See 44 Fed. Reg. 51924, 51944 (September 5, 1979).

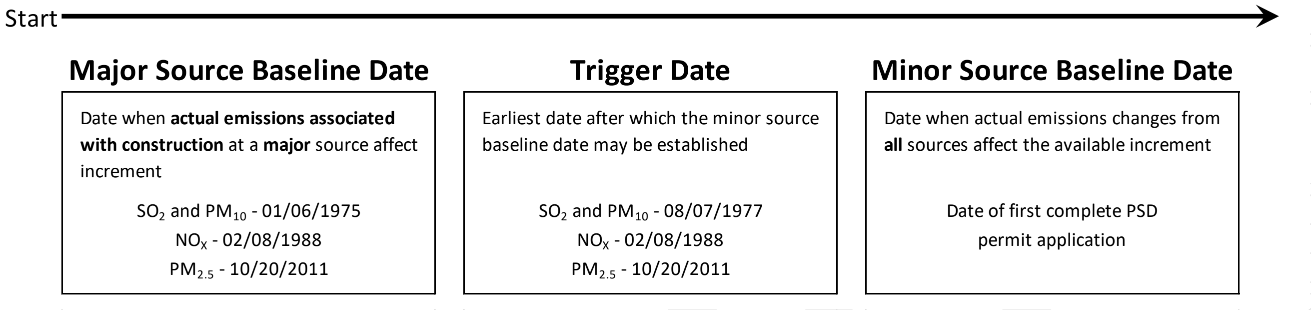
[24] While baseline dates are established on an intrastate basis, once a baseline area is established, emissions changes from other states may contribute to the amount of increment consumed.

in any such additional areas exceeds certain concentrations specified in the regulatory definition of baseline area. Once a baseline area has been established, subsequent PSD applicants proposing to locate, or which could have a significant impact, in that area should rely on the associated baseline dates, discussed below, to determine whether the new or modified source's proposed emissions would cause or contribute to an increment violation.

Within any baseline area, three key dates will apply in order to conduct the required increment analysis: (1) trigger date; (2) minor source baseline date; and (3) major source baseline date. The trigger date is a date fixed by regulation for each pollutant at 40 C.F.R. 52.21(b)(14)(ii), which is the earliest date after which proposed new or modified major sources submitting a complete PSD application establishes the "minor source baseline date" in a newly established baseline area. Accordingly, the minor source baseline date is the date on which PSD permit applicants must actually begin tracking increment tracking. Depending upon the number of separate attainment and unclassifiable areas that exist for a particular pollutant in a state and the timing of major source construction within the state, there may be a number of minor source baseline dates that apply to different baseline areas established in that state. Beginning with the PSD source whose complete application has established the minor source baseline date in a particular area, any increase or decrease in actual emissions occurring after the minor source baseline date at any source that will affect air quality in the baseline area will affect the amount of PSD increment consumed in that baseline area (in the case of an emissions decrease, see discussion on increment expansion in Section V.1.3 of this guidance, below).

Finally, the "major source baseline date" is a date fixed by regulation for each pollutant at 52.21(b)(14)(i) and *precedes* the trigger date. As further explained below, changes in emissions resulting from construction at major stationary sources only that occur after the major source baseline date but before the minor source baseline date will also affect increment. The relationship of these three key dates with each other is further illustrated in Figure V-1.

Figure V-1. Determining Baseline Date(s) and When Increment Consumption Starts



Start

Major Source Baseline Date

Date when **actual emissions associated with construction** at a **major** source affect increment

SO_2 and PM_{10} - 01/06/1975
NO_X - 02/08/1988
$PM_{2.5}$ - 10/20/2011

Trigger Date

Earliest date after which the minor source baseline date may be established

SO_2 and PM_{10} - 08/07/1977
NO_X - 02/08/1988
$PM_{2.5}$ - 10/20/2011

Minor Source Baseline Date

Date when actual emissions changes from **all** sources affect the available increment

Date of first complete PSD permit application

Emissions changes occurring before the minor source baseline date generally do not affect increment in an area (*i.e.*, are not increment-consuming) but are considered to affect the baseline concentration, which, as explained above, represents the ambient pollutant concentration levels that exist at the time of the minor source baseline date, or the date of the first complete application for a PSD permit in a an area after the trigger date. However, as noted above, the CAA provides an exception for certain emissions changes that occur specifically at major stationary sources as a result of construction[25] that commences after the major source baseline date. Specifically, for projects at major stationary sources on which construction commenced on a date prior to the major source baseline date, the changes in emissions from such projects affect the baseline concentration (not the amount of increment consumed) even if the emissions change may not actually occur until after the major or minor source baseline dates. Alternately, for projects at major stationary sources on which construction commenced after the

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[25] The CAA section 169(2)(C) indicates that the term “construction,” when used in connection with any source or facility, includes modifications defined in CAA section 111(a)(4). “Modification” is defined at section 111(a)(4) to mean any physical change or change in the method of operation at a stationary source which increases the amount of any air pollutant emitted by the source or which results in the emission of any air pollutant not previously emitted.

major source baseline date, the project emissions will be considered to affect increment, even if the new or modified source actually begins operation before the minor source baseline date.

V.1.3 PSD Increment Expansion

The "increment consumption" analysis allows permit applicants and permitting authorities to take into account emissions reductions that occur in the baseline area of concern. Such emissions reductions are generally said to result in the *expansion* of increment in the area; however, not all emissions reductions truly result in an expansion of the increment. Some emissions reductions, instead, result in a *freeing up* of increment that had previously been consumed.

In the case of true "increment expansion," emissions in the area are allowed to increase by the amount allowed by the original increment plus the amount of air quality improvement (relative to the baseline concentration) achieved by the reduction of emissions that were not considered to consume increment because of their relationship to the established baseline dates for the area.[26] In such cases, it is appropriate to model the emissions decrease as a negative amount to account for the resulting lowering of the baseline concentration and simulate the expansion of the increment.

On the other hand, in cases where a source's emissions contribute to the amount of increment consumed, a reduction in such increment-consuming emissions at some later date

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[26] The concept of increment expansion is derived from CAA section 163(a), which provides that a PSD applicant must assure "that maximum allowable increases *over baseline concentrations* … shall not be exceeded." [Emphasis added.] The target for determining significant deterioration thus becomes the ambient concentration resulting from the sum of the increment and the baseline concentration. When a decrease in emissions that contribute to the baseline concentration occurs, an emissions increase that simply "restores" the air quality to the original baseline concentration in a particular baseline area can be allowed, regardless of the amount of increment otherwise being consumed.

results in some amount of the consumed increment being freed up. That is, the resulting air quality improvement is now available for a source to increase its emissions within the limits of the original increment level. A subsequent reduction in increment-consuming emissions should not be modeled as a negative value to determine the amount of increment that has been freed up; instead, such emissions reductions are simply no longer counted in the increment consumption equation.

V.2 PSD $PM_{2.5}$ Increments

In 2010, the EPA established the $PM_{2.5}$ increments at the levels shown in Table V-1 through the "Prevention of Significant Deterioration (PSD) for Particulate Matter Less Than 2.5 Micrometers ($PM_{2.5}$) – Increments, Significant Impact Levels (SILs) and Significant Monitoring Concentration (SMC)" final rule.[27] This 2010 rule established October 20, 2011, as the trigger date and October 20, 2010, as the major source baseline date for $PM_{2.5}$ increments. The EPA developed the increment system for $PM_{2.5}$ generally following the same concepts that were previously applied for development of the increments for PM_{10}, SO_2, and nitrogen dioxide (NO_2). As explained above, the framework reflects the statutory concepts set forth in the statutory definition of baseline concentration that was explained in Section V.1 of this guidance.

Table V-1. $PM_{2.5}$ Increments

	Class I	Class II	Class III
Increments, $\mu g/m^3$			
Annual arithmetic mean………………………………………………………	1	4	8
24-hour maximum………………………………………………………………	2	9	18

Source: Prevention of Significant Deterioration (PSD) for Particulate Matter Less Than 2.5 Micrometers (PM2.5) - Increments, Significant Impact Levels (SILs) and Significant Monitoring Concentration (SMC) final rule (75 FR 64864)

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[27] See 75 FR 64864.

The obvious difference between an increment analysis and the NAAQS analysis for $PM_{2.5}$ is that the increment analysis is concerned with the degree of change in air quality caused by a new or modified PSD source rather than the impact of that source on overall air quality (as defined by the applicable NAAQS) in the area of concern (baseline area). With this in mind, it should be noted here that an increment analysis is relevant only to the extent that NAAQS compliance has been ensured. That is, an adequate air quality analysis demonstrating compliance with the statutory requirements must ensure that the proposed PSD source's emissions will not cause or contribute to either the NAAQS or PSD increments.[28]

Another key difference involves the modeling inventory from which the necessary emissions data is derived. That is, only sources that have $PM_{2.5}$ emissions (direct and precursor) that affect the amount of increment consumed in the area of concern should be included in the modeling inventory for the increment analysis. Moreover, from such sources only those specific emissions changes that affect increment should be included in the actual modeling analysis.

The cumulative impact analysis for $PM_{2.5}$ increments is also different and based on the actual emission changes occurring at existing sources in the baseline area after the pertinent baseline dates (*i.e.*, major and minor source baseline dates), whereas NAAQS analyses are generally based on the cumulative impact associated with the maximum allowable emissions from the new or modifying source and other nearby sources (with specific provisions for operating levels of nearby sources). Furthermore, ambient monitoring data, while useful for establishing background concentration for the NAAQS analysis, may not be particularly useful for the typical increment analysis. The limitations associated with using monitoring data for an

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[28] The CAA section 163(b)(4) provides that the maximum allowable concentration of any air pollutant allowed in an area shall not exceed the concentration allowed by the primary or secondary NAAQS.

increment analysis are discussed in greater detail in Sections V.1 and V.3 of this guidance.

It is also important to note that the $PM_{2.5}$ NAAQS and increments for the 24-hour averaging period are defined in different forms and therefore must be analyzed differently.[29] The 24-hour $PM_{2.5}$ NAAQS is defined based on the 3-year average of the annual 98th percentile of the 24-hour average concentrations, while the 24-hour $PM_{2.5}$ increments are based on the second highest maximum 24-hour concentration.

V.3 PSD Compliance Demonstration for the $PM_{2.5}$ Increments

The initial steps for the $PM_{2.5}$ increment analysis, which include the determination of the significant emissions increases to include in the source impact analysis and comparison of the modeled impacts against the $PM_{2.5}$ SILs will rely upon the results derived from the $PM_{2.5}$ NAAQS analysis described in Sections III and IV of this guidance. Moreover, the technical approach involving the options and alternatives agreed upon for estimating secondary $PM_{2.5}$ impacts and combining primary and secondary $PM_{2;5}$ impacts for the NAAQS analysis will also be relevant for completing the $PM_{2.5}$ increment analysis to determine whether the emissions increase from the proposed source or modification will cause or contribute to any $PM_{2.5}$ increment violation.

V.3.1 $PM_{2.5}$ Increments: Source Impact Analysis

The EPA's recommendations on completing the required compliance demonstration for the $PM_{2.5}$ PSD increments is based upon the same four assessment cases detailed in Section II.4 for $PM_{2.5}$ NAAQS. As shown in Table V-2, a modeled compliance demonstration is not required

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[29] The annual NAAQS and increments for $PM_{2.5}$ are both measured as annual arithmetic mean values.

for Case 1 since neither direct $PM_{2.5}$ emissions nor $PM_{2.5}$ precursor (NO_X and/or SO_2) emissions are equal to or greater than the respective SERs. Case 1 is the only assessment case that does not require a modeled compliance demonstration for $PM_{2.5}$, whereas each of the remaining three assessment cases would necessitate a source impact analysis that should be conducted following the detailed recommendations provided in previous sections for a NAAQS analysis.

Table V-2. EPA Recommended Approaches for Assessing Primary and Secondary PM$_{2.5}$ Impacts by Assessment Case

Assessment Case	**Description of Assessment Case**	**Primary Impacts Approach**	**Secondary Impacts Approach***
Case 1: No Air Quality Analysis	Direct PM$_{2.5}$ emissions $<$ 10 tpy SER NO$_X$ emissions and SO$_2$ emissions $<$ 40 tpy SER	N/A	N/A
Case 2: Primary Air Quality Impacts Only	Direct PM$_{2.5}$ emissions $\geq$ 10 tpy SER NO$_X$ emissions and SO$_2$ emissions $<$ 40 tpy SER	**Appendix W preferred or approved alternative dispersion model**	N/A
Case 3: Primary and Secondary Air Quality Impacts	Direct PM$_{2.5}$ emissions $\geq$ 10 tpy SER NO$_X$ emissions and/or SO$_2$ emissions $\geq$ 40 tpy SER	**Appendix W preferred or approved alternative dispersion model**	Include each precursor of PM$_{2.5}$ emitted in a significant amount, see Section II.2. • **Tier 1 Approach** (*e.g.*, MERPs) • **Tier 2 Approach** (*e.g.*, Chemical Transport Modeling)
Case 4: Secondary Air Quality Impacts Only	Direct PM$_{2.5}$ emissions $<$ 10 tpy SER NO$_X$ emissions and/or SO$_2$ emissions $\geq$ 40 tpy SER	N/A	Include each precursor of PM$_{2.5}$ emitted in a significant amounts, see Section II.2. • **Tier 1 Approach** (*e.g.*, MERPs) • **Tier 2 Approach** (*e.g.*, Chemical Transport Modeling)

* In unique situations (*e.g.*, in parts of Alaska where photochemistry is not possible for portions of the year), it may be acceptable for the applicant to rely upon a qualitative approach to assess the secondary impacts. Any qualitative assessments should be justified on a case-by-case basis in consultation with the appropriate EPA Regional Office or other applicable permitting authority.

A modeling analysis based solely on the PSD applicant's proposed emissions increase (*i.e.*, source impact analysis) that does not predict *anywhere* an ambient impact equal to or greater than the applicable PM$_{2.5}$ SIL generally will satisfy the requirement for a demonstration that the source will not cause or contribute to a violation of the PM$_{2.5}$ increments. When the PSD applicant relies on such analysis to make the required compliance demonstration, the EPA recommends that the applicant should include: (1) a comparison of the predicted impacts of the proposed new or modified source and the allowable increment values, (2) information on the extent, if any, to which increment has already been consumed since the major source baseline date (by major source construction occurring prior to the minor source baseline date) or since the minor source baseline date by nearby emissions changes occurring prior to the proposed source, and (3) information on increment consumption or expansion by more distant emissions changes.

In light of the relatively recent establishment of the fixed dates (*i.e.*, major source baseline date and trigger date) associated with the $PM_{2.5}$ increments (compared to comparable fixed dates for other PSD increments), and the possibility that the minor source baseline date for a particular area has not yet been set, a proposed new or modified source being evaluated for compliance with the $PM_{2.5}$ increments in a particular area may be the first source in the area with increment-consuming emissions. As indicated in Figure II-2, under this situation, a permitting authority may have a sufficient basis to conclude that the $PM_{2.5}$ impacts of the new or modified PSD source, although greater than the applicable $PM_{2.5}$ SILs, may be compared directly to the allowable $PM_{2.5}$ increments without the need for a cumulative analysis (described in Section V.3.2 of this guidance below). Reliance on this initial source impact analysis (rather than a source or cumulative impact analysis that is compared to the applicable $PM_{2.5}$ SILs) likely would be appropriate to assess the amount of increment consumed when the proposed new or modified source represents the first complete PSD application since the trigger date, thus establishing the baseline concentration in the area, and there has been no other major source construction since the major source baseline date.

V.3.2 $PM_{2.5}$ Increments: Cumulative Analysis

Where the source impact analysis described above is insufficient to show that a proposed PSD source will not cause or contribute to a violation of the $PM_{2.5}$ PSD increments, a cumulative impact assessment would be necessary to complete the required increment analysis. A cumulative assessment of increment consumption accounts for the combined impacts of the following:

1. Direct and/or precursor *allowable* emissions that the proposed new or modifying source would emit in significant amounts;
2. Direct and/or precursor *actual* emissions changes that have occurred at existing sources (including the existing source at which a major modification is being proposed, where applicable) since the minor source baseline date for the proposed source's baseline area;
3. Direct and/or precursor *actual* emissions from any major stationary source on which construction commenced after October 20, 2010 (major source baseline date for $PM_{2.5}$); and
4. Direct and/or precursor *allowable* emissions of permitted sources that are not yet fully operative.[30]

Unlike the guidance provided for the cumulative NAAQS analysis for $PM_{2.5}$, it is not typically practical to utilize ambient monitoring data to represent any portion of the impacts that affect the $PM_{2.5}$ increments. Therefore, it is usually necessary to model the applicable emissions from any existing source that will be considered to consume a portion of the $PM_{2.5}$ increments in

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[30] Regarding the use of allowable emissions, see 40 CFR 52.21(b)(21)(iv).

the baseline area of concern. It is highly recommended that the PSD applicant work closely with the permitting authority to determine the existing sources (including newly permitted sources) of direct $PM_{2.5}$ and precursor emissions that should be included in the modeling inventory for the increment analysis. Sources whose emissions have not changed substantially since the applicable baseline date may not need to be included for purposes of increment consumption. If there is reason to believe that an existing source's actual emissions have decreased since the applicable baseline date, the PSD applicant may want to check with the permitting authority to ascertain whether the authority allows for increment expansion to be considered.

Once the modeling inventory for the increment analysis has been developed and approved, and the increment-consuming emissions have been determined, the modeled cumulative impacts resulting from the increases and decreases in emissions are then compared to the $PM_{2.5}$ increments to determine whether any increment violations will result. This section provides recommendations on conducting an appropriate cumulative impact assessment for $PM_{2.5}$ increments.

V.3.2.1 Assessing Primary $PM_{2.5}$ Impacts

As explained in Section III.3 of this guidance, the assessment of primary $PM_{2.5}$ impacts from the proposed new or modifying PSD source is essentially the same for the $PM_{2.5}$ NAAQS and increments. In both cases, the permit applicant must account for the impacts from the proposed new or modifying source's *allowable* emissions increase of direct $PM_{2.5}$.

To assess the impact of direct $PM_{2.5}$ emissions from existing increment-consuming sources, *actual* emissions increases that have occurred since the applicable minor source baseline date should generally be modeled. Alternatively, existing source impacts from direct $PM_{2.5}$

emissions may be conservatively modeled using an existing source's *allowable* emissions where the PSD applicant determines that such emissions are more readily available and especially when such allowable emissions are not expected to contribute substantially to the amount of increment consumed. In the event that an applicant chooses to conduct the cumulative analysis using *allowable* emissions and identifies potential problems concerning increment consumption, the PSD applicant may then rely on more refined data that better represent a particular source's *actual* emissions.

The $PM_{2.5}$ increments analysis would follow the traditional approach involving modeling only direct $PM_{2.5}$ emissions changes that affect the increment and should be based on application of AERMOD (or other acceptable preferred or approved alternative model), using actual emission changes associated with any increment-consuming or increment-expanding sources. The AERMOD model allows for inclusion of these emissions (represented as negative emissions for the sources expanding increment)[31] in the same model run that includes the allowable increase in emissions from the proposed source and will, therefore, output the net cumulative concentrations at each receptor established for the modeling domain.[32]

V.3.2.2 Assessing Secondary $PM_{2.5}$ Impacts

To assess the impacts from changes in secondary $PM_{2.5}$ precursor emissions from the new or modified source, as well as from other increment-consuming sources, the EPA recommends the analysis for each applicable precursor of $PM_{2.5}$ be conducted collectively based on the two-tiered demonstration approach outlined in EPA's 2017 *Guideline*.

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[31] See discussion about increment expansion in Section V.1.3 of this guidance.

[32] The "maximum" cumulative impacts will be output as zero if the cumulative impacts computed in the model are less than zero).

In recent years, several rules promulgated by the EPA have resulted in control requirements that have significantly reduced NO_X and SO_2 precursor emissions affecting ambient $PM_{2.5}$ concentrations in many areas.[33] This is particularly true in the eastern U.S. As a result, in some cases, the impacts of secondary $PM_{2.5}$ emissions may be addressed by a demonstration that provides ambient monitoring data that generally confirms a downward trend in contributions of precursor emissions occurring after the applicable $PM_{2.5}$ minor source baseline date (or the major source baseline date). If it can be confirmed that such secondary emissions reductions have occurred in a particular baseline area, it may be possible to complete the $PM_{2.5}$ increments modeling analysis simply by focusing on potential increment consumption associated with direct $PM_{2.5}$ emissions. For areas where $PM_{2.5}$ precursor emission increases from other increment-consuming sources have occurred since the major or minor source baseline dates, and are, thus, likely to have added to $PM_{2.5}$ concentration increases within the baseline area (and, thus, consume $PM_{2.5}$ increment), the chemical transport modeling methods (using the emissions input data applicable to increment analyses) discussed in Section III of this guidance may be appropriate for estimating the portion of $PM_{2.5}$ increment consumed due to secondary $PM_{2.5}$ impacts associated with those increases in precursor emissions.

V.4. Determining Whether a Proposed Source Will Cause or Contribute to an Increment Violation

When a proposed PSD source predicts, through a cumulative impact analysis, that a

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[33] Such rules include the Finding of Significant Contribution and Rulemaking for Certain States in the Ozone Transport Assessment Group Region for Purposes of Reducing Regional Transport of Ozone (also known as the NOx SIP Call), 63 FR 57356 (October 27, 1998); the Clean Air Interstate Rule (CAIR) Final Rule, 70 FR 25162 (May 12, 2005); CSAPR Final Rule, 76 FR 48208 (August 8, 2011); CSAPR Update for the 2008 Ozone NAAQS (CSAPR Update) Final Rule, 81 FR 74504 (October 26, 2016); and the Mercury and Air Toxics Standards Rule (MATS), 77 FR 9304 (February 16, 2012).

modeled violation of any $PM_{2.5}$ increment will occur within the baseline area of concern, a closer examination of the proposed source's individual impact(s) at the violating receptor(s) and the time(s) of violation become important considerations. The EPA's longstanding policy is that a proposed PSD source will be considered to cause or contribute to an increment violation if its impact (primary and secondary) is significant (equal to or greater than the applicable $PM_{2.5}$ SIL) at the location and time of the modeled violation.[34] Accordingly, a proposed source or modification generally will not be considered to cause or contribute to an increment violation, even if it's modeled impacts equal or exceed the applicable $PM_{2.5}$ SILs, if it can demonstrate to the satisfaction of the permitting authority that such significant impacts do *not* occur at the location and time of any modeled violation.[35] In cases where a proposed PSD source models impacts that equal or exceed the applicable $PM_{2.5}$ SIL *and* would cause a new violation of any $PM_{2.5}$ increment, it is the EPA's longstanding policy to allow the PSD applicant to obtain sufficient offsets, in the form of emissions reductions internally or from another existing source, to avoid causing the violation at each affected receptor where (and when) a violation is modeled. In an area where a proposed PSD source would cause or contribute to an existing increment violation(s), the PSD source cannot be approved for construction unless such existing violation(s) is entirely corrected at each affected receptor prior to the operation of the proposed

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[34] *See*, *e.g.*, 43 FR 26380 at 26401, June 19, 1978; EPA memo titled "Interpretation of 'Significant Contribution,'" December 16, 1980; EPA memo titled "Air Quality Analysis for Prevention of Significant Deterioration," July 5, 1988; and more recently, EPA memo titled "Guidance on Significant Impact Levels for Ozone and Fine Particles in the Prevention of Significant Deterioration Permitting Program," April 17, 2018, Attachment at page 18 ("If the modeled impact is below the recommended SIL value *at the violating receptor during the violation*, the EPA believes this will be sufficient…to conclude that the source does not cause or contribute to…the predicted violation.")(Emphasis added).

[35] The difficulties associated with combining primary and secondary impacts spatially and temporally were described in Sections III and IV of this guidance. In the case of a $PM_{2.5}$ increment analysis, as with the $PM_{2.5}$ NAAQS analysis, the applicant and permitting authority will need to agree upon an approach that best satisfies the required compliance demonstration.

source.[36]

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[36] *See*, *e.g.*, 43 FR 26380 at 26401, June 19, 1978; 45 FR 52676 at 52678, August 7, 1980; and EPA memo titled "Air Quality Analysis for Prevention of Significant Deterioration," July 5, 1988. ("…for any increment violation (new or existing) for which the proposed source has a significant impact, the permit should not be approved unless the increment violation is corrected prior to operation of the proposed source.) Note that this policy for the PSD increments differs from the policy for sources that contribute to an existing NAAQS violation, for which the proposed sources needs only compensate for its own adverse impact on the NAAQS violation in accordance with 40 CFR 51.165(b)(3).

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Appendix A: Draft Conceptual Description of O_3 and $PM_{2.5}$ Concentrations in the U.S.

This appendix provides a brief summary of the current O_3 and $PM_{2.5}$ monitoring networks. It also characterizes O_3 and PM air quality in terms of their precursor emissions and chemical composition, concentration levels, and spatial and temporal patterns across the nation based on the ambient data and analyses contained in the EPA's "Integrated Science Assessment for Ozone and Related Photochemical Oxidants,"[37] "The Particle Pollution Report,"[38] and "Particulate Matter Staff Paper."[39] Such information may be useful for permit applicants in preparing conceptual descriptions, as discussed in this guidance. Permit applicants also encouraged to reference the EPA's "Air Quality Trends" website at https://www.epa.gov/air-trends for the current O_3 and $PM_{2.5}$ trends and design values.

Conceptual Descriptions of O_3

1. O_3 Monitoring Networks

To monitor compliance with the NAAQS, state, local, and tribal environmental agencies operate O_3 monitoring sites at various locations, depending on the population of the area and typical peak O_3 concentrations. In 2015, there were over 1,300 O_3 monitors reporting O_3 concentration data to EPA. All monitors that currently report O_3 concentration data to the EPA use ultraviolet Federal Equivalent Methods (FEMs). Since the highest O_3 concentrations tend to be associated with particular seasons for various locations, EPA requires O_3 monitoring during specific monitoring seasons which vary by state. The O_3 monitoring seasons for each state are listed in Appendix D to 40 CFR part 58.

Figure A-1 shows the locations of all U.S. ambient O_3 monitoring sites reporting data to EPA during the 2013-2015 period. The gray dots represent State and Local Ambient Monitoring Stations (SLAMS) which are operated by state and local governments to meet regulatory requirements and provide air quality information to public health agencies. SLAMS monitors make up about 80 percent of the ambient O_3 monitoring network in the U.S. The minimum monitoring requirements to meet the SLAMS O_3 network design criteria are specified in Appendix D to 40 CFR part 58. The requirements are based on both population and ambient concentration levels for each Metropolitan Statistical Area (MSA). At least one site for each MSA must be designed to record the maximum concentration for that particular area. The blue dots highlight two important subsets of monitoring sites within the SLAMS network: the "National Core" (NCore) network, which consists of about 80 monitoring sites that collect multi-pollutant measurements on a year-round basis, and the "Photochemical Assessment Monitoring

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[37] U.S. Environmental Protection Agency (2013). Integrated Science Assessment for Ozone and Related Photochemical Oxidants. U.S. Environmental Protection Agency, Research Triangle Park, NC. EPA/600/R-10/076 (2013 ISA), section 3.2.2 found at https://cfpub.epa.gov/ncea/isa/recordisplay.cfm?deid=247492.

[38] The Particle Pollution Report: Current Understanding of Air Quality and Emissions through 2003. http://www.epa.gov/airtrends/aqtrnd04/pmreport03/pmcover_2405.pdf#page=1.

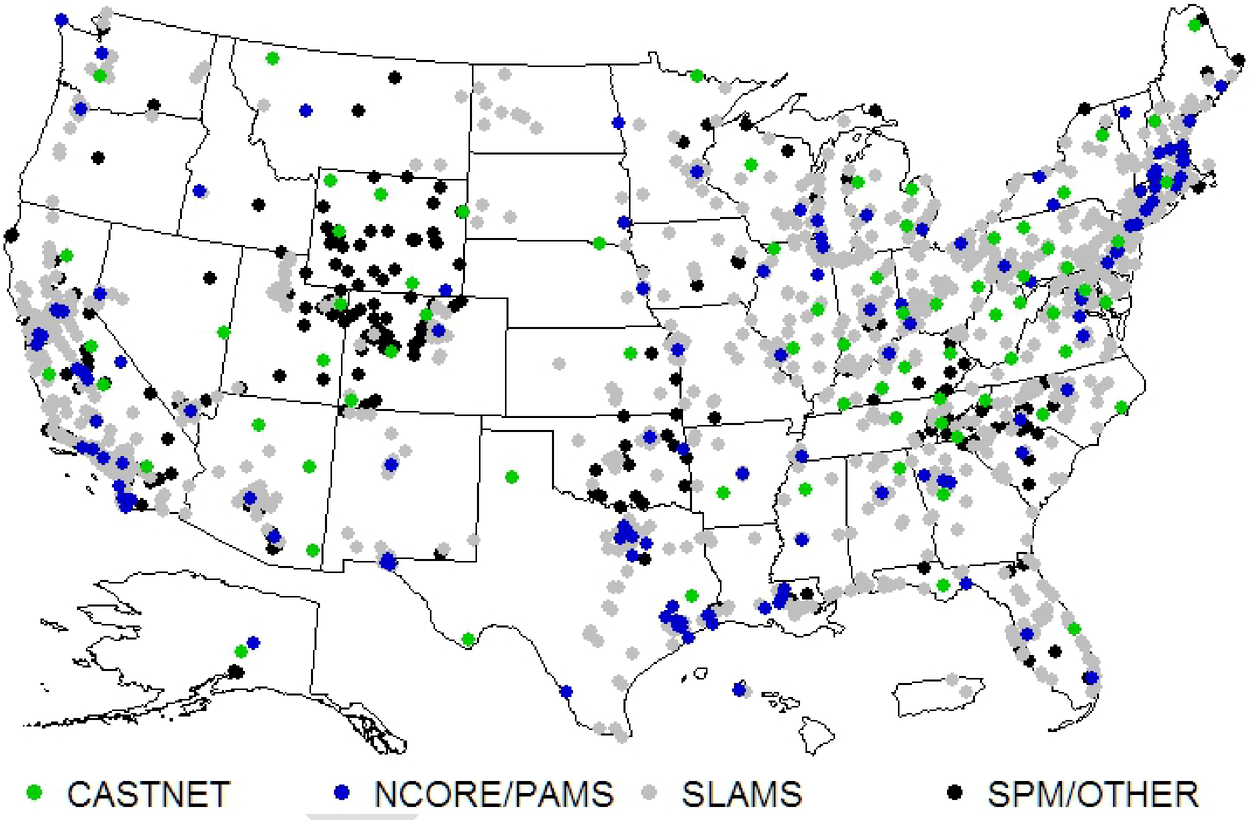
[39] Particulate Matter Staff Paper: Review completed in 2012. http://www.epa.gov/ttn/naaqs/standards/pm/s_pm_cr_sp.html.

Stations" (PAMS) network, which consists of about 75 monitoring sites that collect summertime measurements of various precursor gases involved O_3 formation.

The green dots in Figure A-1 represent O_3 monitoring sites in the Clean Air Status and Trends Network (CASTNet) which are mostly located in rural areas. There were about 80 CASTNet sites reporting data to EPA in 2015, with sites in the eastern U.S. generally being operated by the EPA, and sites in the western U.S. generally being operated by the National Park Service (NPS).

Finally, the black dots in Figure A-1 represent "Special Purpose" (SPM) monitoring sites, which generally collect data for research studies, public health reporting, or other non-regulatory purposes, and all other O_3 monitoring sites which includes monitors operated by tribes, industry, and other federal agencies such as the U.S. Forest Service (USFS).

Figure A-1. Locations of U.S. Ambient O_3 Monitoring Sites in 2013-2015



2. O_3 Precursor Emissions and Atmospheric Chemistry

O_3 is formed by photochemical reactions of precursor gases and is not directly emitted from specific sources. In the stratosphere, O_3 occurs naturally and provides protection against harmful solar ultraviolet radiation. In the troposphere, near ground level, O_3 forms through atmospheric reactions involving two main classes of precursor pollutants: volatile organic compounds (VOCs) and nitrogen oxides (NO_X). Carbon monoxide (CO) and methane (CH4) are also important for O_3 formation over longer time periods.[40]

Emissions of O_3 precursor compounds can be divided into anthropogenic and natural source categories, with natural sources further divided into biogenic emissions (from vegetation, microbes, and animals) and abiotic emissions (from biomass burning, lightning, and geogenic sources). Anthropogenic sources, including mobile sources and power plants, account for the majority of NO_X and CO emissions. Anthropogenic sources are also important for VOC emissions, though in some locations and at certain times of the year (*e.g.*, southern states during summer), the majority of VOC emissions come from vegetation.[41] In practice, the distinction between natural and anthropogenic sources is often unclear, as human activities directly or indirectly affect emissions from what would have been considered natural sources during the preindustrial era. Thus, emissions from plants, animals, and wildfires could be considered either natural or anthropogenic, depending on whether emissions result from agricultural practices, forest management practices, lightning strikes, or other types of events.[42]

Rather than varying directly with emissions of its precursors, O_3 changes in a nonlinear fashion with the concentrations of its precursors. NO_X emissions lead to both the formation and destruction of O_3, depending on the local quantities of NO_X, VOC, radicals, and sunlight. In areas dominated by fresh emissions of NO_X, radicals are removed, which lowers the O_3 formation rate. In addition, the scavenging of O_3 by reaction with NO is called "titration" and is often found in downtown metropolitan areas, especially near busy streets and roads, as well as in power plant plumes. This short-lived titration results in localized areas in which O_3 concentrations are suppressed compared to surrounding areas, but which contain NO_2 that adds to subsequent O_3 formation further downwind. Consequently, O_3 response to reductions in NO_X emissions is complex and may include O_3 decreases at some times and locations and increases of O_3 at other times and locations. In areas with relatively low NO_X concentrations, such as those found in remote continental areas and rural and suburban areas downwind of urban centers, O_3 production typically varies directly with NO_X concentrations (*e.g.*, decreases with decreasing NO_X emissions). The NOx titration effect is most pronounced in urban core areas which have higher volume of mobile source NOx emissions from vehicles than do the surrounding areas. It should be noted that such locations, which are heavily NO_X saturated (or radical limited), tend to have much lower observed O_3 concentrations than downwind areas. As a general rule, as NOx emissions reductions occur, one can expect lower O_3 values to increase while the higher O_3 values would be expected to decrease. NOx reductions are expected to result in a compressed O_3 distribution, relative to current conditions.

The formation of O_3 from precursor emissions is also affected by meteorological parameters such as the intensity of sunlight and atmospheric mixing. Major episodes of high ground-level O_3 concentrations in the eastern United States are associated with slow-moving high pressure systems. High pressure systems during the warmer seasons are associated with the sinking of air, resulting in warm, generally cloudless skies, with light winds. The sinking of air

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[40] 2013 ISA, section 3.2.2.

[41] 2013 ISA, section 3.2.1.

[42] 2013 ISA, sections 3.2 and 3.7.1.

results in the development of stable conditions near the surface which inhibit or reduce the vertical mixing of O_3 precursors. The combination of inhibited vertical mixing and light winds minimizes the dispersal of pollutants, allowing their concentrations to build up. In addition, in some parts of the United States (*e.g.*, in Los Angeles), mountain barriers limit mixing and result in a higher frequency and duration of days with elevated O_3 concentrations. Photochemical activity involving precursors is enhanced during warmer seasons because of the greater availability of sunlight and higher temperatures.[43]

3. Spatial and Temporal Patterns in Ambient O_3 Concentrations

3.1. Diurnal and Seasonal Patterns

Since O_3 formation is a photochemical process, it is not surprising that concentration levels have strong diurnal and seasonal patterns. Concentration levels tend to be highest at times when sunlight reaches its highest intensity, namely during the afternoon hours of the late spring and summer months. However, there are other factors at work, such as the influence of biogenic VOC emissions and stratospheric intrusions during the spring months, long-range transport, and traffic patterns which often cause peak NO_X emissions to occur during the morning and evening rush hours.

Figure A-2 shows the diurnal pattern in the hourly O_3 concentrations based on ambient monitoring data from 2000 to 2015. For each monitoring site, the median (top panel) and 95th percentile (bottom panel) values for each hour of the day were calculated, and each boxplot shows the range of those values for that particular hour across all monitoring sites. The whiskers of each boxplot extend to the 5th and 95th percentiles, the box represents the inter-quartile range, and the centerline represents the median value. The median and 95th percentile values show a consistent pattern in that O_3 levels tend to be lowest during the early AM hours, increasing rapidly after sunrise. Concentrations typically reach their peak during the afternoon hours, then decrease at a fairly constant rate throughout the evening and nighttime hours.

Figure A-3 shows the seasonal pattern in the daily maximum 8-hour O_3 concentrations based on ambient monitoring data from 2000 to 2015. For each monitoring site, the median (top panel) and 95th percentile (bottom panel) values for each month of the year were calculated, and each boxplot shows the range of those values for that particular month across all monitoring sites. The whiskers of each boxplot extend to the 5th and 95th percentiles, the box represents the inter-quartile range, and the centerline represents the median value. Again, the median and 95th percentile values show a consistent pattern in that O_3 levels tend to be highest during the spring and summer months (April to September), and lower during the fall and winter months (October to March).

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[43] 2013 ISA, section 3.2.

Figure A-2. Distribution of Median and 95th Percentile Hourly O_3 Concentrations by Hour of the Day based on 2000-2015 Monitoring Data

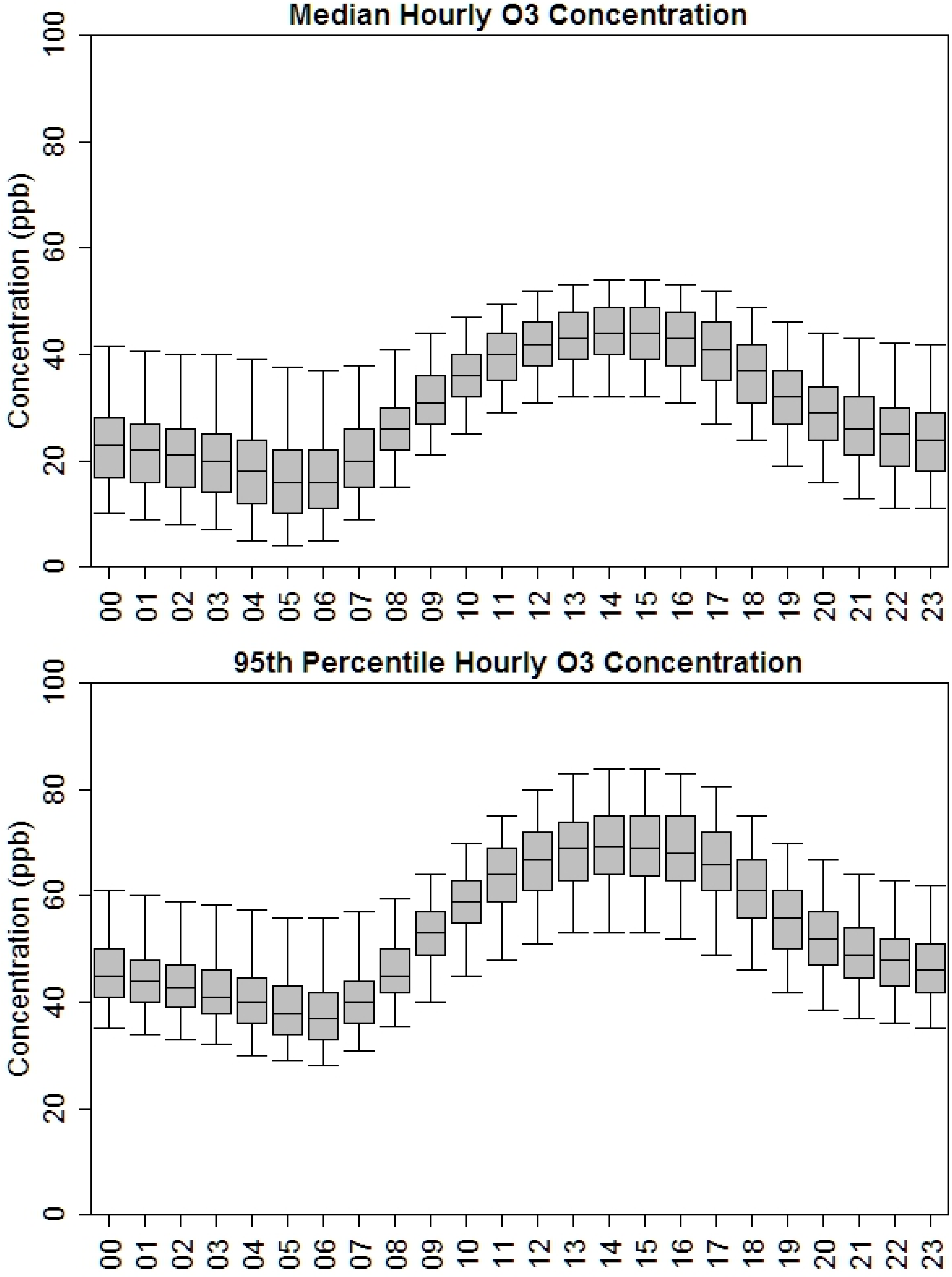
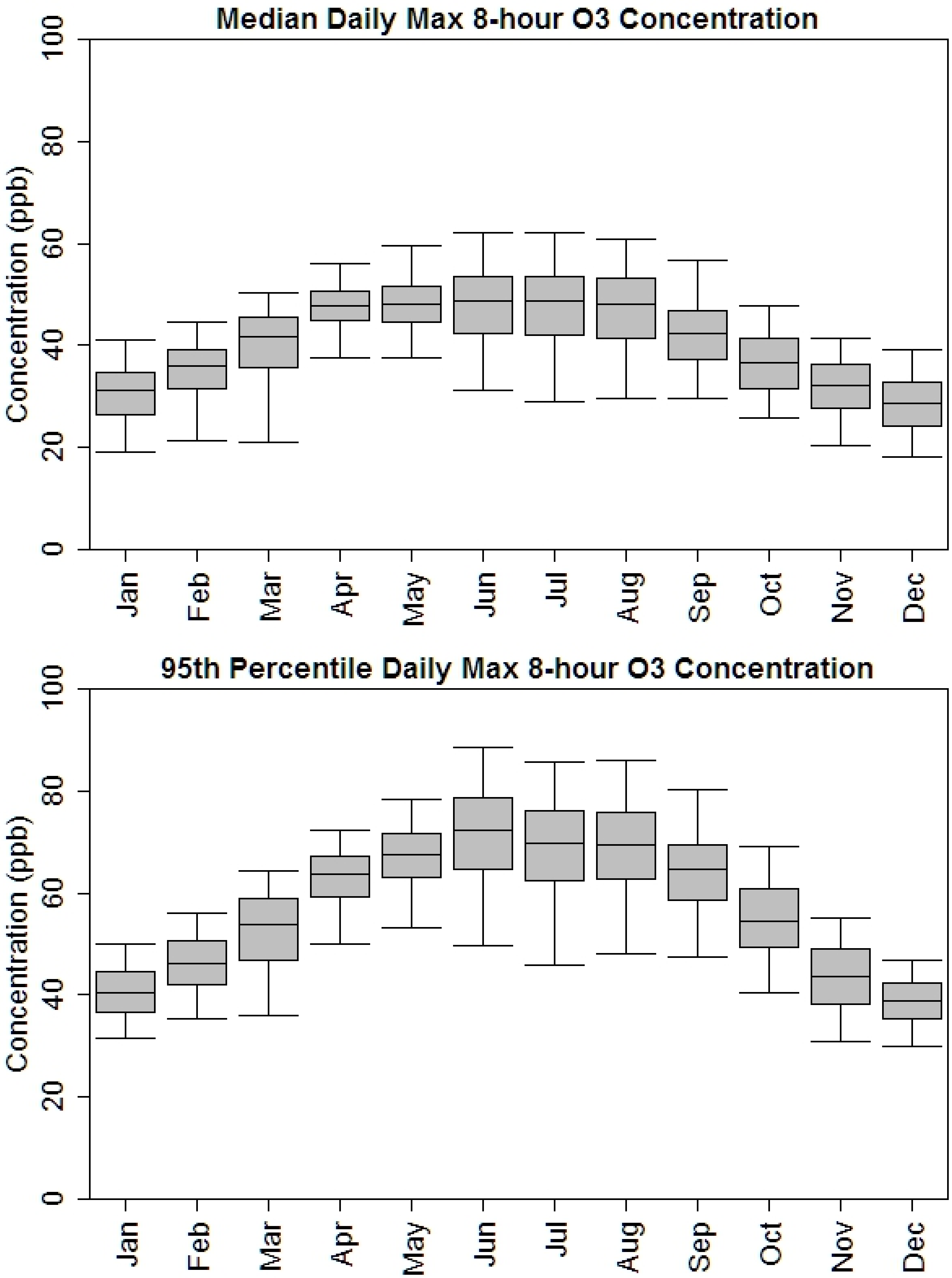


Figure A-3. Distribution of Median and 95th Percentile Daily Maximum 8-hour O_3 Concentrations by Month of the Year based on 2000-2015 Monitoring Data

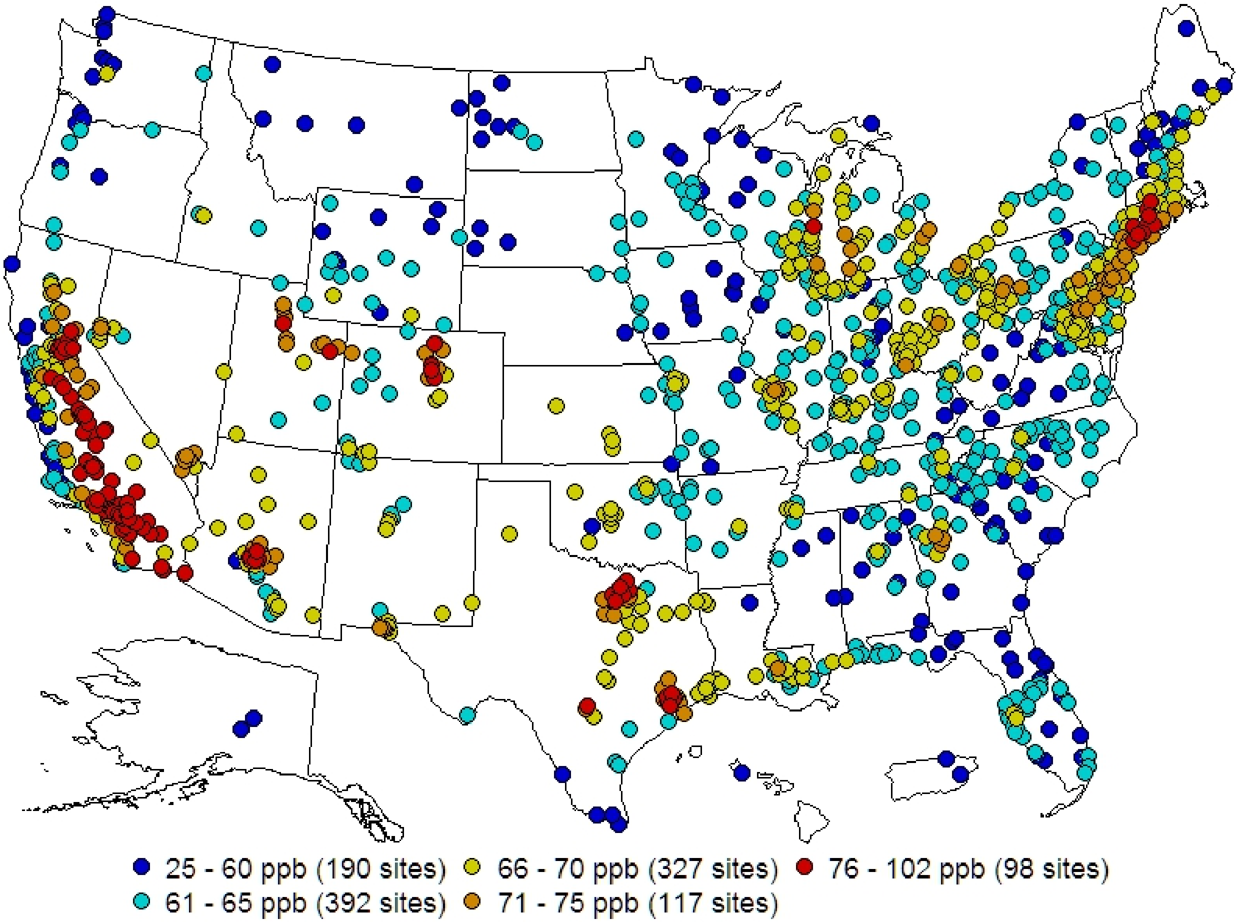


3.2. Spatial Patterns

To determine whether or not the O_3 NAAQS has been met at an ambient monitoring site, a statistic commonly referred to as a “design value” must be calculated based on three consecutive years of data collected from that site. The form of the O_3 NAAQS design value statistic is the 3-year average of the annual 4th highest daily maximum 8-hour O_3 concentration in parts per million (ppm). The O_3 NAAQS is met at an ambient monitoring site when the design value is less than or equal to 0.070 ppm. In counties or other geographic areas with multiple monitors, the area-wide design value is defined as the design value at the highest individual monitoring site, and the area is said to have met the NAAQS if all monitors in the area are meeting the NAAQS.

Figure A-4 shows a map of the O_3 design values in the U.S. based on data collected during the 2013-2015 period. The highest design values occur in California and near large metropolitan areas such as Dallas, Denver, Houston, New York City, and Phoenix. The lowest design values occur in the Pacific Northwest, the Northern Rockies, the Upper Midwest, and parts of New England and the Southeast. In general, sparsely populated areas tend to have lower design values than more urbanized areas.

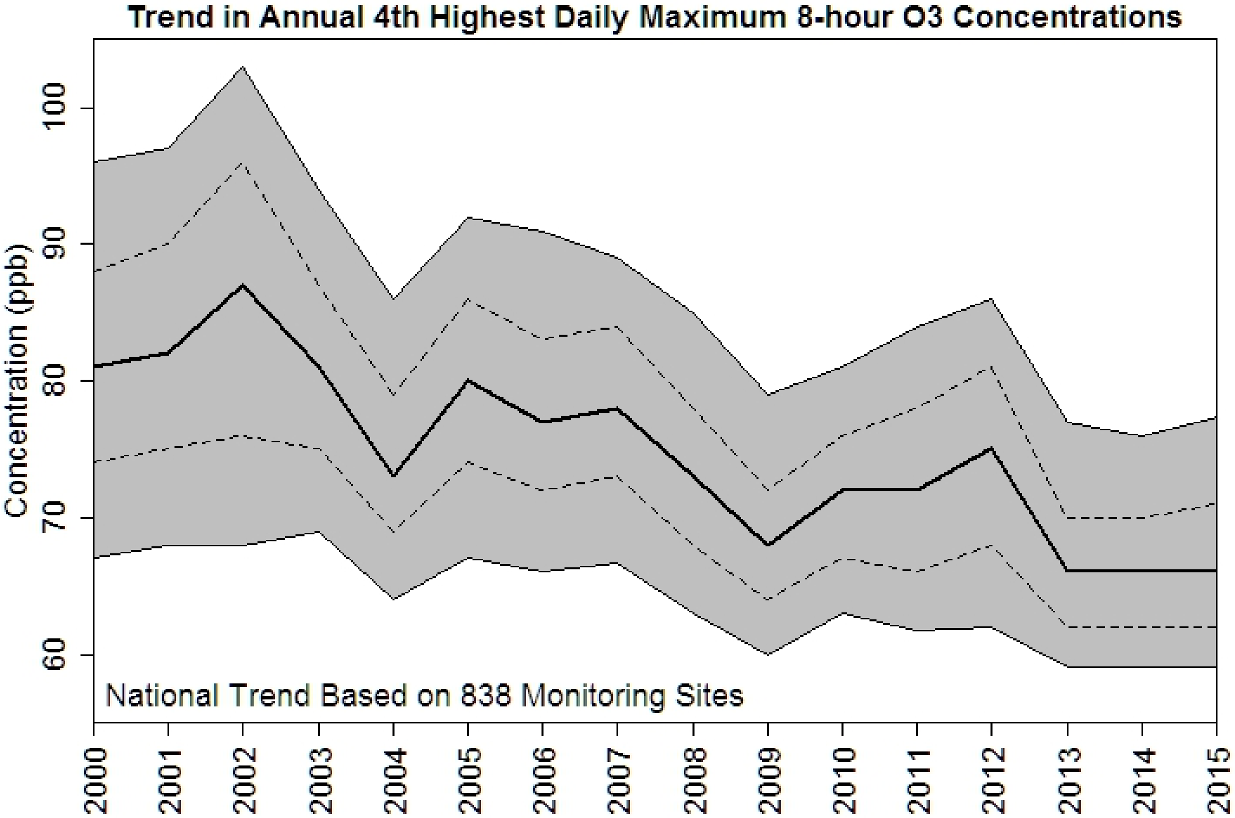
Figure A-4. Map of 2013-2015 O_3 Design Values in parts per billion (ppb)



3.3. Interannual Variability and Trends

Figure A-5 shows the national trend in the annual 4th highest daily maximum 8-hour O_3 concentration from 2000 to 2015. The solid black line represents the median value for each year based on 838 "trends" sites with complete monitoring records, the dashed lines represent the 25th and 75th percentile values for each year, and the shaded gray area covers the 10th percentile value up to the 90th percentile value for each year. While there is considerable year-to-year variability, overall the trend shows an improvement in O_3 air quality over the 15-year period. In fact, the median annual 4th highest value has decreased by 18% since the beginning of the century, and by 24% since 2002.

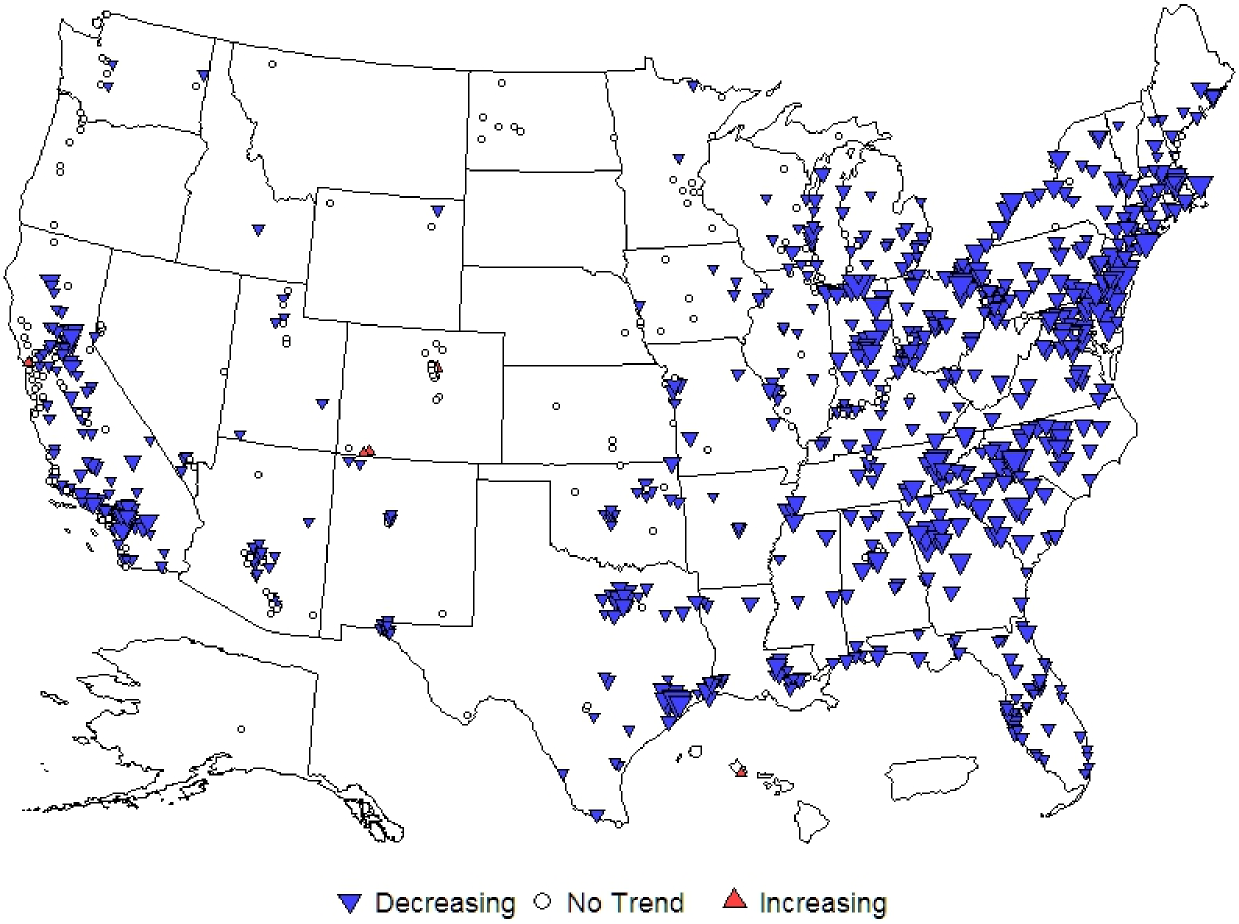
Figure A-5. National Trend in the Annual 4th Highest Daily Maximum 8-hour O_3 Concentration



Since the national trend is a simple aggregate of the site-level trends, it is also important to look at how these trends vary spatially. Figure A-6 shows a map of the trends at each monitoring site with at least 12 complete years of data from 2000-2015. The magnitude of the trend at each site is computed using the Theil-Sen slope estimator, and the Mann-Kendall statistic is calculated in order to test for statistical significance using a threshold of 0.05. The trend at each monitoring site is classified as Decreasing (p-value < 0.05, slope < 0; blue triangles), No Trend (p-value >= 0.05, white circles), or Increasing (p-value < 0.05, slope > 0; red triangles). The size of each triangle is proportional to the magnitude of the trend at each monitoring site.

Figure A-6 shows that O_3 levels have decreased across much of the eastern U.S. as a result of regional control programs such as the NOx SIP Call and the Clean Air Interstate Rule (CAIR). Large reductions have occurred near many urban areas where local control programs have been implemented in addition to the regional controls. In the western U.S., where control programs have been more localized, the reductions have occurred mostly in California and near large urban areas. In other areas most sites have not shown a significant trend, and there are only a handful of sites have shown an increasing trend.

Figure A-6. Map of site-level O_3 trends across the U.S. from 2000 to 2015



Variations in meteorological conditions play an important role in determining O_3 concentrations. Ozone is more readily formed on warm, sunny days when the air is stagnant. Conversely, O_3 generation is more limited when it is cool, rainy, cloudy, or windy. EPA uses a statistical model to adjust for the variability in seasonal average O_3 concentrations due to weather conditions to provide a more accurate assessment of the underlying trend in O_3 caused by emissions.[44] Figure A-7 shows the national trend in the May to September mean of the daily

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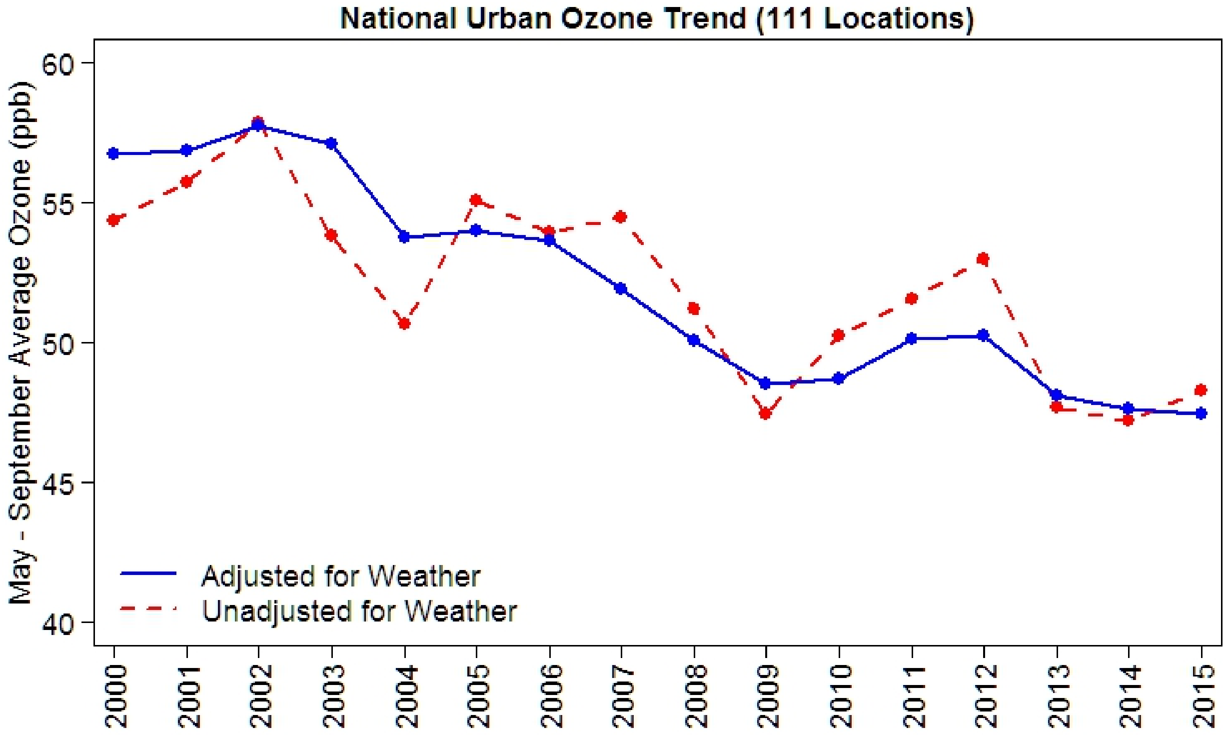
[44] Louise Camalier, William Cox, and Pat Dolwick (2007). The Effects of Meteorology on Ozone in Urban Areas and their use in Assessing Ozone Trends. Atmospheric Environment, Volume 41, Issue 33, October 2007, pages 7127-7137.

maximum 8-hour O_3 concentrations from 2000 to 2015 in 111 urban locations. The dotted red line shows the trend in observed O_3 concentrations at selected monitoring sites, while the solid blue line shows the underlying O_3 trend at those sites after removing the effects of weather. The solid blue lines represent O_3 levels anticipated under "typical" weather conditions and serve as a more accurate assessment of the trend in O_3 due to changes in precursor emissions.

Figure A-7 shows that after adjusting for the year-to-year variability in meteorology, the overall trend in seasonal average O_3 concentrations is much smoother. The adjusted trend clearly shows that the NOx SIP Call program resulted in a sharp decrease in summertime O_3 concentrations starting in 2004. The adjusted trend also indicates that O_3 levels decreased between 2004 and 2009, followed by a small increase from 2009 to 2012, then continued to decrease after 2012.

Figure A-7. Trend in the May to September mean of the daily maximum 8-hour O_3 concentration before (dotted red line) and after (solid blue line) adjusting for year-to-year variability in meteorology.



Conceptual Description of $PM_{2.5}$

1. $PM_{2.5}$ Monitoring Networks

1.1. PM Mass Networks

The 1997 promulgation of a fine particulate NAAQS led to deployment of over 1,500 $PM_{2.5}$ sites (about 1,000 currently in operation) used to determine whether an area complies with the standard. These sites use a Federal Reference Method (FRM) or Federal Equivalent Method (FEM), daily sampling over 24-hours, or every third or sixth day. Nearly 200 additional measurements not meeting FRM or FEM specifications are provided by the chemical speciation sites (Figure A-1). Approximately 450 stations provide indirect measurements of continuous FEM (hourly resolution) $PM_{2.5}$ mass.

1.2. Interagency Monitoring of Protected Visual Environments (IMPROVE) Program

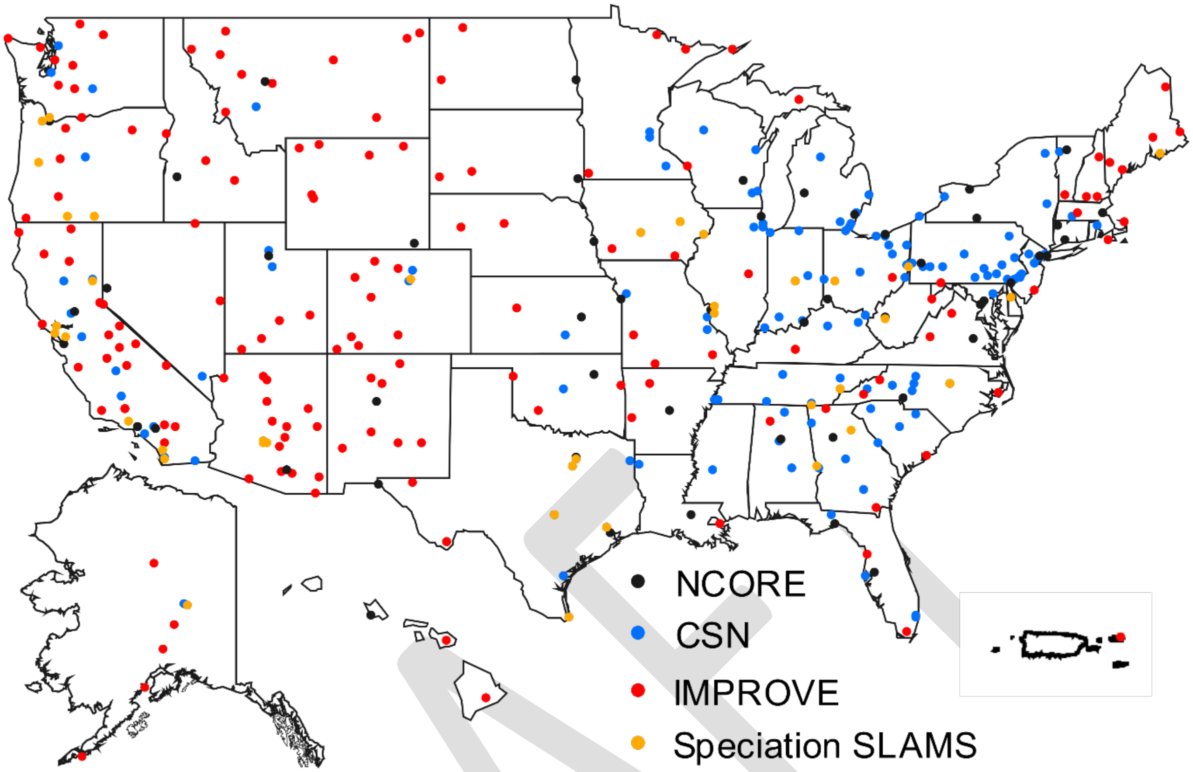
The IMPROVE network, with over 150 sites, has provided nearly a 20+ year record of major components of $PM_{2.5}$ (sulfate, nitrate, organic and elemental carbon fractions, and trace metals) in pristine areas of the United States (Figure A-8). IMPROVE is led by the National Park Service; various federal and state agencies support its operations. The primary focus of the network is to track visibility and trends in visibility.

1.3. $PM_{2.5}$ Chemical Speciation Monitoring

In addition to the IMPROVE network, approximately 200 EPA speciation sites operate in urban areas of the United States to assist $PM_{2.5}$ assessment efforts. No FRM exists for particulate speciation, which is not directly required to determine attainment, and there are slight differences between monitors and methods used in the Chemical Speciation Network (CSN). However, the network's coverage (Figure A-8) across urban and rural areas has proved essential for a wide range of research and analysis. The speciation networks typically collect a 24-hour sample every three, and sometimes six, days.

Only a handful of sites provide near continuous speciation data, usually limited to some combination of sulfate, carbon (organic and elemental splits) and nitrate. This enables insight to diurnal patterns for diagnosing various cause-effect phenomena related to emissions characterization, source attribution analysis and model evaluation.

Figure A-8. Locations of chemical speciation sites delineated by program type



2. Composition of $PM_{2.5}$

Particulate matter (PM) is a highly complex mixture of solid particles and liquid droplets distributed among numerous atmospheric gases which interact with solid and liquid phases. Particles range in size from those smaller than 1 nanometer (10^{-9} meter) to over 100 microns (1 micron is 10^{-6} meter) in diameter (for reference, a typical strand of human hair is 70 microns and particles less than about 20 microns generally are not detectable by the human eye). Particles are classified as $PM_{2.5}$ and $PM_{10-2.5}$, corresponding to their size (diameter) range in microns and referring to total particle mass under 2.5 and between 2.5 and 10 microns, respectively.

Particles span many sizes and shapes and consist of hundreds of different chemicals. Particles are emitted directly from sources and also are formed through atmospheric chemical reactions and often are referred to as primary and secondary particles, respectively. Particle pollution also varies by time of year and location and is affected by several aspects of weather such as temperature, clouds, humidity, and wind. Further complicating particles is the shifting between solid/liquid and gaseous phases influenced by concentration and meteorology, especially temperature.

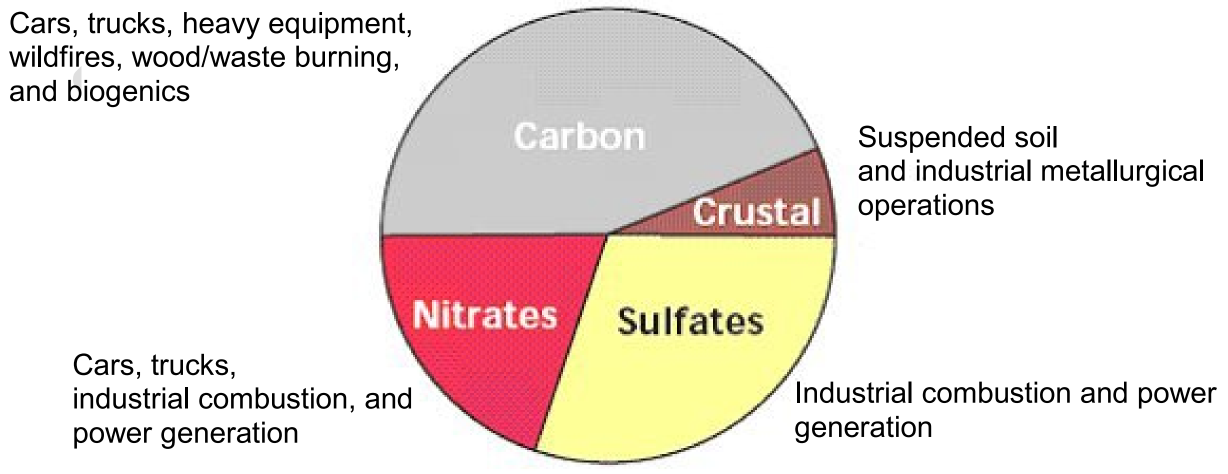
Particles are made up of different chemical components. The major components, or species, are carbon, sulfate and nitrate compounds, and crustal materials such as soil and ash (Figure A-9). The different components that make up particle pollution come from specific sources and are often formed in the atmosphere. Particulate matter includes both “primary” PM, which is directly emitted into the air, and “secondary” PM, which forms indirectly from fuel combustion and other sources. Primary PM consists of carbon (soot) emitted from cars, trucks, heavy equipment, forest fires, and burning waste and crustal material from unpaved roads, stone crushing, construction sites, and metallurgical operations. Secondary PM forms in the atmosphere from gases. Some of these reactions require sunlight and/or water vapor. Secondary PM includes:

- Sulfates formed from sulfur dioxide emissions from power plants and industrial facilities;
- Nitrates formed from nitrogen oxide emissions from cars, trucks, industrial facilities, and power plants; and
- Carbon formed from reactive organic gas emissions from cars, trucks, industrial facilities, forest fires, and biogenic sources such as trees.

In addition, ammonia from sources such as fertilizer and animal feed operations is part of the formation of sulfates and nitrates that exist in the atmosphere as ammonium sulfate and ammonium nitrate. Note that fine particles can be transported long distances by wind and weather and can be found in the air thousands of miles from where they were formed.

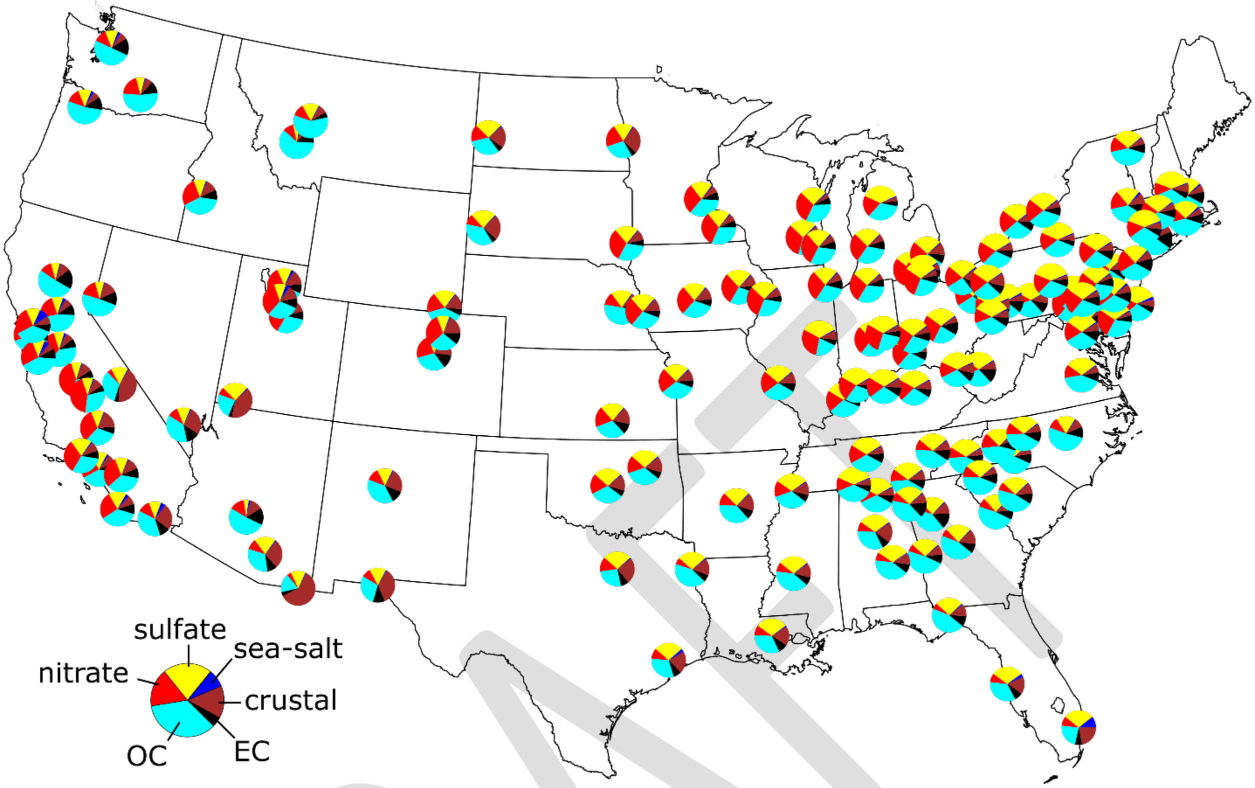
The chemical makeup of particles varies across the United States (as shown in Figure A-10). For example, fine particles in the eastern half of the United States contain more sulfates than those in the West, while fine particles in southern California contain more nitrates than other areas of the country. Organic carbon is a substantial component of fine particle mass everywhere.

Figure A-9. National Average of Source Impacts on Fine Particle Levels



Source: The Particulate Matter Report, EPA-454-R-04-002, Fall 2004. Carbon reflects both organic carbon and elemental carbon. Organic carbon accounts for automobiles, biogenics, gas-powered off-road, and wildfires. Elemental carbon is mainly from diesel powered sources.

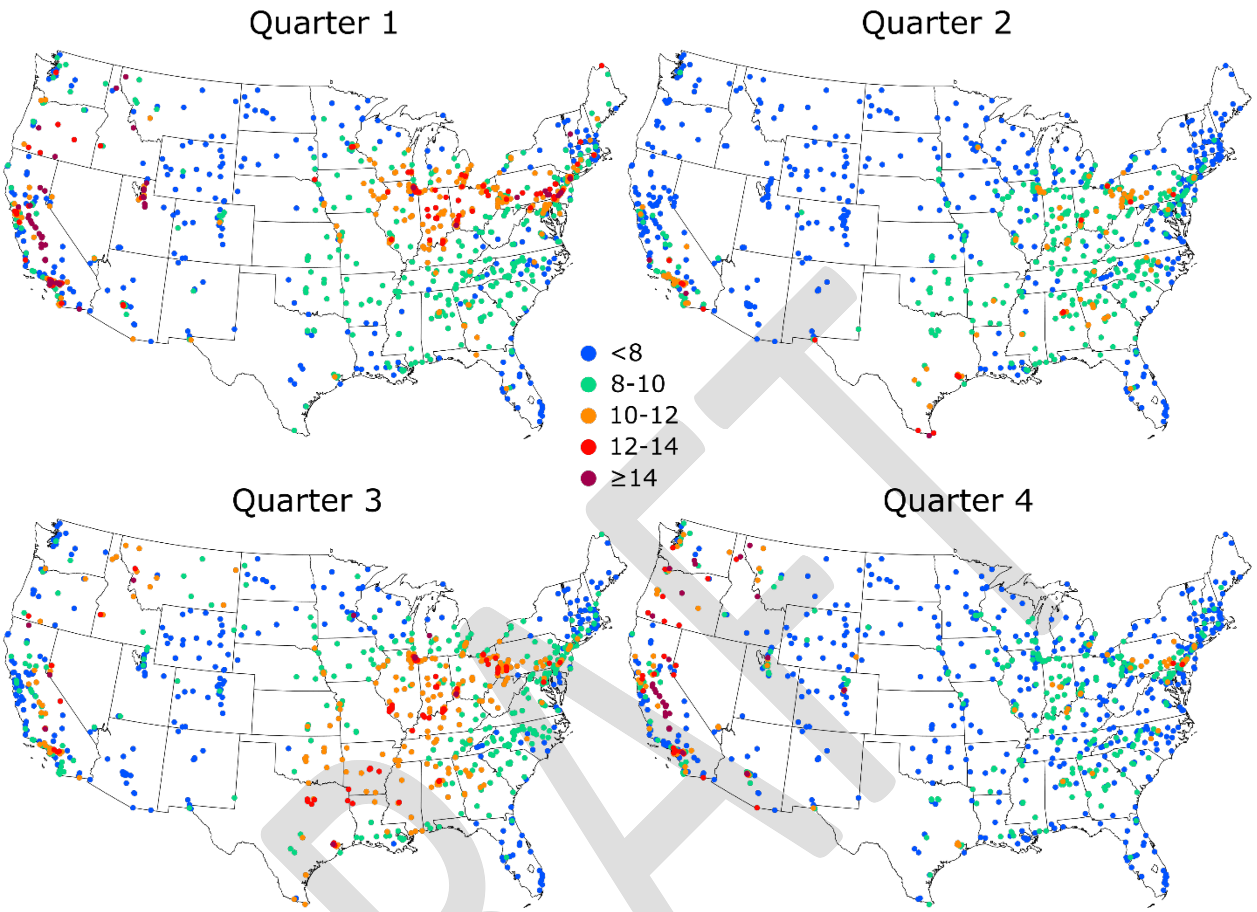
Figure A-10. Annual Average $PM_{2.5}$ Composition grouped by CBSA: 2013-2015



3. Seasonal and Daily Patterns of $PM_{2.5}$

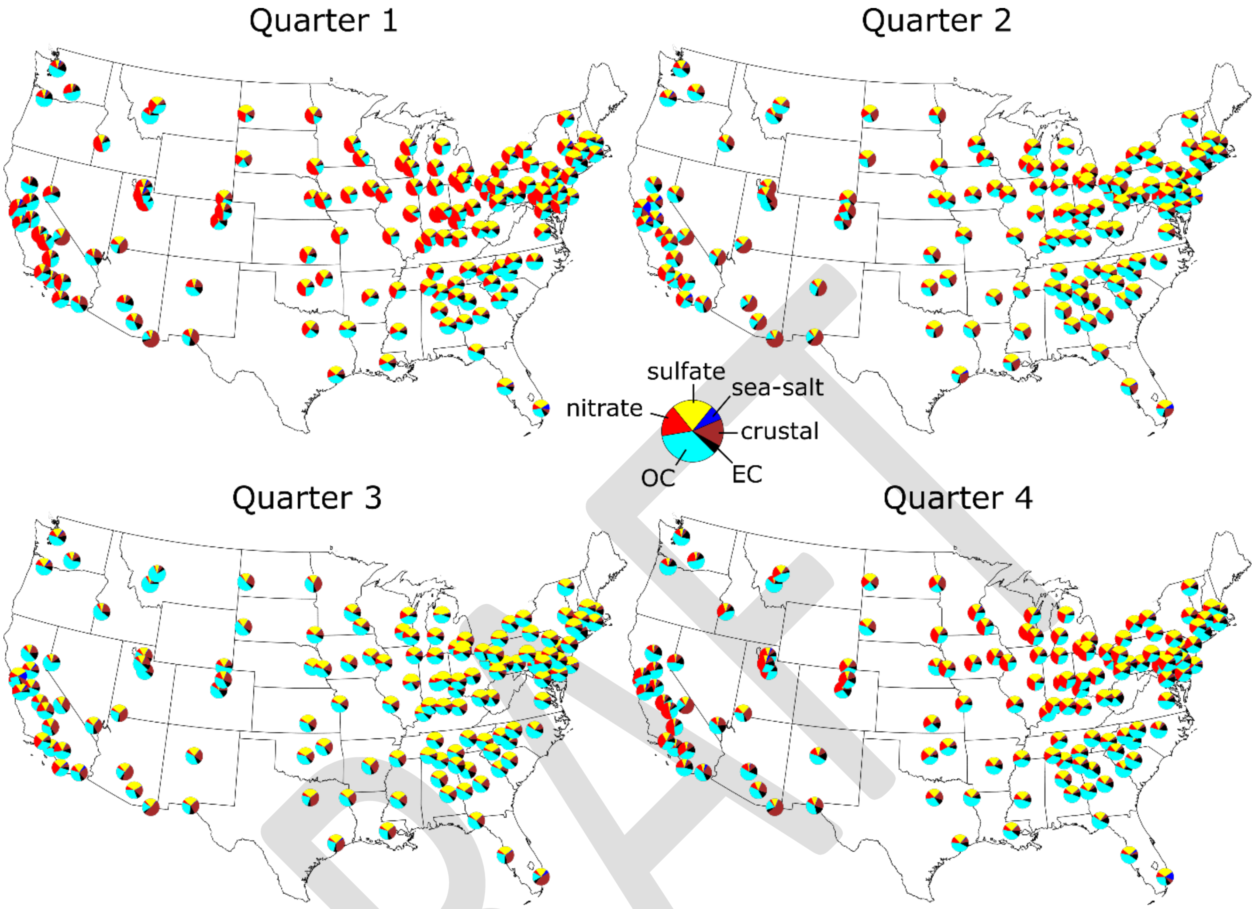
Fine particles often have a seasonal pattern. Both daily values and quarterly average of $PM_{2.5}$ also reveal patterns based on the time of year. Unlike daily O_3 levels, which are usually elevated in the summer, daily $PM_{2.5}$ values at some locations can be high at any time of the year. As shown in Figure A-11, $PM_{2.5}$ values in the eastern half of the United States are typically higher in the third calendar quarter (July-September) when sulfates are more readily formed from sulfur dioxide (SO_2) emissions from power plants in that region and when secondary organic aerosol is more readily formed in the atmosphere. Fine particle concentrations tend to be higher in the first calendar quarter (January through March) in the Midwest in part because fine particle nitrates are more readily formed in cooler weather. $PM_{2.5}$ values are high during the first (January through March) and fourth calendar quarter (October through December) in many areas of the West, in part because of fine particle nitrates and also due to carbonaceous particles which are directly emitted from wood stove and fireplace use. Average concentration from all locations reporting $PM_{2.5}$ with valid design values is shown.

Figure A-11. Quarterly Averages of $PM_{2.5}$ Concentration ($\mu g\ m^{-3}$): 2013-2015



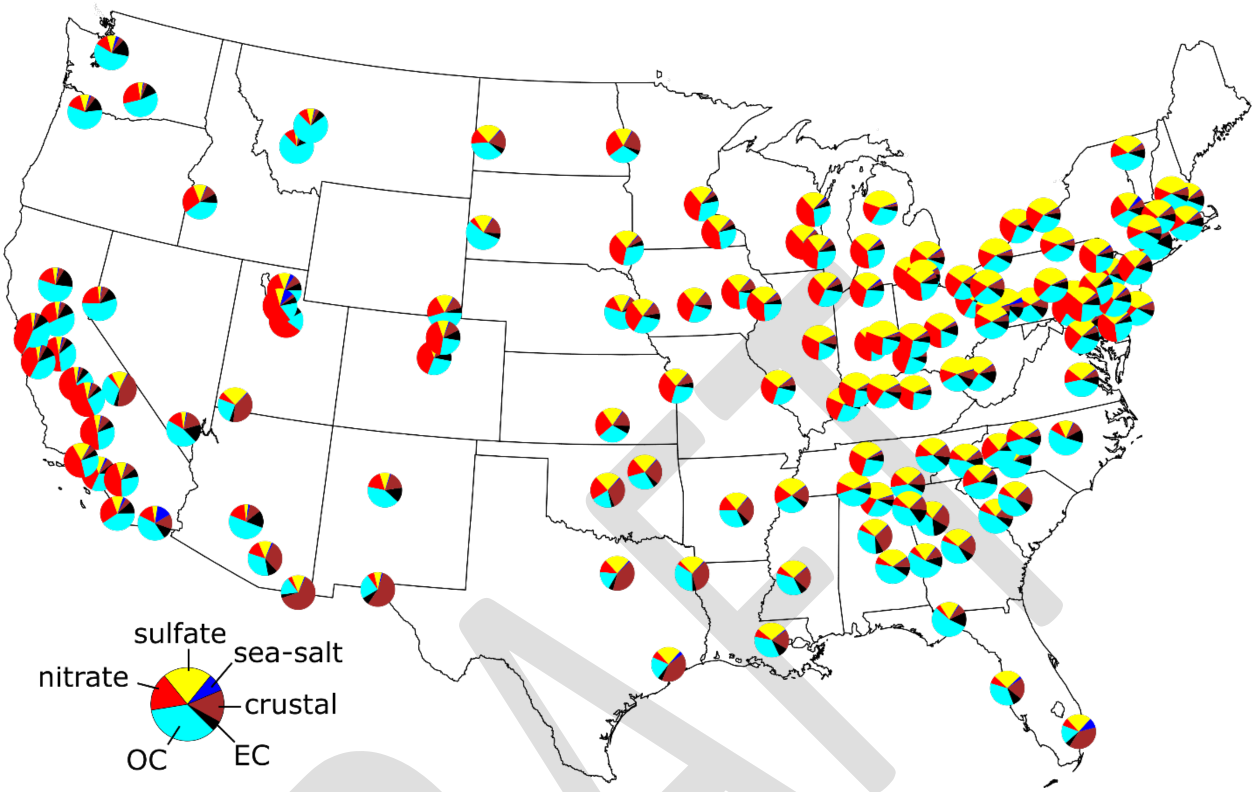
The composition of $PM_{2.5}$ also varies by season and helps explain why mass varies by season. Figure A-12 shows the average composition by season (spring, summer, fall and winter) for $PM_{2.5}$ data collected during 2013-2015. In the eastern United States, sulfate are high in the spring (March-May) and summer (July-September). Nitrates are most evident in the midwest and western cities where its percentage is moderately high in the winter and fall. Organic carbon (OC) is high throughout the year.

Figure A-12. Quarterly Average $PM_{2.5}$ Composition grouped by CBSA: 2013-2015



The composition of the highest daily $PM_{2.5}$ values may be different than that for the annual average. Figure A-13 provides 2013-2015 data $PM_{2.5}$ composition on high mass days across the United States. Mass is proportioned into six components: sulfates, nitrates, OC, elemental carbon (EC), crustal material, and sea-salt. Except for the southeast (where there is little nitrate in $PM_{2.5}$), nitrates are slightly higher in the top 10 percent of the $PM_{2.5}$ days. For the 2013-2015 measurements, the percent of sulfates is currently similar or slightly less on the top 10 percent of the days as compared to the annual averages. The portion of OC appears to be similar on the high days compared to the annual averages, except for the Northern Rockies and Upper Midwest where the high days are influenced by OC from wood stoves/fireplaces and wildfires.

Figure A-13. PM$_{2.5}$ Composition on 10% highest mass concentration days grouped by CBSA: 2013-2015



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Appendix B: General Guidance on Use of Dispersion Models for Estimating Primary $PM_{2.5}$ Concentrations

This appendix provides general guidance on the application of dispersion models for estimating ambient concentrations of $PM_{2.5}$ associated with direct emissions of primary $PM_{2.5}$. This guidance is based on and is consistent with the EPA's *Guideline on Air Quality Models*, published as Appendix W of 40 CFR part 51, and focuses primarily on the application of AERMOD, the EPA's preferred dispersion model for most situations. Appendix W is the primary source of information on the regulatory application of air quality models for State Implementation Plan (SIP) revisions for existing sources and for New Source Review (NSR) and Prevention of Significant Deterioration (PSD) programs. There will be applications of dispersion models unique to specific areas, (*i.e.*, there may be areas of the country where it is necessary to model unique specific sources or types of sources). In such cases, there should be consultation with the state or appropriate permitting authority with the appropriate EPA Regional Office modeling contact to discuss how best to model a particular source.

Recently issued EPA guidance of relevance for consideration in modeling for $PM_{2.5}$ includes:

- "Model Clearinghouse Review of Modeling Procedures for Demonstrating Compliance with $PM_{2.5}$ NAAQS" February 26, 2010 (U.S. EPA, 2010a);
- "Modeling Procedures for Demonstrating Compliance with $PM_{2.5}$ NAAQS" March 23, 2010 (U.S. EPA, 2010b); and
- "Transportation Conformity Guidance for Quantitative Hot-spot Analyses in $PM_{2.5}$ and PM_{10} Nonattainment and Maintenance Areas" November 2013 (U.S.EPA, 2013a).

The guidance listed above, in addition to other relevant support documents can be found on the SCRAM website at: https://www.epa.gov/scram.

The following sections will refer to the relevant sections of Appendix W and other existing guidance with summaries as necessary. Please refer to those original guidance documents for full discussion and consult with the appropriate EPA Regional Office modeling contact if questions arise about interpretation on modeling techniques and procedures.[45]

1. Model selection

Preferred air quality models for use in regulatory applications are addressed in Appendix A of the EPA's *Guideline on Air Quality Models*. If a model is to be used for a particular application, the user should follow the guidance on the preferred model for that application. These models may be used without an area specific formal demonstration of applicability as long as they are used as indicated in each model summary of Appendix A. Further recommendations for the application of these models to specific source problems are found in Appendix W. In

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[45] A list of EPA Regional Office modeling contacts is available on the SCRAM website at: https://www.epa.gov/scram/air-modeling-regional-contacts.

2005, the EPA promulgated the American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD) as the Agency's preferred near-field dispersion model for a wide range of regulatory applications in all types of terrain based on extensive developmental and performance evaluation. For PSD/NSR modeling under the $PM_{2.5}$ NAAQS, AERMOD should be used to model primary $PM_{2.5}$ emissions unless use of an alternative model can be justified (section 3.2, Appendix W).

The AERMOD modeling system includes the following components:

- AERMOD: the dispersion model (U.S. EPA, 2019a);
- AERMAP: the terrain processor for AERMOD (U.S. EPA, 2018,); and
- AERMET: the meteorological data processor for AERMOD (U.S. EPA, 2019b;).

Other components that may be used, depending on the application, are:

- BPIPPRIME: the building input processor (U.S. EPA, 2004);
- AERSURFACE: the surface characteristics processor for AERMET (U.S. EPA, 2008);
- AERSCREEN: a screening version of AERMOD (U.S. EPA, 2016a; U.S. EPA, 2011); and
- AERMINUTE: a pre-processor to calculate hourly average winds from ASOS 2-minute observations (U.S. EPA, 2015).

Before running AERMOD, the user should become familiar with the user's guides associated with the modeling components listed above and the AERMOD Implementation Guide (AIG) (U.S. EPA, 2019c). The AIG lists several recommendations for applications of AERMOD that would be applicable for SIP and PSD permit modeling.

1.2. Receptor grid

The model receptor grid is unique to the particular situation and depends on the size of the modeling domain, the number of modeled sources, and complexity of the terrain. Receptors should be placed in areas that are considered ambient air (*i.e.*, outside of buildings and where the public generally has access) and placed out to a distance such that areas of violation can be detected from the model output to help determine the size of nonattainment areas. Receptor placement should be of sufficient density to provide resolution needed to detect significant gradients in the concentrations with receptors placed closer together near the source to detect local gradients and placed farther apart away from the source. In addition, the user may want to place receptors at key locations such as around facility "fence lines"[46] (which define the ambient air boundary for a particular source) or monitor locations (for comparison to monitored

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[46] It should be noted that the term "fence line" for modeling purposes generally makes reference to a source's property boundary and may not refer literally to the existence of a fence at such boundary. The EPA's "ambient air" policy does not mandate that public access to a source's property be precluded by a fence; other measures that effectively preclude public access may be approved for establishing an ambient air exclusion for PSD modeling purposes.

concentrations for model evaluation purposes). The receptor network should cover the modeling domain. States may already have existing receptor placement strategies in place for regulatory dispersion modeling under NSR/PSD permit programs.

If modeling indicates elevated levels of $PM_{2.5}$ (near the standard) near the edge of the receptor grid, consideration should be given to expanding the grid or conducting an additional modeling run centered on the area of concern. As noted above, terrain complexity should also be considered when setting up the receptor grid. If complex terrain is included in the model calculations, AERMOD requires that receptor elevations be included in the model inputs. In those cases, the AERMAP terrain processor (U.S. EPA, 2018) should be used to generate the receptor elevations and hill heights. The latest version of AERMAP (version 09040 or later) can process either Digitized Elevation Model (DEM) or National Elevation Data (NED) data files. The AIG recommends the use of NED data since it is more up to date than DEM data, which is no longer updated (Section 4.3 of the AIG).

2. Source inputs

This section provides guidance on source characterization to develop appropriate inputs for dispersion modeling with the AERMOD modeling system. Section 2.1 provides guidance on use of emission, Section 2.2 covers guidance on Good Engineering Practice (GEP) stack heights, Section 2.3 provides details on source configuration and source types, Section 2.4 provides details on urban/rural determination of the sources, and Section 2.5 provides general guidance on source grouping, which may be important for design value calculations.

2.1. Emissions

Consistent with Appendix W, dispersion modeling for the purposes of PSD permitting should be based on the use of continuous operation at maximum allowable emissions or federally enforceable permit limits (see Table 8-2 of Appendix W) for the project source for all applicable averaging periods. Also consistent with past and current guidance, in the absence of maximum allowable emissions or federally enforceable permit limits, potential to emit emissions (*i.e.*, design capacity) should be used. Maximum allowable emissions and continuous operation should also be assumed for nearby sources included in the modeled inventory for the 24-hr $PM_{2.5}$ NAAQS, while maximum allowable emissions and the actual operating factor averaged over the most recent 2 years should be used for modeled nearby sources for the annual $PM_{2.5}$ NAAQS.

2.2. Good Engineering Practice (GEP) stack height

Consistent with previous modeling guidance and section 7.2.2.1 of Appendix W, for stacks with heights that are within the limits of Good Engineering Practice (GEP), actual heights should be used in modeling. Under the EPA's regulations at 40 CFR 51.100, GEP height, H_g, is determined to be the greater of:

- 65 m, measured from the ground-level elevation at the base of the stack;
- for stacks in existence on January 12, 1979, and for which the owner or operator had obtained all applicable permits or approvals required under 40 CFR parts 51 and 52

$$H_g=2.5H$$

provided the owner or operator produces evidence that this equation was actually relied on in designing the stack or establishing an emission limitation to ensure protection against downwash;

- for all other stacks,

$$H_g=H + 1.5L,$$

where H is the height of the nearby structure(s) measured from the ground-level elevation at the base of the stack and L is the lesser dimension of height or projected width of nearby structure(s); or

- the height demonstrated by a fluid model or a field study approved by the EPA or the state/local permitting agency which ensures that the emissions from a stack do not result in excessive concentrations of any air pollutant as a result of atmospheric downwash, wakes, eddy effects created by the source itself, nearby structures or nearby terrain features.

For more details about GEP, see the Guideline for Determination of Good Engineering Practice Stack Height Technical Support Document (U.S. EPA, 1985).

If stack heights exceed GEP, then GEP heights should be used with the individual stack's other parameters (temperature, diameter, exit velocity). For stacks modeled with actual heights below GEP that may be subject to building downwash influences, building downwash should be considered as this can impact concentrations near the source (section 7.2.2.1(b), Appendix W). If building downwash is being considered, the BPIPPRIME program (U.S. EPA, 2004) should be used to input building parameters for AERMOD.

2.3. Source configurations and source types

An accurate characterization of the modeled facilities is critical for refined dispersion modeling, including accurate stack parameters and physical plant layout. Accurate stack parameters should be determined for the emissions being modeled. Since modeling would be done with maximum allowable or potential emissions levels at each stack, the stack's parameters such as exit temperature, diameter, and exit velocity should reflect those emissions levels. Accurate locations (*i.e.*, latitude and longitude or Universal Transverse Mercator (UTM) coordinates and datum)[47] of the modeled emission sources are also important, as this can affect the impact of an emission source on receptors, determination of stack base elevation, and relative location to any nearby building structures. Not only are accurate stack locations needed, but accurate information for any nearby buildings is important. This information would include

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[47] Latitudes and longitudes to four decimal places position a stack within 30 feet of its actual location and five decimal places position a stack within three feet of its actual location. Users should use the greatest precision available.

location and orientation relative to stacks and building size parameters (height, and corner coordinates of tiers) as these parameters are input into BPIPPRIME to calculate building parameters for AERMOD. If stack locations and or building information are not accurate, downwash will not be accurately accounted for in AERMOD.

Emission source type characterization within the modeling environment is also important. As stated in the AERMOD User's Guide (U.S. EPA, 2019a), emissions sources can be characterized as several different source types: POINT sources, capped stacks (POINTCAP), horizontal stacks (POINTHOR), VOLUME sources, OPENPIT sources, LINE sources, buoyant lines sources (BUOYLINE), rectangular AREA sources, circular area sources (AREACIRC), and irregularly shaped area sources (AREAPOLY). While most sources can be characterized as POINT sources, some sources, such as fugitive releases or nonpoint sources (emissions from ports/ships, airports, or smaller point sources with no accurate locations), may be best characterized as VOLUME or AREA type sources. Sources such as flares can be modeled in AERMOD using the parameter input methodology described in Section 2.1.2 of the AERSCREEN User's Guide (U. S. EPA, 2016a). If questions arise about proper source characterization or typing, users should consult the appropriate EPA Regional Office modeling contact.

2.4. Urban/rural determination

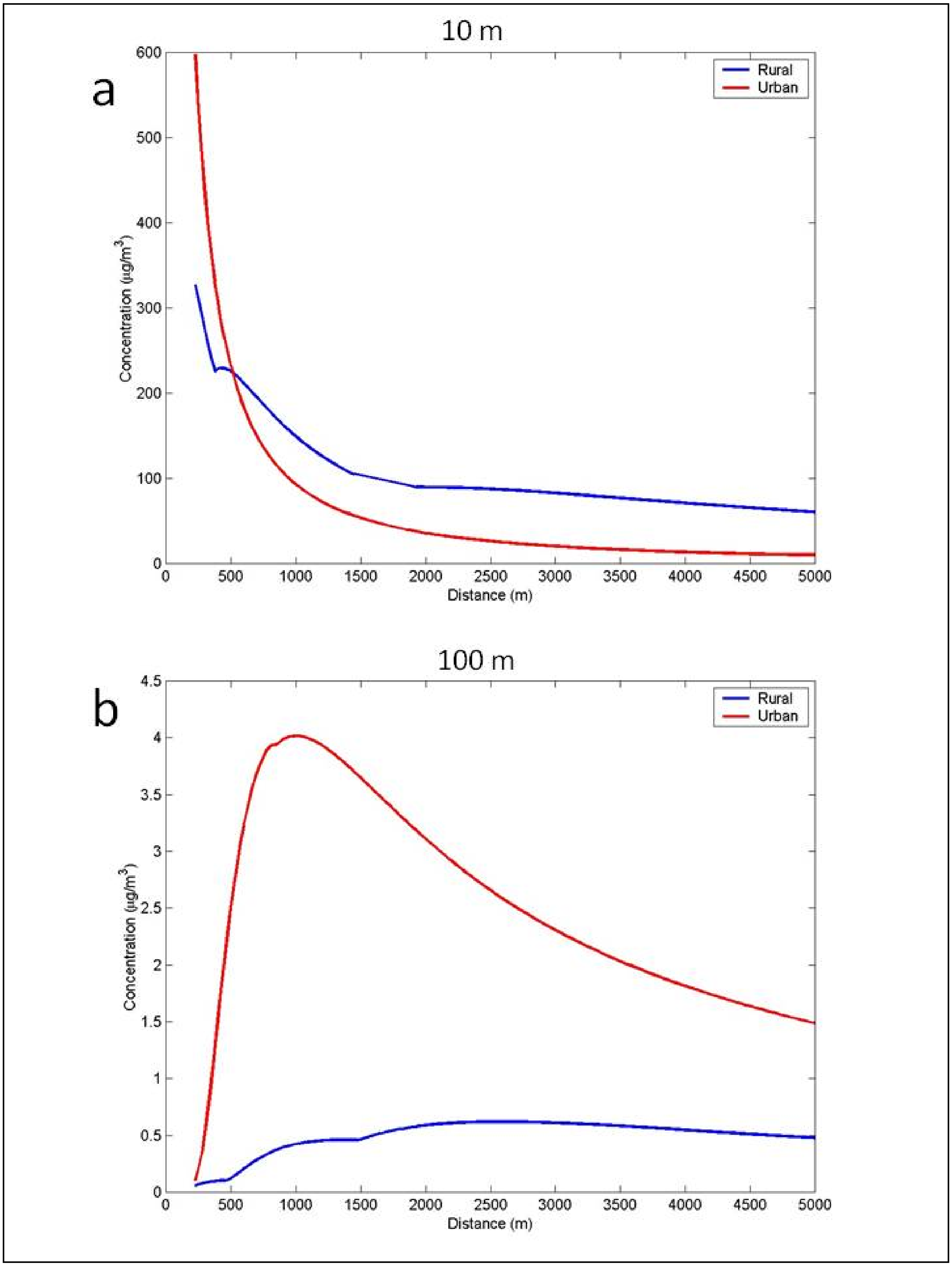
For any dispersion modeling exercise, the urban or rural determination of a source is important in determining the boundary layer characteristics that affect the model's prediction of downwind concentrations. Figure B-1 gives example maximum 24-hour concentration profiles for a 10 meter stack (Figure B-1a) and a 100 m stack (Figure B-1b) based on urban vs. rural designation. The urban population used for the examples is 100,000. In Figure B-1a, the urban concentration is much higher than the rural concentration for distances less than 750 m from the stack but then drops below the rural concentration beyond 750 m. For the taller stack in Figure B-1b, the urban concentration is much higher than the rural concentration even as distances increase from the source. These profiles show that the urban or rural designation of a source can be quite important.

Determining whether a source is urban or rural can be done using the methodology outlined in section 7.2.1.1 of Appendix W and recommendations outlined in Sections 5.1 through 5.3 in the AIG (U.S. EPA, 2019c). In summary, there are two methods of urban/rural classification described in section 7.2.3 of Appendix W.

The first method of urban determination is a land use method (Appendix W, section 7.2.2.1.1(b)(i)). In the land use method, the user analyzes the land use within a 3 km radius of the source using the meteorological land use scheme described by Auer (1978). Using this methodology, a source is considered urban if the land use types I1 (heavy industrial), I2 (light-moderate industrial), C1 (commercial), R2 (common residential), and R3 (compact residential) are 50 percent or more of the area within the 3 km radius circle. Otherwise, the source is considered a rural source. The second method uses population density and is described in section 7.2.2.1.1(b)(ii) of Appendix W. As with the land use method, a circle of 3 km radius is used. If the population density within the circle is greater than 750 people/km^2, then the source is considered urban. Otherwise, the source is modeled as a rural source. Of the two methods, the land use method is considered more definitive (section 7.2.1.1.b, Appendix W).

Caution should be exercised with either classification method. As stated in Section 5.1 of the AIG (U.S. EPA, 2009), when using the land use method, a source may be in an urban area but located close enough to a body of water or other non-urban land use category to result in an erroneous rural classification for the source. The AIG in Section 5.1 cautions users against using the land use scheme on a source by source basis, but advises considering the potential for urban heat island influences across the full modeling domain. When using the population density method, section 7.2.2.1.1(b)(ii)of Appendix W states, "Population density should be used with caution and should not be applied to highly industrialized areas where the population density may be low and thus a rural classification would be indicated, but the area is sufficiently built-up so that the urban land use criteria would be satisfied..." With either method, section 7.2.1.1(f) of Appendix W recommends modeling all sources within an urban complex as urban, even if some sources within the complex would be considered rural using either the land use or population density method.

Figure B-1. Urban (red) and rural (blue) concentration profiles for (a) 10 m buoyant stack release, and (b) 100 m buoyant stack release



Another consideration that may need attention by the user, and is discussed in Section 5.1 of the AIG, relates to tall stacks located within or adjacent to small to moderate size urban areas. In such cases, the stack height or effective plume height for very buoyant sources may extend above the urban boundary layer height. The application of the urban option in AERMOD for these types of sources may artificially limit the plume height. The use of the urban option may not be appropriate for these sources, since the actual plume is likely to be transported over the urban boundary layer. Section 5.1 of the AIG gives details on determining if a tall stack should be modeled as urban or rural based on comparing the stack or effective plume height to the urban boundary layer height. The 100 m stack illustrated in Figure B-1b, may be such an example as the urban boundary layer height for this stack would be 189 m (based on a population of 100,000) and equation 104 of the AERMOD formulation document (Cimorelli, et al., 2004). This equation is:

$$z_{iuc} = z_{iuo}\left(\frac{P}{P_o}\right)^{1/4} \tag{B-1}$$

where z_{iuo} is a reference height of 400 m corresponding to a reference population P_o of 2,000,000 people.

Given that the stack is a buoyant release, the plume may extend above the urban boundary layer and may be best characterized as a rural source, even if it were near an urban complex. However, beginning with version 15181 of AERMOD, a formulation bug fix was incorporated that modified the treatment of plume rise for urban sources, especially for tall stacks in urban areas. See Section 5.1 of the AIG for more information. Even with the bug fix in AERMOD 15181, exclusion of these elevated sources from application of the urban option would need to be justified on a case-by-case basis in consultation with the appropriate permitting authority.

AERMOD requires the input of urban population when utilizing the urban option. Population can be entered to one or two significant digits (*i.e.*, an urban population of 1,674,365 can be entered as 1,700,000). Users can enter multiple urban areas and populations using the URBANOPT keyword in the runstream file (U.S. EPA, 2019a). If multiple urban areas are entered, AERMOD requires that each urban source be associated with a particular urban area or AERMOD model calculations will abort. Urban populations can be determined by using a method described in Section 5.2 of the AIG (U.S. EPA, 2019c).

2.5. Source groups

In AERMOD, individual emission sources' concentration results can be combined into groups using the SRCGROUP keyword (Section 3.3.11 of the AERMOD User's Guide (U.S, EPA, 2019a). The user can automatically calculate a total concentration (from all sources) using the SRCGROUP ALL keyword. For the purposes of design value calculations, source group ALL should be used, especially if all sources in the modeling domain are modeled in one AERMOD run. Design values should be calculated from the total concentrations (all sources and background). Individual source impacts on the total concentration may be necessary to determine the culpability to any NAAQS violations.

3. Meteorological data

This section gives guidance on the selection of meteorological data for input into AERMOD. Much of the guidance from section 8.4 of Appendix W is applicable to SIP and PSD permit modeling and is summarized here. In Section 3.2.1, the use of the tool, AERMINUTE (U.S. EPA, 2015), is introduced. AERMINUTE is an AERMET pre-processor that calculates hourly averaged winds from ASOS (Automated Surface Observing System) 1-minute winds. Section 3.2.4 discusses the use of prognostic meteorological data.

3.1. Surface characteristics and representativeness

The selection of meteorological data that are input into a dispersion model should be considered carefully. The selection of data should be based on spatial and climatological (temporal) representativeness (Appendix W, section 8.4). The representativeness of the data is based on: 1) the proximity of the meteorological monitoring site to the area under consideration, 2) the complexity of terrain, 3) the exposure of the meteorological site, and 4) the period of time during which data are collected. Sources of meteorological data are: National Weather Service (NWS) stations, site-specific or onsite data, and other sources such as universities, Federal Aviation Administration (FAA), military stations, and others. In specific cases, prognostic meteorological data may be appropriate for use and obtained from similar sources. Appendix W addresses spatial representativeness issues in sections 8.4.1.a and 8.4.2.b.

Spatial representativeness of the meteorological data can be adversely affected by large distances between the source and receptors of interest and the complex topographic characteristics of the area (Appendix W, sections 8.4.1.a and 8.4.2.b). If the modeling domain is large enough such that conditions vary drastically across the domain, then the selection of a single station to represent the domain should be carefully considered. Also, care should be taken when selecting a station if the area has complex terrain. While a source and meteorological station may be in close proximity, there may be complex terrain between them such that conditions at the meteorological station may not be representative of the source. An example would be a source located on the windward side of a mountain chain with a meteorological station a few kilometers away on the leeward side of the mountain. Spatial representativeness for off-site data should also be assessed by comparing the surface characteristics (albedo, Bowen ratio, and surface roughness) of the meteorological monitoring site and the analysis area. When processing meteorological data in AERMET (U.S. EPA, 2016c), the surface characteristics of the meteorological site or the prognostic meteorological model output grid cell should be used (section 8.4.2.b of Appendix W and the AERSURFACE User's Guide (U.S. EPA 2008)). Spatial representativeness should also be addressed for each meteorological variable separately. For example, temperature data from a meteorological station several kilometers from the analysis area may be considered adequately representative, while it may be necessary to collect wind data near the plume height (section 8.4.2.b of Appendix W).

Surface characteristics can be calculated in several ways. For details, see Section 3.1.2 of the AIG (U.S. EPA, 2019c). The EPA has developed a tool, AERSURFACE (U.S. EPA, 2008) to aid in the determination of surface characteristics for observed meteorological data. The current version of AERSURFACE uses the 1992 National Land Cover Data. Note that the use of

AERSURFACE is not a regulatory requirement, but the methodology outlined in Section 3.1.2 of the AIG should be followed unless an alternative method can be justified. For prognostic meteorological output, the surface characteristics of the representative grid cell should be used.

3.2. Meteorological inputs

Appendix W states in section 8.4.2.e that the user should acquire enough meteorological data to ensure that worst-case conditions are adequately represented in the model results. Appendix W states that 5 years of NWS meteorological data, at least 1 year of site-specific data, or at least 3 years of prognostic data should be used and should be adequately representative of the study area. If 1 or more years of site-specific data are available, those data are preferred. While the form of the $PM_{2.5}$ NAAQS contemplates obtaining 3 years of monitoring data, this does not preempt the use of 5 years of NWS data or at least 1 year of site-specific data in the modeling. The 5-year average based on the use of NWS data, an average across 3 or more years of prognostic data, or an average across 1 or more years of available site specific data, serves as an unbiased estimate of the 3-year average for purposes of modeling demonstrations of compliance with the NAAQS.

3.2.1. NWS data

NWS data are available from the National Climatic Data Center (NCDC) in many formats, with the most common one in recent years being the Integrated Surface Hourly data (ISH). Most available formats can be processed by AERMET. As stated in Section 3.1, when using data from an NWS station alone or in conjunction with site-specific data, the data should be spatially and temporally representative of conditions at the modeled sources. Key points regarding the use of NWS data can be found in the EPA's March 8, 2013 clarification memo "Use of ASOS meteorological data in AERMOD dispersion modeling" (U.S. EPA, 2013b). The key points are:

- The EPA has previously analyzed the effects of ASOS implementation on dispersion modeling and found that generally AERMOD was less sensitive than ISCST3 to the implementation of ASOS.
- The implementation of the ASOS system over the conventional observation system should not preclude the consideration of NWS stations in dispersion modeling.
- The EPA has implemented an adjustment factor (0.5 knots) in AERMET to adjust for wind speed truncation in ASOS winds
- The EPA has developed the AERMINUTE processor (U.S. EPA, 2015) to process 2-minute ASOS winds and calculate an hourly average for input into AERMET. The use of hourly averaged winds better reflect actual conditions over the hour as opposed to a single 2-minute observation.

3.2.2. Site-specific data

The use of site-specific meteorological data is the best way to achieve spatial representativeness. AERMET can process a variety of formats and variables for site-specific data. The use of site-specific data for regulatory applications is discussed in detail in section 8.4.4 of Appendix W. Due to the range of data that can be collected onsite and the range of formats of data input to AERMET, the user should consult Appendix W, the AERMET User's Guide (U.S. EPA, 2016c), and Meteorological Monitoring Guidance for Regulatory Modeling Applications (U.S. EPA, 2000). Also, when processing site-specific data for an urban application, Section 3.3 of the AERMOD Implementation Guide offers recommendations for data processing. In summary, the guide recommends that site-specific turbulence measurements should not be used when applying AERMOD's urban option in order to avoid double counting the effects of enhanced turbulence due to the urban heat island.

3.2.3. Upper air data

AERMET requires full upper air soundings to calculate the convective mixing height. For AERMOD applications in the U.S., the early morning sounding, usually the 1200 UTC (Universal Time Coordinate) sounding, is typically used for this purpose. Upper air soundings can be obtained from the Radiosonde Data of North America CD for the period 1946-1997. Upper air soundings for 1994 through the present are also available for free download from the Radiosonde Database Access website. Users should choose all levels or mandatory and significant pressure levels[48] when selecting upper air data. Selecting mandatory levels only would not be adequate for input into AERMET as the use of just mandatory levels would not provide an adequate characterization of the potential temperature profile.

3.2.3. Prognostic data

In specific situations where it is infeasible or cost prohibitive to collect adequately representative site-specific data or there is not a representative NWS or comparable meteorological station available, it may be appropriate to use prognostic meteorological data, if deemed adequately representative. However, if prognostic data are not representative of the transport and dispersion conditions in the area of concern, the collection of site-specific data is necessary (section 8.4.5.1 of Appendix W). To facilitate the use of prognostic meteorological data, EPA has developed a processor, Mesoscale Model Interface Program, MMIF (Environ, 2015), to process MM5 (Mesoscale Model 5) or WRF (Weather Research Forecast) model data for input to various models including AERMOD. MMIF can process data for input to AERMET or AERMOD for a single grid cell or multiple grid cells. For regulatory applications, MMIF should be run to create inputs for AERMET input as described in section 8.4.5.1.b of Appendix W and MMIF guidance (U.S. EPA, 2016b). Specific guidance on running MMIF for AERMOD applications can be found in U.S. EPA, 2016b.

4. Running AERMOD and implications for design value calculations

Recent enhancements to AERMOD include options to aid in the calculation of design

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[48] By international convention, mandatory levels are in millibars: 1,000, 850, 700, 500, 400, 300, 200, 150, 100, 50, 30, 20, 10, 7 5, 3, 2, and 1. Significant levels may vary depending on the meteorological conditions at the upper-air station.

values for comparison with the $PM_{2.5}$ NAAQS and to aid in determining whether emissions from the project source caused or contributed to any modeled violations. These enhancements include:

- The MAXDCONT option, which shows the impact of each user-specified source group to the high ranked values for a specified target source group paired in time and space. The user can specify a range of ranks to analyze or specify an upper bound rank, *i.e.*, 8th highest, corresponding to the 98th percentile for the 24-hour $PM_{2.5}$ NAAQS, and a lower threshold concentration value, such as the NAAQS for the target source group. The model will process each rank within the range specified, but will stop after the first rank (in descending order of concentration) that is below the threshold value if specified by the user. A warning message will be generated if the threshold is not reached within the range of ranks analyzed (based on the range of ranks specified on the RECTABLE keyword). This option may be needed to aid in determining which sources should be considered for controls.

For more details about the enhancements, see the AERMOD User's Guide (U. S. EPA, 2019a).

Ideally, all explicitly modeled sources, receptors, and background should be modeled in one AERMOD run for all modeled years. In this case, one of the above output options can be used in AERMOD to calculate design values for comparison to the NAAQS and determine the area's attainment status and/or inform attainment/nonattainment boundaries. The use of these options in AERMOD allows AERMOD to internally calculate concentration metrics that can be used to calculate design values and, therefore, lessen the need for large output files, *i.e.*, hourly POSTFILES.

However, there may be situations where a single AERMOD run with all explicitly modeled sources is not possible. These situations often arise due to runtime or storage space considerations during the AERMOD modeling. Sometimes separate AERMOD runs are done for each facility or group of facilities, or by year, or the receptor network is divided into separate sub-networks. In some types of these situations, the MAXDCONT output option may not be an option for design value calculations, especially if all sources are not included in a single run. If the user wishes to utilize one of the three output options, then care should be taken in developing the model inputs to ensure accurate design value calculations.

Situations that would effectively preclude the use of the MAXDCONT option to calculate meaningful AERMOD design value calculations include the following examples:

- Separate AERMOD runs for each source or groups of sources.
  - SIP modeling includes 10 facilities for 5 years of NWS data and each facility is modeled for 5 years in a separate AERMOD run, resulting in ten separate AERMOD runs.
- Separate AERMOD runs for each source and each modeled year.
  - 10 facilities are modeled for 5 years of NWS data. Each facility is modeled separately for each year, resulting in fifty individual AERMOD runs.

In the two situations listed above, the MAXDCONT option would not be useful as the different AERMOD runs do not include a total concentration with impacts from all facilities. In these situations, the use of 24-hour POSTFILES, which can be quite large, and external post-processing would be needed to calculate design values.

Situations in which the MAXDCONT options may be used but may necessitate some external post-processing afterwards to calculate a design value include:

- The receptor network is divided into sections and an AERMOD run, with all sources and years, is made for each sub-network.
    - A receptor network of 1,000 receptors is divided into four 250 receptor sub-networks. 10 facilities are modeled with 5 years of NWS data in one AERMOD run for each receptor network, resulting in four AERMOD runs. After the AERMOD runs are complete, the MAXDCONT results for each network can be re-combined into the larger network.
- All sources and receptors are modeled in an AERMOD run for each year.
- Ten facilities are modeled with 5 years of NWS data. All facilities are modeled with all receptors for each year individually, resulting in five AERMOD runs. MAXDCONT output can be used and post-processed to generate the necessary design value concentrations. The receptor network is divided and each year is modeled separately for each sub-network with all sources.
- Ten facilities are modeled with 5 years of NWS data for 1,000 receptors. The receptor network is divided into four 250 receptor networks. For each sub-network, all ten facilities are modeled for each year separately, resulting in twenty AERMOD runs. MAXDCONT output can be used and post-processed to generate the necessary design value concentrations.

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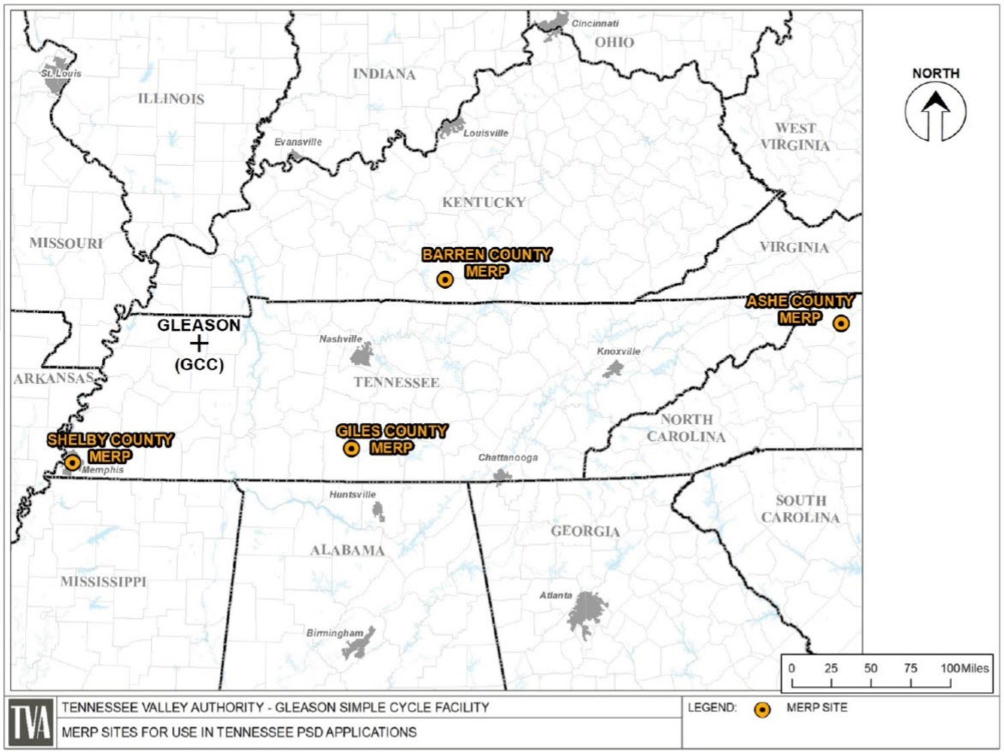
Appendix C: Example of a Tier 1 Demonstration of the Potential for O_3 and Secondary $PM_{2.5}$ Formation

In 2018, a permit applicant, the Tennessee Valley Authority (TVA) Gleason Combustion Turbine Plant, worked closely with the Tennessee Department of Environment and Conservation (TDEC) and EPA Region 4 to develop a compliance demonstration for a major facility modification, including the use of a Tier 1 assessment of O_3 and secondary $PM_{2.5}$ impacts. This Tier 1 assessment was based on the application of Modeled Emission Rates for Precursors (MERPs) and related modeling guidance released by the EPA. In April 2018, the TDEC published state modeling guidance that can be used by PSD applicants in Tennessee that largely restated the technical aspects of the guidance presented in the EPA's 2016 Draft MERPs Guidance.[49] In support of the 2016 Draft MERPs Guidance, the EPA performed photochemical modeling for four hypothetical sources from within Tennessee or in close proximity to Tennessee (Shelby County, TN, Giles County, TN, Barren County, KY and Ashe County, NC), that can be used to represent the O_3 and secondary $PM_{2.5}$ pollutant formation from other large sources in Tennessee (Figure 1).

FIGURE 1



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[49] The EPA released a draft version of the "Guidance on the Development of Modeled Emission Rates for Precursors (MERPs) as a Tier 1 Demonstration Tool for Ozone and $PM_{2.5}$ under the PSD Permitting Program" on December 2, 2016, for public review and comment. Based on the feedback gained from this draft, the EPA released a non-draft or final version of the "MERPs Guidance" on April 30, 2019. The information in the 2016 draft MERPs Guidance from which the TDEC based their April 2018 modeling guidance did not substantively change and is representative of information contained in the current 2019 final version of the MERPs Guidance. The 2019 final MERPs Guidance is available at: https://www3.epa.gov/ttn/scram/guidance/guide/EPA-454_R-19-003.pdf.

Assessment of $PM_{2.5}$

Based on information in the EPA's 2016 Draft MERPs Guidance, the lowest, most conservative MERPs from these four hypothetical source locations were established in the TDEC state modeling guidance as the default MERPs that can be used throughout Tennessee without the need for further justification (Table 1). The TVA used these default MERPs to assess secondary $PM_{2.5}$ impacts for the proposed modification at the Gleason facility.

TABLE 1
Default MERPs for Use in TN PSD Applications [1,2]

Precursor	MERPs for 8-hr O_3 (tons/yr)	MERPs for Daily $PM_{2.5}$ (tons/yr)	MERPs for Annual $PM_{2.5}$ (tons/yr)
NO_x	156	4,000	7,407
SO_2	-	667	6,061
VOC	1,339	-	-

Notes:

1. EPA, 2016
2. TDEC, 2018.

The combined primary and secondary impacts of $PM_{2.5}$ for the source impact analysis were assessed using the highest (AERMOD) modeled primary $PM_{2.5}$ concentration (HMC), the Class II SIL, precursor emissions, and the default MERPs. If the sum of the ratios in Equation 4.1 below is less than 1, then the combined $PM_{2.5}$ impacts are below the $PM_{2.5}$ SIL, an adequate compliance demonstration has been performed, and no additional analyses are necessary.

The following equation was used for this assessment:

$$\frac{HMC}{SIL} + \left(\frac{NOx\_Em}{NOx\_MERP}\right) + \left(\frac{SO2\_Em}{SO2\_MERP}\right) < 1 \qquad [4.1]$$

Where:

HMC = Highest modeled primary $PM_{2.5}$ impact using AERMOD and project related $PM_{2.5}$ emissions (µg/m^3)
SIL = Significant Impact Level (µg/m^3)
NOx_Em = Project related NOx Emissions (tons per year – tpy)
NOx MERP = From Table 1 (tpy)
SO_2_Em = Project related SO_2 Emissions (tpy)
SO_2_MERP = From Table 1 (tpy)

TVA's 24-hour and annual $PM_{2.5}$ inputs to Equation 4.1 are provided in Table 2 below, and the resulting impacts are calculated in Equation 4-2 and Equation 4-3 below, respectively.

TABLE 2
Secondary $PM_{2.5}$ Inputs for the SILs in Class II Areas [1,2]

Secondary $PM_{2.5}$ Impacts	24-hr Average	Annual Average
Highest Modeled Primary $PM_{2.5}$ Concentration ($\mu g/m^3$) [3]	0.49	0.053
SILs for the NAAQS and PSD Increments in Class II areas ($\mu g/m^3$) [4]	1.2	0.2
GCC NO_x Emissions (tons/yr) [5]	2,270	2,270
Default NO_x MERPs [1]	4,000	7,407
GCC SO_2 Emissions (tons/yr) [5]	14.2	14.2
Default SO_2 MERPs [1]	667	6,061

Notes:

1. EPA, 2016 and TDEC, 2018.
2. Calculations taken from "GCC_SecPM25_O3_calcs_20180912.xlsx" provided on optical disc.
3. $PM_{2.5}$ modeling results (Table 4-9).
4. SILs for the NAAQS in Class I and Class II areas and for PSD increments in Class II areas. Based on the April 17, 2018 EPA memo, *Guidance on Significant Impact Levels for Ozone and Fine Particles in the Prevention of Significant Deterioration Permitting Program*.
5. Emissions taken from Table 3 in "Gleasn PSD Modemssn SA 20180831.xlsx" *(provided by TVA to TDEC on optical disc)*.

Combined Impacts for 24-hour $PM_{2.5}$ for the SIL in Class II Areas:

$$\frac{0.49}{1.2} + \left(\frac{2,270}{4,000}\right) + \left(\frac{14.2}{667}\right) = 0.997 \qquad [4.2]$$

Combined Impacts for Annual $PM_{2.5}$ for the SIL in Class II Areas:

$$\frac{0.053}{0.2} + \left(\frac{2,270}{7,407}\right) + \left(\frac{14.2}{6,061}\right) = 0.58 \qquad [4.3]$$

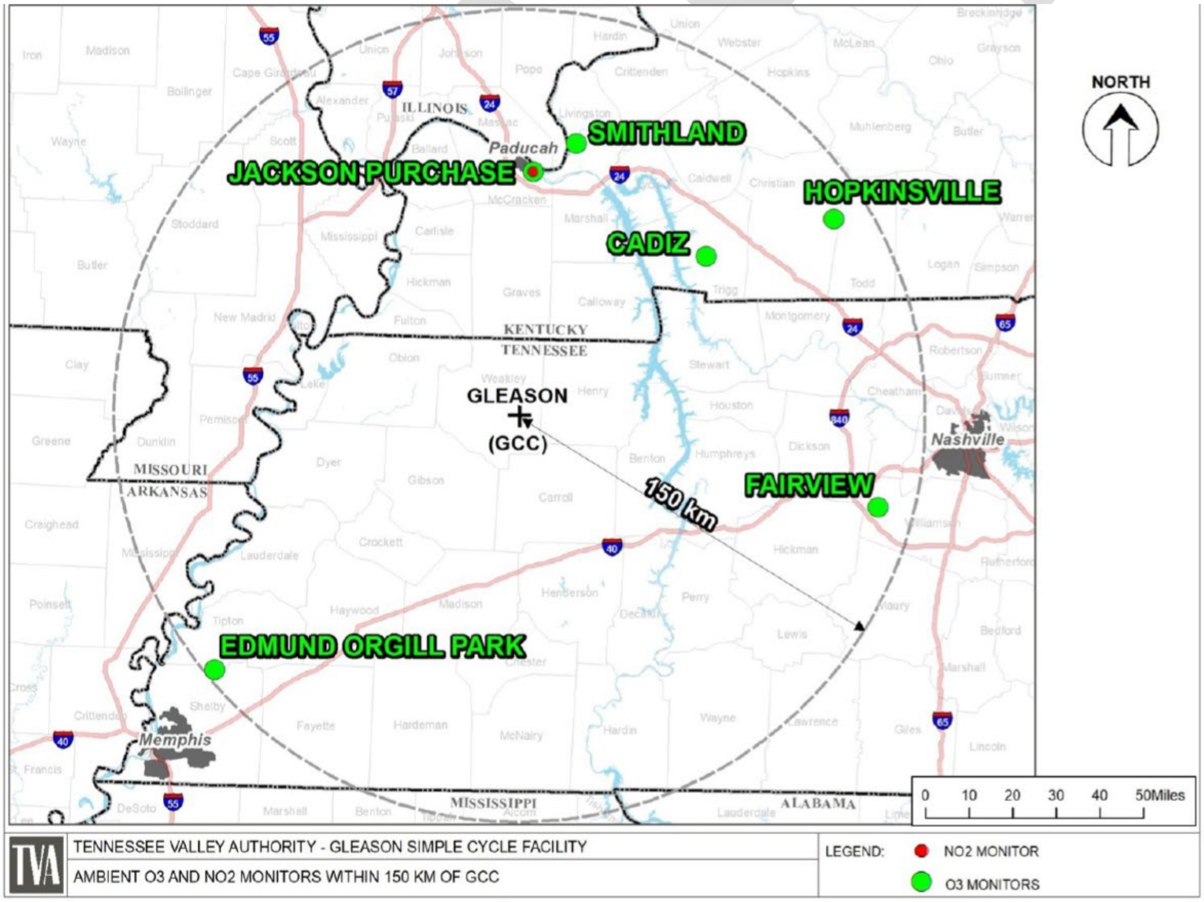
Both 24-hour and annual $PM_{2.5}$ impacts were less than 1, which indicated that $PM_{2.5}$ impacts were expected to be below the Class II SILs for the NAAQS and PSD increments. This indicated that emissions from TVA Gleason would not cause or contribute to a violation of the $PM_{2.5}$ NAAQS in Class II areas.

Assessment of O_3

A somewhat more refined analysis was performed to assess the impacts of the proposed project on O_3 concentrations in the area around the facility. Application of the TDEC default NO_X and VOC MERPs for O_3 shown in Table 1 above indicated that O_3 impacts would be greater than the 8-hour O_3 SIL of 1 ppb and that a cumulative O_3 assessment would be necessary to demonstrate whether the facility modification would cause or contribute to a violation of a the O_3 NAAQS.

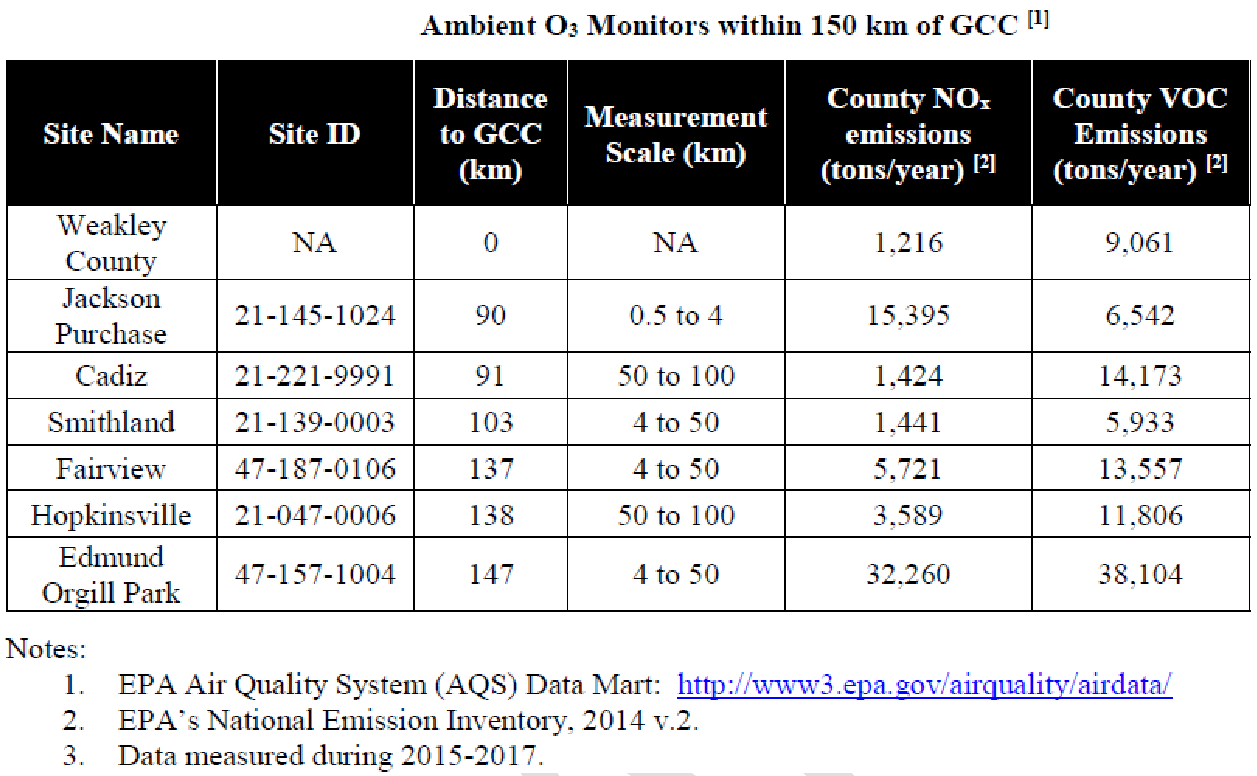
The O_3 assessment first examined ambient O_3 concentrations in the region surrounding TVA Gleason (GCC). There are no ambient O_3 monitors in the immediate vicinity of GCC, but there are six monitors within 150 km of the facility (Figure 2 and Tables 3 and 4). The Cadiz, KY, monitor was selected as the most representative background site due to its proximity to GCC, its comparable levels of precursor emissions in the county, and it has the largest measurement scale indicating it is representative of regional air quality. The three-year average (2015- 2017) of the fourth-highest 8-hour O_3 concentration was 61 ppb, well below the 70 ppb NAAQS.

FIGURE 2



Ambient O_3 Monitors and NO_2 Monitors within 150 km of GCC

TABLE 3



Ambient O_3 Monitors within 150 km of GCC [1]

Site Name	Site ID	Distance to GCC (km)	Measurement Scale (km)	County NO_x emissions (tons/year) [2]	County VOC Emissions (tons/year) [2]
Weakley County	NA	0	NA	1,216	9,061
Jackson Purchase	21-145-1024	90	0.5 to 4	15,395	6,542
Cadiz	21-221-9991	91	50 to 100	1,424	14,173
Smithland	21-139-0003	103	4 to 50	1,441	5,933
Fairview	47-187-0106	137	4 to 50	5,721	13,557
Hopkinsville	21-047-0006	138	50 to 100	3,589	11,806
Edmund Orgill Park	47-157-1004	147	4 to 50	32,260	38,104

Notes:

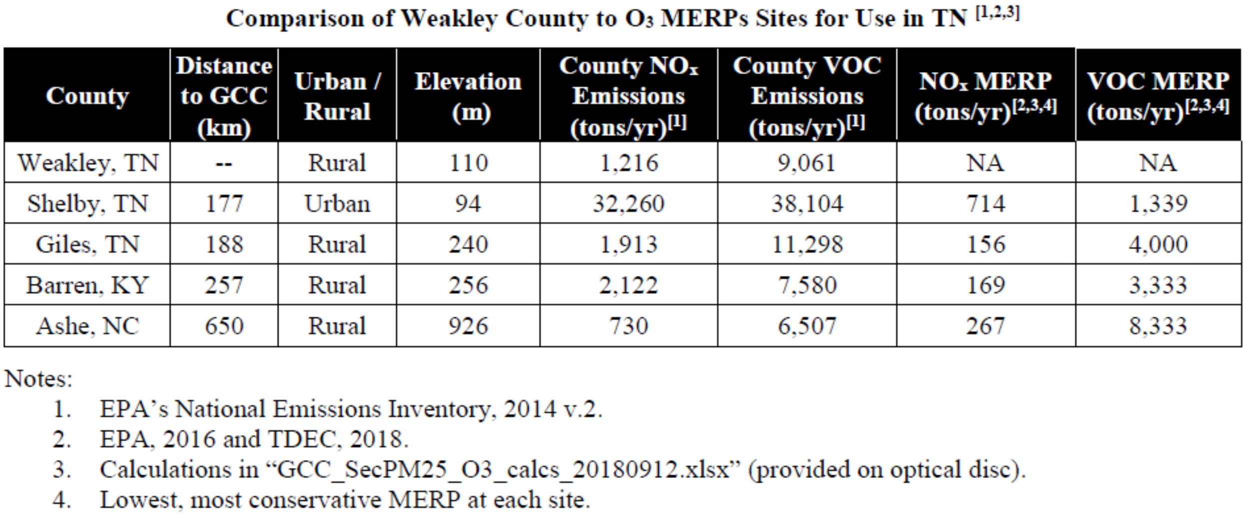
1. EPA Air Quality System (AQS) Data Mart: http://www3.epa.gov/airquality/airdata/
2. EPA's National Emission Inventory, 2014 v.2.
3. Data measured during 2015-2017.

TABLE 4

Site Name	Site ID	3 Year Avg. 4th High 8-Hr Ozone Conc. (ppb)
Jackson Purchase	21-145-1024	62
Cadiz	21-221-9991	61
Smithland	21-139-0003	64
Fairview	47-187-0106	60
Hopkinsville	21-047-0006	61
Edmund Orgill Park	47-157-1004	65

As previously discussed, in April 2018, TDEC published modeling guidance on the use of EPA's MERPs in Tennessee (TDEC, 2018) that identified four hypothetical sites, located in Shelby County, TN, Giles County, TN, Barren County, KY and Ashe County, NC, to represent Tennessee sources (Figure 1). Precursor emissions in these four counties were compared to Weakley County, where GCC is located. Weakley County precursor emissions are comparable to emissions in the three rural counties (Giles, Barren and Ashe) and are much lower than Shelby County which is urban (Table 5). Ashe County is much further from GCC and is located in mountainous terrain, unlike the relatively flat terrain around GCC. Both Giles County and Barren County have similar terrain features to Weakley County. NO_X MERPs at these two sites are also lower than in Shelby County and Ashe County, which makes the analysis more conservative as ozone impacts from GCC are dominated by NO_X emissions.

TABLE 5



Comparison of Weakley County to O_3 MERPs Sites for Use in TN [1,2,3]

County	Distance to GCC (km)	Urban / Rural	Elevation (m)	County NO_x Emissions (tons/yr)[1]	County VOC Emissions (tons/yr)[1]	NO_x MERP (tons/yr)[2,3,4]	VOC MERP (tons/yr)[2,3,4]
Weakley, TN	--	Rural	110	1,216	9,061	NA	NA
Shelby, TN	177	Urban	94	32,260	38,104	714	1,339
Giles, TN	188	Rural	240	1,913	11,298	156	4,000
Barren, KY	257	Rural	256	2,122	7,580	169	3,333
Ashe, NC	650	Rural	926	730	6,507	267	8,333

Notes:

1. EPA's National Emissions Inventory, 2014 v.2.
2. EPA, 2016 and TDEC, 2018.
3. Calculations in "GCC_SecPM25_O3_calcs_20180912.xlsx" (provided on optical disc).
4. Lowest, most conservative MERP at each site.

For the two most representative hypothetical sources selected, as part of EPA's MERPs Guidance, the EPA performed photochemical modeling for two hypothetical source heights (low and high stack releases) and three hypothetical emission rates (500, 1000, and 3000 tons per year). As can be seen in Table 6 below, predicted O_3 impacts are nonlinear with respect to precursor emissions. At these hypothetical sources, the amount of O_3 formed from 3,000 tons of NO_X is substantially less than six times the amount formed from 500 tons of NO_X on a per ton basis, so using a MERP based on 500 tons of NO_X would significantly over-estimate the O_3 impacts from GCC. Therefore, this analysis used the most conservative MERPs based on emission rates most similar to emissions from GCC (hypothetical source emissions of 3,000 tons per year for NO_X and 500 tons per year for VOCs) at the two most representative sites (Giles County and Barren County) (Table 7).

TABLE 6

PRECURSOR	POLL	State	County	FIPS	TPY	Stack Ht	CONC	MERP
NO_X	OZONE	Kentucky	Barren	21009	500	10	2.908	172
NO_X	OZONE	Kentucky	Barren	21009	500	90	2.946	170
NO_X	OZONE	Kentucky	Barren	21009	1000	90	5.026	199
NO_X	OZONE	Kentucky	Barren	21009	3000	90	10.687	281
NO_X	OZONE	Tennessee	Giles	47055	500	10	2.616	191
NO_X	OZONE	Tennessee	Giles	47055	500	90	3.208	156
NO_X	OZONE	Tennessee	Giles	47055	1000	90	5.387	186
NO_X	OZONE	Tennessee	Giles	47055	3000	90	10.356	290

GCC Project Emissions are 2,270 for NOx and 158 tpy for VOC.

TABLE 7
O$_3$ MERPs for Various Emission Rates in Giles County and Barren County [1,2]

County	Stack	NOx Emissions (tons/yr)	NO$_x$ MERP (tons/yr)[1,2]	VOC Emissions (tons/yr)	VOC MERP (tons/yr)[1,2]
Giles, TN	Low	500	163	500	12,500
Giles, TN	High	500	156	500	NA
Giles, TN	Low	1,000	NA	1,000	11,111
Giles, TN	High	1,000	186	1,000	10,000
Giles, TN	High	3,000	290	3,000	4,000
Barren, KY	Low	500	172	500	8,333
Barren, KY	High	500	169	500	8,333
Barren, KY	High	1,000	199	1,000	7,692
Barren, KY	High	3,000	281	3,000	3,333
Most Conservative for Emissions Similar to GCC [3]	-	-	281	-	8,333

Notes:
1. EPA, 2016 and TDEC, 2018.
2. Calculations in "GCC_SecPM25_O3_calcs_20180912.xlsx" (provided on optical disc).
3. Hypothetical sources with NO$_x$ emissions of 3,000 tons per year and VOC emissions of 500 tons per year.

The O$_3$ impacts for the source impact assessment were calculated as the sum of the ratio of precursor emissions to the MERPs. If the sum of the ratios is less than 1, then O$_3$ impacts are below the O$_3$ SIL and no cumulative analysis is necessary.

$$\left(\frac{NOx\_Em}{NOx\_MERP}\right) + \left(\frac{VOC\_Em}{VOC\_MERP}\right) < 1 \qquad [4.4]$$

Where:

NOx_Em = Project related NOx Emissions (tons per year – tpy)
NOx MERP = From Table 7 (tpy)
VOC_Em = Project related VOC Emissions (tpy)
VOC_MERP = From Table 7 (tpy)

GCC's ozone inputs to Equation 4.4 are provided in Table 8, and the resulting impacts are shown in Equation 4.5.

TABLE 8

O_3 Inputs for the SIL in Class II Areas [1,2]

O_3 Precursor	GCC Emissions (tons/yr) [3]	MERP [4,5]
NO_x	2,270	281 [4]
VOC	158	8,333 [5]

Notes:
1. EPA, 2016 and TDEC, 2018.
2. Calculations in "GCC_SecPM25_O3_calcs_20180912.xlsx" (provided on optical disc).
3. Emissions taken from Table 5 in "Gleasn PSD Mod emssn SA 20180831.xlsx" (provided on optical disc).
4. Most conservative MERP for NO_x emissions of 3,000 tons per year at Giles County or Barren County.
5. Most conservative MERP for VOC emissions of 500 tons per year at Giles County or Barren County.

According to Equation 4.5, the sum of the ratios was greater than 1, and O_3 impacts are above the SIL. Therefore, a cumulative O_3 analysis was necessary and performed, which added background O_3 and compared the combined impacts to the NAAQS as shown in Equation 4.6.

$$\left(\frac{2{,}270}{281}\right) + \left(\frac{158}{8{,}333}\right) = 8.10 \qquad [4.5]$$

$$Background\ Ozone + \left[\left(\left(\frac{NOx_{Em}}{NOx_{MERP}}\right) + \left(\frac{VOC_{Em}}{VOC_{MERP}}\right)\right) * SIL\right] \leq NAAQS \qquad [4.6]$$

Where:

Background Ozone = 2015-2017 8-hour ozone design value (ppb) for Cadiz monitor
NOx_Em = Project related NOx Emissions (tons per year – tpy)
NOx MERP = From Table 7 (tpy)
VOC_Em = Project related VOC Emissions (tpy)
VOC_MERP = From Table 7 (tpy)
SIL = 1 ppb ozone
NAAQS = 8-hour ozone NAAQS (70 ppb)

Cumulative O_3 impacts from GCC are shown below. Using the 3-year 8-hour ozone design value of 61 ppb from Cadiz, KY, the ratios defined in Equation 4.5, and the O_3 SIL of 1 ppb, the cumulative O_3 impacts did not exceed the NAAQS. This indicated that emissions from GCC would not cause or contribute to a violation of the O_3 NAAQS.

$$61 + [(2{,}270 \div 281) + (158 \div 8{,}333)] * 1 \text{ ppb} = 69.1 \text{ ppb}$$

$$61 + [8.08 + .02] * 1 = 69.1 \text{ ppb}$$

$$61 + 8.1 = 69.1 \text{ ppb}$$

Appendix D: Example of the background monitoring data calculations for a Second Level 24-hour modeling analysis

This appendix provides an illustrative example of the calculations and data sorting recommendations for the background monitoring data to be used in a Second Level 24-hour $PM_{2.5}$ modeling analysis. In this example, it was determined through discussion and coordination with the appropriate permitting authority that the impacts from the project source's primary $PM_{2.5}$ emissions were most prominent during the cool season and were not temporally correlated with background $PM_{2.5}$ levels that were typical highest during the warm season. So, combining the modeled and monitored levels through a First Level 24-hour $PM_{2.5}$ modeling analysis was determined to be potentially overly conservative. Extending the compliance demonstration to a Second Level analysis allows for a more refined and appropriate assessment of the cumulative impacts on the primary $PM_{2.5}$ emissions in this particular situation.

The example provided is from an idealized Federal Reference Method (FRM) $PM_{2.5}$ monitoring site that operates on a daily (1-in-1 day) frequency with 100% data completeness. In this case, the annual 98th percentile concentration is the 8th highest concentration of the year. In most cases, the FRM monitoring site will likely operate on a 1-and-3 day frequency and will also likely have missing data due to monitor maintenance or collected data not meeting all of the quality assurance criteria. Please reference Appendix N to 40 CFR part 50 to determine the appropriate 98th percentile rank of the monitored data based on the monitor sampling frequency and valid number of days sampled during each year.

The appropriate seasonal (or quarterly) background concentrations to be included as inputs to the AERMOD model per a Second Level 24-hour $PM_{2.5}$ modeling analysis are as follows:

- Step 1 – Start with the most recent 3-years of representative background $PM_{2.5}$ ambient monitoring data that are being used to develop the monitored background $PM_{2.5}$ design value. In this example, the 3-years of 2008 to 2010 are being used to determine the monitored design value.

- Step 2 – For each year, determine the appropriate rank for the daily 98th percentile $PM_{2.5}$ concentration. Again, this idealized example is from a 1-in-1 day monitor with 100% data completeness. So, the 8th highest concentration of each year is the 98th percentile $PM_{2.5}$ concentration. The 98th percentile $PM_{2.5}$ concentration for 2008 is highlighted in Table E-1. The full concentration data from 2009 and 2010 are not shown across the steps in this Appendix for simplicity but would be similar to that of 2008.

- Step 3 – Remove from further consideration in this analysis the $PM_{2.5}$ concentrations from each year that are greater than the 98th percentile $PM_{2.5}$ concentration. In the case presented for a 1-in-1 day monitor, the top 7 concentrations are removed. If the monitor were a 1-in-3 day monitor, only the top 2 concentrations would be removed. The resultant dataset after the top 7 concentrations have been removed from further consideration in this analysis for 2008 is presented in Table E-2.

- Step 4 – For each year, divide the resultant annual dataset of the monitored data equal to or less than the 98th percentile $PM_{2.5}$ concentration into each season (or quarter). For 2008, the seasonal subsets are presented in Table E-3.

- Step 5 – Determine the maximum $PM_{2.5}$ concentration from each of the seasonal (or quarterly) subsets created in Step 4 for each year. The maximum $PM_{2.5}$ concentration from each season for 2008 is highlighted in Table E-3.

- Step 6 – Average the seasonal (or quarterly) maximums from Step 5 across the three years of monitoring data to create the four seasonal background PM2.5 concentrations to be included as inputs to the AERMOD model. These averages for the 2008 to 2010 dataset used in this example are presented in Table E-4. As noted above, the full concentration data from 2009 and 2010 are not shown across the steps in this Appendix for simplicity, but the seasonal maximums from 2009 and 2010 presented in Table E-4 were determined by following the previous five steps similar to that of 2008.

Table E-1. 2008 Daily PM$_{2.5}$ Concentrations

Date	Conc.	Date	Conc.	Date	Conc.	Date	Conc.	Date	Conc.	Date	Conc.	Date	Conc.	Date	Conc.
1-Jan	10.4	16-Feb	15.1	2-Apr	10.5	18-May	11.1	3-Jul	17.1	18-Aug	18.7	3-Oct	12.3	18-Nov	4.4
2-Jan	5.4	17-Feb	11.8	3-Apr	8.2	19-May	7.7	4-Jul	19.8	19-Aug	21.5	4-Oct	19.5	19-Nov	8.2
3-Jan	10.0	18-Feb	3.4	4-Apr	9.7	20-May	13.6	5-Jul	14.3	20-Aug	20.1	5-Oct	23.7	20-Nov	11.1
4-Jan	16.4	19-Feb	4.5	5-Apr	6.9	21-May	12.1	6-Jul	11.5	21-Aug	18.4	6-Oct	19.8	21-Nov	5.3
5-Jan	11.2	20-Feb	4.8	6-Apr	6.3	22-May	10.0	7-Jul	14.3	22-Aug	16.7	7-Oct	21.7	22-Nov	8.9
6-Jan	11.1	21-Feb	11.9	7-Apr	7.9	23-May	13.3	8-Jul	12.2	23-Aug	13.8	8-Oct	12.2	23-Nov	14.0
7-Jan	10.2	22-Feb	20.1	8-Apr	9.8	24-May	11.2	9-Jul	11.1	24-Aug	19.0	9-Oct	5.1	24-Nov	12.7
8-Jan	11.4	23-Feb	11.4	9-Apr	16.5	25-May	17.7	10-Jul	9.7	25-Aug	17.6	10-Oct	10.2	25-Nov	9.7
9-Jan	8.1	24-Feb	19.3	10-Apr	13.3	26-May	14.2	11-Jul	16.4	26-Aug	15.4	11-Oct	10.7	26-Nov	12.8
10-Jan	9.4	25-Feb	18.2	11-Apr	11.0	27-May	15.4	12-Jul	21.5	27-Aug	12.6	12-Oct	5.6	27-Nov	16.6
11-Jan	5.7	26-Feb	12.8	12-Apr	8.8	28-May	13.9	13-Jul	25.1	28-Aug	12.1	13-Oct	5.9	28-Nov	17.2
12-Jan	8.9	27-Feb	5.5	13-Apr	6.3	29-May	9.3	14-Jul	11.7	29-Aug	10.1	14-Oct	9.7	29-Nov	16.6
13-Jan	18.1	28-Feb	9.7	14-Apr	5.1	30-May	14.5	15-Jul	18.9	30-Aug	17.2	15-Oct	12.8	30-Nov	4.5
14-Jan	11.0	29-Feb	12.1	15-Apr	7.9	31-May	20.5	16-Jul	28.9	31-Aug	19.9	16-Oct	16.4	1-Dec	7.5
15-Jan	11.8	1-Mar	9.6	16-Apr	8.2	1-Jun	15.3	17-Jul	27.6	1-Sep	19.4	17-Oct	12.0	2-Dec	10.6
16-Jan	10.7	2-Mar	5.6	17-Apr	14.7	2-Jun	11.5	18-Jul	12.8	2-Sep	18.2	18-Oct	7.9	3-Dec	16.7
17-Jan	10.0	3-Mar	12.5	18-Apr	22.5	3-Jun	17.9	19-Jul	6.2	3-Sep	24.0	19-Oct	6.6	4-Dec	12.5
18-Jan	15.6	4-Mar	7.1	19-Apr	12.8	4-Jun	21.1	20-Jul	20.1	4-Sep	15.4	20-Oct	8.1	5-Dec	7.3
19-Jan	18.0	5-Mar	4.9	20-Apr	6.9	5-Jun	17.9	21-Jul	26.5	5-Sep	12.4	21-Oct	12.2	6-Dec	10.4
20-Jan	6.6	6-Mar	9.9	21-Apr	7.5	6-Jun	17.6	22-Jul	16.9	6-Sep	12.5	22-Oct	4.6	7-Dec	13.4
21-Jan	7.4	7-Mar	11.2	22-Apr	6.0	7-Jun	15.0	23-Jul	12.8	7-Sep	15.8	23-Oct	6.1	8-Dec	10.5
22-Jan	13.5	8-Mar	5.5	23-Apr	9.1	8-Jun	22.3	24-Jul	7.9	8-Sep	23.4	24-Oct	4.6	9-Dec	9.3
23-Jan	16.0	9-Mar	8.8	24-Apr	10.3	9-Jun	27.9	25-Jul	15.7	9-Sep	11.5	25-Oct	4.5	10-Dec	6.5
24-Jan	9.4	10-Mar	11.0	25-Apr	12.0	10-Jun	21.6	26-Jul	24.9	10-Sep	6.0	26-Oct	10.5	11-Dec	3.0
25-Jan	12.6	11-Mar	12.1	26-Apr	12.5	11-Jun	19.4	27-Jul	22.2	11-Sep	11.8	27-Oct	6.4	12-Dec	3.5
26-Jan	13.6	12-Mar	9.7	27-Apr	11.3	12-Jun	21.2	28-Jul	17.5	12-Sep	10.7	28-Oct	4.6	13-Dec	10.2
27-Jan	16.1	13-Mar	15.1	28-Apr	7.6	13-Jun	29.1	29-Jul	19.1	13-Sep	7.6	29-Oct	5.6	14-Dec	17.6
28-Jan	10.0	14-Mar	21.6	29-Apr	7.4	14-Jun	15.6	30-Jul	21.1	14-Sep	7.5	30-Oct	7.6	15-Dec	12.4
29-Jan	10.4	15-Mar	16.6	30-Apr	11.4	15-Jun	14.8	31-Jul	18.0	15-Sep	7.1	31-Oct	11.2	16-Dec	9.7
30-Jan	6.9	16-Mar	7.9	1-May	12.6	16-Jun	17.8	1-Aug	16.3	16-Sep	7.7	1-Nov	16.2	17-Dec	7.0
31-Jan	4.9	17-Mar	9.6	2-May	10.0	17-Jun	12.6	2-Aug	19.3	17-Sep	11.3	2-Nov	17.3	18-Dec	7.9
1-Feb	5.4	18-Mar	10.3	3-May	11.2	18-Jun	10.5	3-Aug	17.9	18-Sep	16.8	3-Nov	18.3	19-Dec	6.9
2-Feb	7.1	19-Mar	8.4	4-May	10.4	19-Jun	15.0	4-Aug	25.1	19-Sep	14.8	4-Nov	8.9	20-Dec	8.1
3-Feb	10.9	20-Mar	4.9	5-May	15.7	20-Jun	22.7	5-Aug	29.3	20-Sep	8.0	5-Nov	5.8	21-Dec	4.9
4-Feb	12.1	21-Mar	8.7	6-May	16.1	21-Jun	18.7	6-Aug	19.1	21-Sep	10.8	6-Nov	8.6	22-Dec	7.7
5-Feb	17.1	22-Mar	13.3	7-May	16.8	22-Jun	15.2	7-Aug	14.0	22-Sep	14.5	7-Nov	15.0	23-Dec	7.7
6-Feb	10.3	23-Mar	12.2	8-May	14.5	23-Jun	16.8	8-Aug	10.8	23-Sep	21.2	8-Nov	8.3	24-Dec	10.5
7-Feb	4.0	24-Mar	10.3	9-May	11.7	24-Jun	15.1	9-Aug	15.0	24-Sep	8.6	9-Nov	10.0	25-Dec	6.5
8-Feb	9.7	25-Mar	11.9	10-May	9.0	25-Jun	20.7	10-Aug	21.7	25-Sep	1.2	10-Nov	12.8	26-Dec	7.6
9-Feb	11.5	26-Mar	20.1	11-May	6.7	26-Jun	23.0	11-Aug	14.3	26-Sep	16.0	11-Nov	11.8	27-Dec	13.3
10-Feb	3.0	27-Mar	22.5	12-May	7.9	27-Jun	17.8	12-Aug	14.7	27-Sep	12.1	12-Nov	14.8	28-Dec	6.4
11-Feb	5.5	28-Mar	18.2	13-May	8.3	28-Jun	12.4	13-Aug	13.0	28-Sep	18.0	13-Nov	14.5	29-Dec	3.7
12-Feb	18.9	29-Mar	10.8	14-May	12.2	29-Jun	12.7	14-Aug	13.5	29-Sep	17.8	14-Nov	7.7	30-Dec	4.7
13-Feb	17.6	30-Mar	6.4	15-May	13.1	30-Jun	8.9	15-Aug	17.5	30-Sep	16.4	15-Nov	3.6	31-Dec	4.4
14-Feb	11.2	31-Mar	3.3	16-May	8.8	1-Jul	7.1	16-Aug	23.9	1-Oct	12.3	16-Nov	4.6		
15-Feb	14.4	1-Apr	7.8	17-May	8.2	2-Jul	13.8	17-Aug	18.4	2-Oct	8.2	17-Nov	7.8		

Annual 98th Percentile Concentration = 25.1 µg/m^3

Table E-2. 2008 Daily $PM_{2.5}$ Concentrations Less Than or Equal to the 98th Percentile

Date	Conc.	Date	Conc.	Date	Conc.	Date	Conc.	Date	Conc.	Date	Conc.	Date	Conc.	Date	Conc.
1-Jan	10.4	16-Feb	15.1	2-Apr	10.5	18-May	11.1	3-Jul	17.1	18-Aug	18.7	3-Oct	12.3	18-Nov	4.4
2-Jan	5.4	17-Feb	11.8	3-Apr	8.2	19-May	7.7	4-Jul	19.8	19-Aug	21.5	4-Oct	19.5	19-Nov	8.2
3-Jan	10.0	18-Feb	3.4	4-Apr	9.7	20-May	13.6	5-Jul	14.3	20-Aug	20.1	5-Oct	23.7	20-Nov	11.1
4-Jan	16.4	19-Feb	4.5	5-Apr	6.9	21-May	12.1	6-Jul	11.5	21-Aug	18.4	6-Oct	19.8	21-Nov	5.3
5-Jan	11.2	20-Feb	4.8	6-Apr	6.3	22-May	10.0	7-Jul	14.3	22-Aug	16.7	7-Oct	21.7	22-Nov	8.9
6-Jan	11.1	21-Feb	11.9	7-Apr	7.9	23-May	13.3	8-Jul	12.2	23-Aug	13.8	8-Oct	12.2	23-Nov	14.0
7-Jan	10.2	22-Feb	20.1	8-Apr	9.8	24-May	11.2	9-Jul	11.1	24-Aug	19.0	9-Oct	5.1	24-Nov	12.7
8-Jan	11.4	23-Feb	11.4	9-Apr	16.5	25-May	17.7	10-Jul	9.7	25-Aug	17.6	10-Oct	10.2	25-Nov	9.7
9-Jan	8.1	24-Feb	19.3	10-Apr	13.3	26-May	14.2	11-Jul	16.4	26-Aug	15.4	11-Oct	10.7	26-Nov	12.8
10-Jan	9.4	25-Feb	18.2	11-Apr	11.0	27-May	15.4	12-Jul	21.5	27-Aug	12.6	12-Oct	5.6	27-Nov	16.6
11-Jan	5.7	26-Feb	12.8	12-Apr	8.8	28-May	13.9	13-Jul	RC	28-Aug	12.1	13-Oct	5.9	28-Nov	17.2
12-Jan	8.9	27-Feb	5.5	13-Apr	6.3	29-May	9.3	14-Jul	11.7	29-Aug	10.1	14-Oct	9.7	29-Nov	16.6
13-Jan	18.1	28-Feb	9.7	14-Apr	5.1	30-May	14.5	15-Jul	18.9	30-Aug	17.2	15-Oct	12.8	30-Nov	4.5
14-Jan	11.0	29-Feb	12.1	15-Apr	7.9	31-May	20.5	16-Jul	RC	31-Aug	19.9	16-Oct	16.4	1-Dec	7.5
15-Jan	11.8	1-Mar	9.6	16-Apr	8.2	1-Jun	15.3	17-Jul	RC	1-Sep	19.4	17-Oct	12.0	2-Dec	10.6
16-Jan	10.7	2-Mar	5.6	17-Apr	14.7	2-Jun	11.5	18-Jul	12.8	2-Sep	18.2	18-Oct	7.9	3-Dec	16.7
17-Jan	10.0	3-Mar	12.5	18-Apr	22.5	3-Jun	17.9	19-Jul	6.2	3-Sep	24.0	19-Oct	6.6	4-Dec	12.5
18-Jan	15.6	4-Mar	7.1	19-Apr	12.8	4-Jun	21.1	20-Jul	20.1	4-Sep	15.4	20-Oct	8.1	5-Dec	7.3
19-Jan	18.0	5-Mar	4.9	20-Apr	6.9	5-Jun	17.9	21-Jul	RC	5-Sep	12.4	21-Oct	12.2	6-Dec	10.4
20-Jan	6.6	6-Mar	9.9	21-Apr	7.5	6-Jun	17.6	22-Jul	16.9	6-Sep	12.5	22-Oct	4.6	7-Dec	13.4
21-Jan	7.4	7-Mar	11.2	22-Apr	6.0	7-Jun	15.0	23-Jul	12.8	7-Sep	15.8	23-Oct	6.1	8-Dec	10.5
22-Jan	13.5	8-Mar	5.5	23-Apr	9.1	8-Jun	22.3	24-Jul	7.9	8-Sep	23.4	24-Oct	4.6	9-Dec	9.3
23-Jan	16.0	9-Mar	8.8	24-Apr	10.3	9-Jun	RC	25-Jul	15.7	9-Sep	11.5	25-Oct	4.5	10-Dec	6.5
24-Jan	9.4	10-Mar	11.0	25-Apr	12.0	10-Jun	21.6	26-Jul	24.9	10-Sep	6.0	26-Oct	10.5	11-Dec	3.0
25-Jan	12.6	11-Mar	12.1	26-Apr	12.5	11-Jun	19.4	27-Jul	22.2	11-Sep	11.8	27-Oct	6.4	12-Dec	3.5
26-Jan	13.6	12-Mar	9.7	27-Apr	11.3	12-Jun	21.2	28-Jul	17.5	12-Sep	10.7	28-Oct	4.6	13-Dec	10.2
27-Jan	16.1	13-Mar	15.1	28-Apr	7.6	13-Jun	RC	29-Jul	19.1	13-Sep	7.6	29-Oct	5.6	14-Dec	17.6
28-Jan	10.0	14-Mar	21.6	29-Apr	7.4	14-Jun	15.6	30-Jul	21.1	14-Sep	7.5	30-Oct	7.6	15-Dec	12.4
29-Jan	10.4	15-Mar	16.6	30-Apr	11.4	15-Jun	14.8	31-Jul	18.0	15-Sep	7.1	31-Oct	11.2	16-Dec	9.7
30-Jan	6.9	16-Mar	7.9	1-May	12.6	16-Jun	17.8	1-Aug	16.3	16-Sep	7.7	1-Nov	16.2	17-Dec	7.0
31-Jan	4.9	17-Mar	9.6	2-May	10.0	17-Jun	12.6	2-Aug	19.3	17-Sep	11.3	2-Nov	17.3	18-Dec	7.9
1-Feb	5.4	18-Mar	10.3	3-May	11.2	18-Jun	10.5	3-Aug	17.9	18-Sep	16.8	3-Nov	18.3	19-Dec	6.9
2-Feb	7.1	19-Mar	8.4	4-May	10.4	19-Jun	15.0	4-Aug	25.1	19-Sep	14.8	4-Nov	8.9	20-Dec	8.1
3-Feb	10.9	20-Mar	4.9	5-May	15.7	20-Jun	22.7	5-Aug	RC	20-Sep	8.0	5-Nov	5.8	21-Dec	4.9
4-Feb	12.1	21-Mar	8.7	6-May	16.1	21-Jun	18.7	6-Aug	19.1	21-Sep	10.8	6-Nov	8.6	22-Dec	7.7
5-Feb	17.1	22-Mar	13.3	7-May	16.8	22-Jun	15.2	7-Aug	14.0	22-Sep	14.5	7-Nov	15.0	23-Dec	7.7
6-Feb	10.3	23-Mar	12.2	8-May	14.5	23-Jun	16.8	8-Aug	10.8	23-Sep	21.2	8-Nov	8.3	24-Dec	10.5
7-Feb	4.0	24-Mar	10.3	9-May	11.7	24-Jun	15.1	9-Aug	15.0	24-Sep	8.6	9-Nov	10.0	25-Dec	6.5
8-Feb	9.7	25-Mar	11.9	10-May	9.0	25-Jun	20.7	10-Aug	21.7	25-Sep	1.2	10-Nov	12.8	26-Dec	7.6
9-Feb	11.5	26-Mar	20.1	11-May	6.7	26-Jun	23.0	11-Aug	14.3	26-Sep	16.0	11-Nov	11.8	27-Dec	13.3
10-Feb	3.0	27-Mar	22.5	12-May	7.9	27-Jun	17.8	12-Aug	14.7	27-Sep	12.1	12-Nov	14.8	28-Dec	6.4
11-Feb	5.5	28-Mar	18.2	13-May	8.3	28-Jun	12.4	13-Aug	13.0	28-Sep	18.0	13-Nov	14.5	29-Dec	3.7
12-Feb	18.9	29-Mar	10.8	14-May	12.2	29-Jun	12.7	14-Aug	13.5	29-Sep	17.8	14-Nov	7.7	30-Dec	4.7
13-Feb	17.6	30-Mar	6.4	15-May	13.1	30-Jun	8.9	15-Aug	17.5	30-Sep	16.4	15-Nov	3.6	31-Dec	4.4
14-Feb	11.2	31-Mar	3.3	16-May	8.8	1-Jul	7.1	16-Aug	23.9	1-Oct	12.3	16-Nov	4.6		
15-Feb	14.4	1-Apr	7.8	17-May	8.2	2-Jul	13.8	17-Aug	18.4	2-Oct	8.2	17-Nov	7.8		

Annual 98th Percentile Concentration = 25.1 µg/m^3

RC = Above 98th Percentile and Removed from Consideration

Table E-3. 2008 Daily $PM_{2.5}$ Concentrations Less Than or Equal to the 98th Percentile by Quarter

Season / Quarter 1			
Date	**Conc.**	**Date**	**Conc.**
1-Jan	10.4	16-Feb	15.1
2-Jan	5.4	17-Feb	11.8
3-Jan	10.0	18-Feb	3.4
4-Jan	16.4	19-Feb	4.5
5-Jan	11.2	20-Feb	4.8
6-Jan	11.1	21-Feb	11.9
7-Jan	10.2	22-Feb	20.1
8-Jan	11.4	23-Feb	11.4
9-Jan	8.1	24-Feb	19.3
10-Jan	9.4	25-Feb	18.2
11-Jan	5.7	26-Feb	12.8
12-Jan	8.9	27-Feb	5.5
13-Jan	18.1	28-Feb	9.7
14-Jan	11.0	29-Feb	12.1
15-Jan	11.8	1-Mar	9.6
16-Jan	10.7	2-Mar	5.6
17-Jan	10.0	3-Mar	12.5
18-Jan	15.6	4-Mar	7.1
19-Jan	18.0	5-Mar	4.9
20-Jan	6.6	6-Mar	9.9
21-Jan	7.4	7-Mar	11.2
22-Jan	13.5	8-Mar	5.5
23-Jan	16.0	9-Mar	8.8
24-Jan	9.4	10-Mar	11.0
25-Jan	12.6	11-Mar	12.1
26-Jan	13.6	12-Mar	9.7
27-Jan	16.1	13-Mar	15.1
28-Jan	10.0	14-Mar	21.6
29-Jan	10.4	15-Mar	16.6
30-Jan	6.9	16-Mar	7.9
31-Jan	4.9	17-Mar	9.6
1-Feb	5.4	18-Mar	10.3
2-Feb	7.1	19-Mar	8.4
3-Feb	10.9	20-Mar	4.9
4-Feb	12.1	21-Mar	8.7
5-Feb	17.1	22-Mar	13.3
6-Feb	10.3	23-Mar	12.2
7-Feb	4.0	24-Mar	10.3
8-Feb	9.7	25-Mar	11.9
9-Feb	11.5	26-Mar	20.1
10-Feb	3.0	27-Mar	22.5
11-Feb	5.5	28-Mar	18.2
12-Feb	18.9	29-Mar	10.8
13-Feb	17.6	30-Mar	6.4
14-Feb	11.2	31-Mar	3.3
15-Feb	14.4		
Seasonal / Quarterly Maximum			**22.5**

Season / Quarter 2			
Date	**Conc.**	**Date**	**Conc.**
1-Apr	7.8	17-May	8.2
2-Apr	10.5	18-May	11.1
3-Apr	8.2	19-May	7.7
4-Apr	9.7	20-May	13.6
5-Apr	6.9	21-May	12.1
6-Apr	6.3	22-May	10.0
7-Apr	7.9	23-May	13.3
8-Apr	9.8	24-May	11.2
9-Apr	16.5	25-May	17.7
10-Apr	13.3	26-May	14.2
11-Apr	11.0	27-May	15.4
12-Apr	8.8	28-May	13.9
13-Apr	6.3	29-May	9.3
14-Apr	5.1	30-May	14.5
15-Apr	7.9	31-May	20.5
16-Apr	8.2	1-Jun	15.3
17-Apr	14.7	2-Jun	11.5
18-Apr	22.5	3-Jun	17.9
19-Apr	12.8	4-Jun	21.1
20-Apr	6.9	5-Jun	17.9
21-Apr	7.5	6-Jun	17.6
22-Apr	6.0	7-Jun	15.0
23-Apr	9.1	8-Jun	22.3
24-Apr	10.3	9-Jun	RC
25-Apr	12.0	10-Jun	21.6
26-Apr	12.5	11-Jun	19.4
27-Apr	11.3	12-Jun	21.2
28-Apr	7.6	13-Jun	RC
29-Apr	7.4	14-Jun	15.6
30-Apr	11.4	15-Jun	14.8
1-May	12.6	16-Jun	17.8
2-May	10.0	17-Jun	12.6
3-May	11.2	18-Jun	10.5
4-May	10.4	19-Jun	15.0
5-May	15.7	20-Jun	22.7
6-May	16.1	21-Jun	18.7
7-May	16.8	22-Jun	15.2
8-May	14.5	23-Jun	16.8
9-May	11.7	24-Jun	15.1
10-May	9.0	25-Jun	20.7
11-May	6.7	26-Jun	23.0
12-May	7.9	27-Jun	17.8
13-May	8.3	28-Jun	12.4
14-May	12.2	29-Jun	12.7
15-May	13.1	30-Jun	8.9
16-May	8.8		
Seasonal / Quarterly Maximum			**23.0**

Season / Quarter 3			
Date	**Conc.**	**Date**	**Conc.**
1-Jul	7.1	16-Aug	23.9
2-Jul	13.8	17-Aug	18.4
3-Jul	17.1	18-Aug	18.7
4-Jul	19.8	19-Aug	21.5
5-Jul	14.3	20-Aug	20.1
6-Jul	11.5	21-Aug	18.4
7-Jul	14.3	22-Aug	16.7
8-Jul	12.2	23-Aug	13.8
9-Jul	11.1	24-Aug	19.0
10-Jul	9.7	25-Aug	17.6
11-Jul	16.4	26-Aug	15.4
12-Jul	21.5	27-Aug	12.6
13-Jul	RC	28-Aug	12.1
14-Jul	11.7	29-Aug	10.1
15-Jul	18.9	30-Aug	17.2
16-Jul	RC	31-Aug	19.9
17-Jul	RC	1-Sep	19.4
18-Jul	12.8	2-Sep	18.2
19-Jul	6.2	3-Sep	24.0
20-Jul	20.1	4-Sep	15.4
21-Jul	RC	5-Sep	12.4
22-Jul	16.9	6-Sep	12.5
23-Jul	12.8	7-Sep	15.8
24-Jul	7.9	8-Sep	23.4
25-Jul	15.7	9-Sep	11.5
26-Jul	24.9	10-Sep	6.0
27-Jul	22.2	11-Sep	11.8
28-Jul	17.5	12-Sep	10.7
29-Jul	19.1	13-Sep	7.6
30-Jul	21.1	14-Sep	7.5
31-Jul	18.0	15-Sep	7.1
1-Aug	16.3	16-Sep	7.7
2-Aug	19.3	17-Sep	11.3
3-Aug	17.9	18-Sep	16.8
4-Aug	25.1	19-Sep	14.8
5-Aug	RC	20-Sep	8.0
6-Aug	19.1	21-Sep	10.8
7-Aug	14.0	22-Sep	14.5
8-Aug	10.8	23-Sep	21.2
9-Aug	15.0	24-Sep	8.6
10-Aug	21.7	25-Sep	1.2
11-Aug	14.3	26-Sep	16.0
12-Aug	14.7	27-Sep	12.1
13-Aug	13.0	28-Sep	18.0
14-Aug	13.5	29-Sep	17.8
15-Aug	17.5	30-Sep	16.4
Seasonal / Quarterly Maximum			**25.1**

Season / Quarter 4			
Date	**Conc.**	**Date**	**Conc.**
1-Oct	12.3	16-Nov	4.6
2-Oct	8.2	17-Nov	7.8
3-Oct	12.3	18-Nov	4.4
4-Oct	19.5	19-Nov	8.2
5-Oct	23.7	20-Nov	11.1
6-Oct	19.8	21-Nov	5.3
7-Oct	21.7	22-Nov	8.9
8-Oct	12.2	23-Nov	14.0
9-Oct	5.1	24-Nov	12.7
10-Oct	10.2	25-Nov	9.7
11-Oct	10.7	26-Nov	12.8
12-Oct	5.6	27-Nov	16.6
13-Oct	5.9	28-Nov	17.2
14-Oct	9.7	29-Nov	16.6
15-Oct	12.8	30-Nov	4.5
16-Oct	16.4	1-Dec	7.5
17-Oct	12.0	2-Dec	10.6
18-Oct	7.9	3-Dec	16.7
19-Oct	6.6	4-Dec	12.5
20-Oct	8.1	5-Dec	7.3
21-Oct	12.2	6-Dec	10.4
22-Oct	4.6	7-Dec	13.4
23-Oct	6.1	8-Dec	10.5
24-Oct	4.6	9-Dec	9.3
25-Oct	4.5	10-Dec	6.5
26-Oct	10.5	11-Dec	3.0
27-Oct	6.4	12-Dec	3.5
28-Oct	4.6	13-Dec	10.2
29-Oct	5.6	14-Dec	17.6
30-Oct	7.6	15-Dec	12.4
31-Oct	11.2	16-Dec	9.7
1-Nov	16.2	17-Dec	7.0
2-Nov	17.3	18-Dec	7.9
3-Nov	18.3	19-Dec	6.9
4-Nov	8.9	20-Dec	8.1
5-Nov	5.8	21-Dec	4.9
6-Nov	8.6	22-Dec	7.7
7-Nov	15.0	23-Dec	7.7
8-Nov	8.3	24-Dec	10.5
9-Nov	10.0	25-Dec	6.5
10-Nov	12.8	26-Dec	7.6
11-Nov	11.8	27-Dec	13.3
12-Nov	14.8	28-Dec	6.4
13-Nov	14.5	29-Dec	3.7
14-Nov	7.7	30-Dec	4.7
15-Nov	3.6	31-Dec	4.4
Seasonal / Quarterly Maximum			**23.7**

Seasonal / Quarterly Maximum Concentration

RC = Above 98th Percentile and Removed from Consideration

Table E-4. Resulting Average of Seasonal (or Quarterly) Maximums for Inclusion into AERMOD

Seasonal / Quarterly Average Highest Monitored Concentration

(From Annual Datasets Equal To and Less Than the 98th Percentile)

	Q1	**Q2**	**Q3**	**Q4**
2008	22.5	23.0	25.1	23.7
2009	21.1	20.7	21.2	19.8
2010	20.7	22.6	23.5	20.7
Average	**21.433**	**22.100**	**23.267**	**21.400**

(Note, the complete datasets for 2009 and 2010 are not shown in Appendix D but would follow the same steps as for 2008)

United States
Environmental Protection
Agency

Office of Air Quality Planning and Standards
Air Quality Assessment Division
Research Triangle Park, NC

Publication No. EPA-457/P-20-002
February 2020

NMED
EXHIBIT 5

STATE OF NEW MEXICO
ENVIRONMENTAL IMPROVEMENT BOARD

IN THE MATTER OF THE APPEALS
OF THE AIR QUALITY PERMIT
NO. 7482-M1 ISSUED TO 3 BEAR **EIB No. 20-21(A)**
DELAWARE OPERATING – NM LLC

AND

REGISTRATION NOS. 8729, 8730, AND 8733 **EIB No. 20-33(A)**
UNDER GENERAL CONSTRUCTION PERMIT
FOR OIL AND GAS FACILITIES

WildEarth Guardians,
Petitioner

TECHNICAL TESTIMONY OF ELIZABETH BISBEY-KUEHN

I. INTRODUCTION

My name is Elizabeth Bisbey-Kuehn. I am the Bureau Chief of the Air Quality Bureau ("AQB" or "Bureau") of the New Mexico Environment Department ("NMED" or "Department"). I present this written testimony on behalf of the Department for the consolidated public hearings on the appeal petitions filed by WildEarth Guardians ("WEG") in EIB 20-21(A) and EIB 20-33(A). In EIB 20-21(A), WEG challenges the Department's approval of Air Quality Permit No. 7482-M1, issued to 3-Bear Delaware Operating – NM LLC ("3-Bear Permit") for the Libby Gas Plant in Lea County, New Mexico. WEG contends that the Department failed to perform air quality modeling or other technical analysis on the impacts of the permitted activities on ambient ozone levels in the area. WEG further objects that monitors in Hobbs and Carlsbad are registering ozone levels in excess of the U.S. Environmental Protection Agency's ("EPA") National Ambient Air Quality Standard ("NAAQS"), and therefore the Department's decision to approve the Permit was arbitrary and capricious because it authorized additional ozone precursors that would necessarily "cause or contribute to air contaminant levels in excess of any [NAAQS]."

NMED Exhibit 5

In EIB 20-33(A), WEG challenges the Department's approval of General Construction Permit for Oil and Gas Facilities ("GCP O&G") Registration Nos. 8729, 8730, and 8733 (collectively, the "Registrations") for XTO Energy Co.'s Corral Canyon 23 and Big Eddy Unit DI 38 (Nos. 8729 and 8730, respectively), and Spur Energy Partners LLC's Dorami 2H, 4H and 9H Federal Oil Tank Battery (No. 8733), all located in Eddy County. WEG points to Table 103 in the GCP O&G, which lists all applicable regulations that a registrant must comply with and includes ambient air quality standards. WEG contends that because monitors in the area are registering exceedances of the ozone NAAQS, it is impossible for the facilities to demonstrate compliance with the requirements of the GCP O&G, and therefore the Department's approval of the Registrations was unlawful, arbitrary and capricious.

As the Air Quality Bureau Chief, I am charged with overseeing the permitting program and ensuring that the program is administered in accordance with the Department's enabling statutes and the Board's regulations, and that the permits issued by the Bureau meet the requirements of the federal Clean Air Act ("CAA") and regulations promulgated by EPA pursuant to the CAA, as well as the New Mexico Air Quality Control Act ("AQCA") and the regulations promulgated by the Board pursuant to the AQCA. My testimony will address the following topics: the regulatory regime for ozone set forth under the CAA and the State of New Mexico's role in that regime; the New Mexico statutory and regulatory framework for regulating ozone pollution; the Department's Ozone Attainment Initiative and the steps that the Department is currently taking to address areas of the State where monitors are registering exceedances of the ozone NAAQS; the path forward for the State in addressing ozone pollution.

II. QUALIFICATIONS

I have been an employee of the Bureau for over fifteen years, working as a staff member for six years, staff manager for seven years, and in my current position as Bureau Chief for over two years. As a staff member and staff manager, I oversaw several complex, high-profile projects for the Department, including serving as the Department's technical expert for the Best Available Retrofit Technology analysis for the San Juan Generation Station. I developed multiple general construction permits for the oil and gas industry, led bi-monthly technical meetings for the State's Associated Contractors, drafted technical guidance and policy documents, and represented the Department in multiple public meetings and public hearings. As Bureau Chief, I manage the four Section Chiefs who oversee the four Sections of the Bureau. I direct the overall management of the Bureau, including the Bureau's resources; staff who enforce the state and federal air quality standards; air quality related planning and policy, operational, permitting, and compliance and enforcement services; financial oversight of the bureau's federal grant and state matching funds; and support services for the Bureau.

My full background and qualifications are set forth in my resume, which is marked as NMED Exhibit 5.

III. THE CLEAN AIR ACT REGULATORY FRAMEWORK FOR OZONE

The CAA requires EPA to set NAAQS for pollutants that EPA determines are harmful to public health and the environment. The CAA identifies two sets of NAAQS to accomplish this. Primary standards provide public health protection, including protecting the health of vulnerable populations such as asthmatics, children, and the elderly. Secondary standards provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings.

The EPA has set NAAQS for six principal pollutants, known as "criteria" air pollutants: ozone, nitrogen dioxide, sulfur dioxide, carbon monoxide, particulate matter 10 microns or less, particulate matter 2.5 microns or less, and lead. The CAA requires EPA to review the standards on a periodic basis, which may result in the standards being revised based on health and environmental criteria that apply to the concentration of a pollutant in outdoor air to limit harmful exposures and detrimental effects.

Following promulgation of a new NAAQS or revised NAAQS, EPA undertakes a process of “designating” areas as in attainment or nonattainment with the standard. This process entails collaborating with states and tribes and considering data and information from air quality monitors and modeling. If the air quality in a geographic area meets or exceeds the national standard, it is designated as an “attainment” area. Areas that do not meet the national standard are designated as “nonattainment” areas. Areas that do not have monitoring data available are designated as “attainment/unclassifiable”. EPA is required to designate areas of the States within two years of promulgating a new or revised NAAQS.

The process of determining whether an area is in attainment or nonattainment of the ozone NAAQS is triggered when the “design value” for ozone is shown to be in excess of the standard. The design value is determined by calculating the three-year average of the annual fourth highest daily maximum 8-hour ozone concentration. It is important to note that readings from monitors showing design values that exceed the ozone NAAQS do not in themselves constitute a nonattainment designation or trigger changes to permitting or other actions on the part of the Department. Under the CAA, the AQCA, and the Regulations, an ozone “nonattainment area” means an area that has gone through the formal nonattainment designation process and has been designated as such by EPA.

Designated nonattainment areas are further classified based on the extent to which they exceed the standard. These classifications are marginal, moderate, serious, severe, or extreme. State and local governments are required to develop a plan, known as a state implementation plan (“SIP”), that details how nonattainment areas will improve the air quality to attain and maintain the standards. Once a nonattainment area meets the standards, states can petition EPA to designate the area as a maintenance area. Until the promulgation of the 2015 ozone NAAQS, New Mexico had no designated nonattainment areas in the State.

In October 2015, following a periodic review, EPA revised the ozone NAAQS downward from 0.075 parts per million (ppm) to 0.070 ppm. For the 2015 ozone NAAQS, all states were required to submit their designation recommendations to EPA by October 1, 2016. Ozone data collected by NMED from 2014 through 2016 showed that a monitor located in the Sunland Park area in southern New Mexico was exceeding the revised ozone standard. NMED submitted a nonattainment area recommendation for the Sunland Park area and recommended attainment or attainment/unclassifiable designations for the remainder of areas in New Mexico. EPA concurred with the recommendations and finalized the area designations for New Mexico on August 3, 2018.

EPA classified the Sunland Park nonattainment area as marginal, allowing NMED 3 years to develop a SIP revision that includes the planning elements required for a marginal nonattainment classification. The SIP revision outlines the strategies and emissions control measures that are expected to reduce the amount of ozone precursors emitted to the atmosphere and improve air quality in the area by August 3, 2021. States may rely on current or upcoming federal rules, new or revised state rules, and other programs, such as the New Mexico Volkswagen mitigation plan projects and the 2021 Regional Haze SIP revision.

On July 13, 2020, EPA proposed to retain the existing 2015 ozone NAAQS. The CAA does not require EPA to promulgate area designations when an existing NAAQS is retained following the periodic review process. Historically, EPA has not designated new nonattainment areas when a NAAQS is not revised during a periodic review. Thus, New Mexico's current ozone designations under the CAA will remain in place unless and until the ozone NAAQS is revised, or EPA or the State seeks a redesignation.

Ozone monitoring data for 2017-2019 indicate that other areas of the state are approaching or violating the 2015 ozone NAAQS. In particular, the counties of Eddy, Lea, and the remainder of Doña Ana are monitoring ozone levels in violation of the standard, while San Juan, Rio Arriba, Sandoval and Valencia County are within 95% of it. The AQCA requires the State to plan for ozone mitigation in areas where monitors indicate ozone levels greater than or equal to 95% of the ozone standard. NMED is addressing these areas through the Ozone Attainment Initiative and EPA's Ozone Advance program, as discussed below.

IV. OZONE REGULATION UNDER THE NEW MEXICO AIR QUALITY CONTROL ACT AND REGULATIONS

Section 74-2-5.3 of the AQCA specifically mandates that the Board take action to control VOC and NOx emissions when the Board determines that emissions from sources within its jurisdiction cause or contribute to ozone concentrations in excess of ninety-five percent of the ozone NAAQS. Under this statutory provision, the Board is required to adopt a plan, including regulations, to control emissions of oxides of nitrogen, or NO_X, and volatile organic compounds, or VOCs, to provide for the attainment and maintenance of the ozone standard for those areas that exceed 95% of the ozone standard.

In accordance with this section, the Board is required to consider the following in the adoption of regulations:

(1) the public interest, including the social and economic value of the sources of emissions and subjects of air contaminants;

(2) previous experience with equipment and methods available to control the air contaminants involved;

(3) energy, environmental and economic impacts and other social costs;

(4) efforts by sources of emissions to reduce emissions prior to the effective date of regulations adopted under this section; and

(5) for existing sources of emissions, the remaining useful life of any existing source to which the regulation would apply.

V. THE DEPARTMENT'S OZONE ATTAINMENT INITIATIVE

Currently, seven counties under the Board's jurisdiction are registering or contributing to ozone design values exceeding 95% of the NAAQS: San Juan, Rio Arriba, Sandoval, Valencia, Eddy, Lea, and Doña Ana.

To address this statutory requirement, the Bureau has embarked upon the Ozone Attainment Initiative ("OAI") to develop a series of rules and voluntary measures to mitigate emissions of NO_X and VOCs in the aforementioned counties. A proposed rule to control NO_X and VOC emissions from various types of equipment related to the production of oil and gas in the South San Juan and Permian Basins has been developed, and the Bureau intends to bring this proposal to the Board for a hearing in December of this year. The Bureau has contracted with the Western States Air Resources Council and Ramboll to conduct photochemical grid modeling for ozone to support our rulemaking efforts. The results of this modeling will identify anthropogenic natural, and state and international contributions to the ozone concentrations monitored in the counties of concern. The results of this modeling effort are expected in October of 2020.

The oil and gas industry is not the only significant contributor to monitored ozone concentrations in New Mexico; previously conducted regional modeling efforts, including the Southern New Mexico Ozone Study ("SNMOS") completed in 2016, have shown that emissions from onroad mobile sources are the largest New Mexico anthropogenic contribution to the design values at most monitors in southern New Mexico. A copy of the Technical Support Document from the SNMOS is attached as NMED Exhibit 6. Section 177 of the Clean Air Act allows other states to adopt California's motor vehicle emission standards, and the Department intends to bring before the Board regulations setting standards for low emission vehicles ("LEV"), and zero emission vehicles ("ZEV") for adoption in 2021 that will provide further mitigation of ozone precursors.

The Department has also submitted a letter of participation to EPA for the Advance Program. The Advance Program is a means to promote local actions in areas designated as in attainment to reduce ozone and/or fine particulate pollution ($PM_{2.5}$) for the continued maintenance of the NAAQS. The Bureau will coordinate efforts with local governments that wish to take proactive steps towards the protection of air quality. In addition to positioning areas to avoid a nonattainment designation, it can allow communities to choose control measures that are cost effective and that make the most sense for their area, potentially resulting in multi-pollutant benefits.

Because the ozone design value in Bernalillo County also exceeds 95% of the ozone NAAQS, the Bureau is coordinating its efforts for ozone mitigation with the City of Albuquerque's Environmental Health Department, which has jurisdiction over air quality in Bernalillo County.

In addition to the OAI and Ozone Advance, the Bureau is also working with the City of Albuquerque on preparing revised Regional Haze State Implementation Plans for submittal to EPA in July of 2021. The goal of the Regional Haze provisions of the CAA is to improve visibility in national parks and wilderness areas (referred to as Class I areas), and states are required to make reasonable progress over time towards the long-term goal of attaining natural visibility conditions by 2064. The Regional Haze program requires states to submit Regional Haze State Implementation Plans approximately once every ten years. Based on data collected at monitors operated by federal land managers, visibility impairment at the Class I areas in New Mexico is driven by sulfates and nitrates, so the Department is evaluating potential additional controls for sulfur dioxide (SO_2) and NO_X emissions from twenty-three major sources within our jurisdiction. Two of these sources are electric generating units, and the remainder are in the oil and gas sector. The additional controls for certain emission units adopted as part of this Regional Haze SIP revision will also serve to reduce the formation of ozone.

While the Department will use its authority to reduce the contribution from New Mexico anthropogenic sources that contribute to ozone design values, contributions from other sources are beyond our control. The aforementioned Southern New Mexico Ozone Study evaluated contributions to design values at monitors in southern New Mexico in the base year (2011) and a future year (2025). The most frequent contributors to the design values of the six Doña Ana County monitors were on-road mobile sources (New Mexico, Texas, and Mexico), natural sources (Mexico), electric generating units (“EGUs”) (Mexico), non-EGU point sources (Mexico), and oil and gas (Texas). *See* SNMOS Technical Support Document, at p. 67. Therefore, it is possible that, even with all the regulatory efforts of the OAI, some areas may not be able to reach or stay in attainment of the ozone NAAQS. In that case, the regulatory path will be a formal nonattainment designation by EPA, with attendant demonstrations by the Department showing that the primary causes of such nonattainment are outside of the State's control either because they are due to natural events/conditions or interstate and international transport.

VI. CONCLUSION

The Department acknowledges that the monitors in the Southeastern part of the state are registering design values above the 2015 ozone NAAQS. The Department is taking comprehensive action to address that situation in a manner that is consistent with its statutory and regulatory authority. If the Department were to simply deny every single permit application or GCP registration, it would be acting outside its authority and without scientific or technical basis, and would be subject to challenge on every single permit or registration. The Board should uphold the Department's decision to approve the Permit and the Registrations and should await the upcoming rulemakings that will be brought before it shortly to address the issue of ozone pollution in the State.

NMED
EXHIBIT 6

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Effective Permit Writing
Sources and Control of PM Emissions
Introduction to Hazardous Air Pollutants
Control of Gaseous Emissions
Advance PSD Permitting
Permit Practices and Procedures I and II
NSR Reform and Advanced PSD
Basic NSR/PSD
Environmental Negotiations

NMED Exhibit 6

NMED
EXHIBIT 7

Southern New Mexico Ozone Study

Technical Support Document

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ACRONYMS AND ABBREVIATIONS

3SAQS	Three-State Air Quality Study
AIRS	Aerometric Information Retrieval System
AMET	Atmospheric Model Evaluation Tool
APCA	Anthropogenic Precursor Culpability Assessment
AQ	Air Quality
AQS	Air Quality System
BC	Boundary Condition
CAMx	Comprehensive Air-quality Model with extensions
CARB	California Air Resources Board
CASTNet	Clean Air Status and Trends Network
CB6r2	Carbon Bond mechanism version 6, revision 2
CMAQ	Community Multiscale Air Quality modeling system
CONUS	Continental United States
CPC	Center for Prediction of Climate
CSAPR	Cross State Air Pollution Rule
CSN	Chemical Speciation Network
EC	Elemental Carbon Fine Particulate Matter
ECMWF	European Center for Medium Range Weather Forecasting
EGU	Electrical Generating Units
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
FB	Fractional Bias
FE	Fractional Error
FRM	Federal Reference Method
GCM	Global Chemistry Model
GEOS-Chem	Goddard Earth Observing System (GEOS) global chemistry model
GIRAS	Geographic Information Retrieval and Analysis System
IMPROVE	Interagency Monitoring of Protected Visual Environments
IWDW	Intermountain West Data Warehouse
LCP	Lambert Conformal Projection
LSM	Land Surface Model
MADIS	Meteorological Assimilation Data Ingest System
MATS	Modeled Attainment Test Software
MCIP	Meteorology-Chemistry Interface Processor
MEGAN	Model of Emissions of Gases and Aerosols in Nature
MNGE	Mean Normalized Gross Error
MNB	Mean Normalized Bias
MNE	Mean Normalized Error
MOVES	Motor Vehicle Emissions Simulator
MOZART	Model for OZone And Related chemical Tracers
MPE	Model Performance Evaluation
MSKF	Multi-Scale Kain-Fritsch Cumulus Parameterization

NAAQS	National Ambient Air Quality Standard
NAM	North American Mesoscale Forecast System
NCAR	National Center for Atmospheric Research
NCEP	National Center for Environmental Prediction
NCDC	National Climatic Data Center
NEI	National Emissions Inventory
NEPA	National Environmental Policy Act
NH_4	Ammonium Fine Particulate Matter
NMB	Normalized Mean Bias
NME	Normalized Mean Error
NO_2	Nitrogen Dioxide
NO_3	Nitrate Fine Particulate Matter
NOAA	National Oceanic and Atmospheric Administration
OA	Organic Aerosol Fine Particulate Matter
OC	Organic Carbon Fine Particulate Matter
OSAT	Ozone Source Apportionment Technology
PAVE	Package for Analysis and Visualization
PBL	Planetary Boundary Layer
PGM	Photochemical Grid Model
PM	Particulate Matter
PPM	Piecewise Parabolic Method
QA	Quality Assurance
QC	Quality Control
RMP	Resource Management Plan
RRF	Relative Reduction Factor
SCC	Source Classification Code
SIP	State Implementation Plan
SMOKE	Sparse Matrix Kernel Emissions modeling system
SNMOS	Southern New Mexico Ozone Study
SOA	Secondary Organic Aerosol
SO_2	Sulfur Dioxide
SO_4	Sulfate Fine Particulate Matter
TCEQ	Texas Commission on Environmental Quality
UNC-IE	University of North Carolina Institute for the Environment
USFS	United States Forest Service
VERDI	Visualization Environment for Rich Data Interpretation
VMT	Vehicle Miles Traveled
WBD	Wind Blown Dust model
WAQS	Western Air Quality Study
WESTAR	Western States Air Resources Council
WESTUS	Western United States
WRAP	Western Regional Air Partnership
WGA	Western Governors’ Association
WRF	Weather Research Forecasting model

1.0 EXECUTIVE SUMMARY

The Southern New Mexico Ozone Study (SNMOS) studied the factors contributing to high ozone in Doña Ana County. Photochemical modeling was carried out for May 1 – September 30, 2011 using emissions scenarios for a 2011 base year and a 2025 future year. The SNMOS modeling platform was derived from the Western Air Quality Study (WAQS) regional modeling platform that was available through the Intermountain West Data Warehouse (IWDW) with adjustments and updates to the meteorology and modeling domains to optimize the platform for application to Southern New Mexico and surrounding regions.

The Weather Research Forecasting (WRF) model was used to provide meteorology data for use in the photochemical modeling. Emissions processing was primarily conducted using the Sparse Matrix Operator Kernel Emissions (SMOKE) modeling system using emissions data from the EPA 2011-based modeling platform (2011v6) version 2 and the WAQS (2011b) inventories. Photochemical grid modeling was done with the Comprehensive Air-quality Model with extensions (CAMx) version 6.20. A model performance evaluation was carried out for the meteorological and photochemical models; performance was determined to be acceptable through comparison with EPA Modeling Guidance (EPA, 2014) and to be consistent with performance in similar regional modeling studies. The major findings of the SNMOS are listed below:

- 2025 future year design value projections indicate that all Doña Ana County ozone monitors are expected to attain the 70 ppb National Ambient Air Quality Standard for ozone (NAAQS) in 2025.
- The modeled decreases in Doña Ana County ozone design values between 2011 and 2025 are mainly driven by projected reductions in emissions from cars, trucks and other on-road mobile sources
- All Doña Ana County ozone monitors would have attained the 70 ppb ozone NAAQS in 2011 but for the ozone contribution due to anthropogenic emissions from Mexico
- Regional emissions sources contributing the most ozone to 2011 Doña Ana County ozone were: (1) on-road mobile emissions from Texas, Mexico and New Mexico; (2) power plant emissions from Mexico; and (3) natural emissions (mainly from plants as well as lightning and fires) from Mexico.
- Regional emissions sources contributing the most ozone to Doña Ana County ozone monitors in 2025 were: (1) on-road mobile emissions from Texas and Mexico; (2) power plant and non-power plant point source emissions from Mexico; and (3) natural emissions from Mexico.
- Ozone transport plays an important role in determining ozone levels in Doña Ana County. Ozone from emissions sources outside the region was the largest contributor of ozone; this is a typical result for a regional modeling study. For all Doña Ana County monitors except Solano, the individual ozone contribution from Texas and Mexico was larger than that of New Mexico.

- New Mexico anthropogenic emission sources that contributed the most ozone to Southern New Mexico monitors were: (1) on-road mobile; (2) offroad mobile; (3) oil and gas; and (4) power plants.

We provide recommendations for model improvement and further study at the end of this report.

2.0 INTRODUCTION

2.1 Project Background

Doña Ana County in Southern New Mexico experiences some of the highest observed ground-level ozone concentrations in the state. The Sunland Park Ozone Nonattainment Area (NAA) which lies within Doña Ana County was designated as marginal nonattainment for the 1-hour ozone standard on June 12, 1995 (60 FR 30789). With the revocation of the 1-hour ozone standard in 2004, the Sunland Park NAA was designated a maintenance area for 8-hour ozone (NMED, 2007). Lowering of the 8-hour ozone standard by EPA in 2008 to 0.75 ppm (75 ppb) and again in 2015 to 0.70 ppm (70 ppb) will likely lead to the Sunland Park NAA receiving a nonattainment designation for 8-hour ozone. In addition, the New Mexico Air Quality Control Act (NMAQCA) requires the New Mexico Environment Department (NMED) to develop a plan for reducing ozone levels in areas that are within 95% of the ozone standard (NMSA 1978, § 74-2-5.3). Table 2-1 shows the 1st through 4th highest daily maximum 8-hour average ozone (MDA8) concentrations measured from 2011 to 2014 at the EPA Air Quality System (AQS) monitors in Doña Ana County. This table shows that all but a handful of the measurements at these monitors exceeded either the 2015 NAAQS for ozone (orange) or the NMAQCA 95% threshold (yellow).

Table 2-1. Daily maximum 8-hour average ozone measurements from 2011-2014 at AQS sites in Doña Ana County, NM.

	1st Highest		2nd Highest		3rd Highest		4th Highest	
Station	**Date**	**ppmV**	**Date**	**ppmV**	**Date**	**ppmV**	**Date**	**ppmV**
La Union	5/24/2011	0.064	6/22/2011	0.064	7/28/2011	0.064	4/26/2011	0.063
SPCY	6/22/2011	0.078	6/4/2011	0.076	7/28/2011	0.068	6/27/2011	0.067
Chaparral	8/2/2011	0.074	5/24/2011	0.073	5/25/2011	0.071	6/22/2011	0.07
Desert V	6/4/2011	0.084	6/22/2011	0.081	8/27/2011	0.073	7/28/2011	0.072
Sta Teresa	6/22/2011	0.078	5/24/2011	0.074	4/26/2011	0.07	6/27/2011	0.07
Solano	5/24/2011	0.068	5/25/2011	0.068	8/6/2011	0.068	8/27/2011	0.067
La Union	8/31/2012	0.079	7/13/2012	0.078	6/28/2012	0.075	7/14/2012	0.074
SPCY	8/31/2012	0.078	7/13/2012	0.076	7/12/2012	0.075	6/28/2012	0.073
Chaparral	6/2/2012	0.075	6/1/2012	0.07	7/13/2012	0.069	6/3/2012	0.067
Desert V	7/13/2012	0.077	8/31/2012	0.077	7/12/2012	0.076	6/28/2012	0.075
Sta Teresa	8/31/2012	0.083	7/13/2012	0.08	7/12/2012	0.078	9/1/2012	0.077
Solano	5/16/2012	0.069	6/3/2012	0.068	7/13/2012	0.067	6/2/2012	0.066
La Union	8/17/2013	0.066	8/16/2013	0.065	8/21/2013	0.065	8/4/2013	0.064
SPCY	7/3/2013	0.068	6/11/2013	0.063	6/9/2013	0.063	8/17/2013	0.062
Chaparral	5/24/2013	0.074	6/15/2013	0.074	7/3/2013	0.071	7/5/2013	0.07
Desert V	7/3/2013	0.076	8/16/2013	0.072	7/27/2013	0.072	6/9/2013	0.071
Sta Teresa	7/27/2013	0.089	7/3/2013	0.081	7/25/2013	0.081	7/7/2013	0.08
Solano	7/31/2013	0.066	7/27/2013	0.065	7/16/2013	0.065	5/20/2013	0.064
La Union	6/10/2014	0.07	5/29/2014	0.07	8/18/2014	0.068	5/28/2014	0.066
SPCY	6/10/2014	0.073	5/29/2014	0.068	8/30/2014	0.068	7/22/2014	0.068
Chaparral	8/6/2014	0.075	6/10/2014	0.071	7/18/2014	0.069	5/29/2014	0.068
Desert V	6/10/2014	0.077	5/29/2014	0.074	7/15/2014	0.073	5/28/2014	0.072

Station	1st Highest		2nd Highest		3rd Highest		4th Highest	
	Date	ppmV	Date	ppmV	Date	ppmV	Date	ppmV
Sta Teresa	7/15/2014	0.071	8/18/2014	0.07	7/31/2014	0.069	6/10/2014	0.067
Solano	6/10/2014	0.072	6/7/2014	0.069	5/29/2014	0.068	6/9/2014	0.067

The statutory requirements of both the NAAQS and the NMAQCA include the development of a plan to control the emissions of sources pursuant to attainment and maintenance of the NAAQS. In the case of a NAAQS NAA State Implementation Plan (SIP), air quality modeling is required to identify the causes of high pollution and to propose emissions control strategies that will bring the area into attainment.

The Southern New Mexico Ozone Study (SNMOS) studied the factors contributing to high ozone in Doña Ana County and investigated future emissions scenarios that will produce NAAQS attainment. The SNMOS is a collaborative project between NMED, the Western Regional Air Partnership (WRAP), the Western Air Resources Council (WESTAR), Ramboll Environ US Corporation (RE), and the University of North Carolina Institute for the Environment (UNC-IE). This Study built off of the Western Air Quality Study (WAQS), a cooperative project that is intended to facilitate air resource analyses for federal and state agencies in the intermountain western U.S. toward improved information for the public and stakeholders as a part of air quality planning. The Intermountain West Data Warehouse (IWDW) at the Cooperative Institute for Research in the Atmosphere (CIRA) at Colorado State University was the source for the regional air quality modeling data and software resources from the WAQS. The SNMOS leveraged the WAQS 2011 version B (WAQS_2011b) modeling platform to conduct base and future year air quality modeling for Doña Ana County.

2.2 Organization of the Technical Support Document

This Technical Support Document (TSD) summarizes the objectives, methods and results of the SNMOS. In the remainder of Section 2, we provide a summary of the SNMOS modeling approach. In Section 3, we present an overview of the results of the study. The organization of Section 3 of the TSD follows that of the SNMOS, which was broken into 13 separate Tasks:

- **Task 1**: 2011 WRF 36/12/4-km modeling with 4-km grid focused on Dona Ana/El Paso/Juárez and Data Analysis/Modeling Work Plan
- **Task 2**: 2011 update of Permian Basin oil and gas emission inventory
- **Task 3**: 2011 update of emissions inventories for Juárez and nearby Mexico and 2025 Mexico emissions
- **Task 4**: SMOKE modeling of current 2011 National Emission Inventory for 4-km domain
- **Task 5**: Gridded 2011 biogenic, fires, wind-blown dust, lightning emissions for 4-km domain
- **Task 6**: Develop 2011 4-km CAMx database and perform base case modeling
- **Task 7**: 2011 CAMx model performance evaluation and sensitivity modeling for Doña Ana County
- **Task 8**: SMOKE current 2025 US emission inventory and Mexico emissions update

- **Task 9**: Future year (2025) 12/4-km CAMx simulation
- **Task 10**: FY (2025) ozone design value projections (MATS)
- **Task 11**: 2025 emissions sensitivity tests/controls
- **Task 12:** Ozone source apportionment modeling of 2011 and 2025
- **Task 13**: Technical Support Document (TSD)

For each Task, we outline the methods, data used and results. Then we summarize the major findings of the Task. Finally, we list the Task deliverables and their completion dates. A PowerPoint presentation and/or written documentation describing each Task in more detail are available on the WRAP SNMOS website.

In Section 4, we provide a summary of results and conclusions of the SNMOS and make recommendations for future work.

2.3 Overview of the SNMOS Modeling Approach

The SNMOS modeling platform was derived from the WAQS_2011b regional modeling platform. A regional modeling platform is the suite of data and software required for conducting a regional-scale air quality modeling study. The procedures for the SNMOS 2011 modeling followed those performed for the 2011 WAQS with adjustments to the meteorology and modeling domains to optimize the modeling platform for application to southern New Mexico. The SNMOS 2011 modeling platform included nested 36, 12 and 4-km resolution meteorology modeling domains. The regional air quality modeling was conducted at 12 and 4-km resolution.

The SNMOS modeling domains were selected to facilitate high resolution modeling for sources around Doña Ana County and to enable regional source apportionment modeling among all of the surrounding Western states. The SNMOS 12 and 4-km domains, shown in Figure 2-1, were designed to encompass the meteorology and emissions features that are most important to ground-level ozone formation in southern New Mexico. Also shown in Figure 2-1 are the locations of EPA's Air Quality System (AQS) ozone monitors (green) and point sources of nitrogen oxide (NOx) emissions (blue).

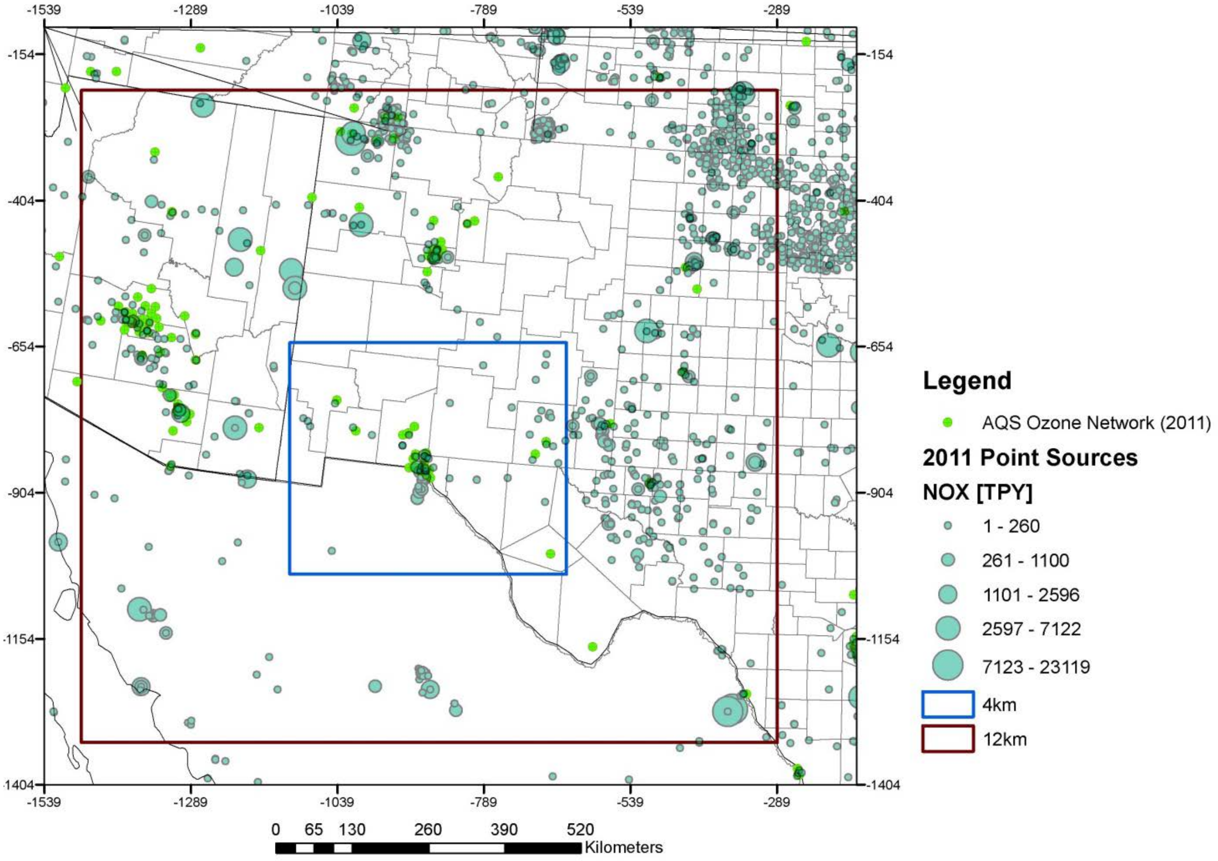


Figure 2-1. SNMOS 2011 CAMx 12/4-km modeling domains.

The CAMx and emissions domains for modeling of 2011 were chosen for the following reasons:

- New continental-scale coarse grid modeling was not needed for the SNMOS because we were able to extract BCs for the 12-km domain from the WAQS 2011 CAMx modeling results. The WAQS modeling used the 36-km RPO grid and a 12-km modeling domain that encompassed much of the western U.S. As we used the same emissions data and CAMx configuration for the SNMOS as were used for the WAQS, there was consistency between these simulations enabling the use of the WAQS modeling as lateral boundary conditions (BCs) for the SNMOS domains.
- The SNMOS 12-km CAMx domain encompasses all of New Mexico, extends west to include the metropolitan area of Phoenix, east to include East Texas, and south to include the Carbon II power plant in Coahuila, Mexico. This facility is a large source of NOx emissions and lies in a region that was sometimes upwind of Doña Ana County on high ozone days during 2011. The SNMOS 12-km domain was designed to balance computational efficiency and the need to model transport from sources likely to influence Doña Ana County at 12-km resolution.
- The SNMOS 4-km Doña Ana County domain focuses on Southern New Mexico and the major emissions source regions in the immediate vicinity, including Ciudad Juárez, Mexico and El Paso, TX.

We simulated the 2011 ozone season and evaluated the meteorology and air quality model performance against surface and aloft monitors that operated in the modeling domains during the study period. Following the base year model performance evaluation, we used projected emissions data to simulate air quality in the year 2025. Along with future year attainment tests, the future year modeling included emissions sensitivity testing and ozone source apportionment modeling of emissions source region and source category contributions to ozone concentrations and ozone design values at ozone monitoring sites in Doña Ana County (and elsewhere in the region). A summary of the SNMOS modeling approach is given below.

- The 2011 ozone season for New Mexico (May 1 – September 30) was selected for the modeling period.
- Year 2011 and 2025 inventories were used to estimate base and future year emissions.
- The Weather Research Forecasting (WRF) version 3.7.1 was used to simulate meteorology data for this study.
- Emissions processing was primarily conducted using the Sparse Matrix Operator Kernel Emissions (SMOKE) modeling system version 3.7 using emissions data from the EPA 2011-based modeling platform (2011v6) version 2 and the WAQS (2011b).
- Photochemical grid modeling (PGM) was done with the Comprehensive Air-quality Model with extensions (CAMx) version 6.20. The Carbon Bond 6 revision 2 (CB6r2) photochemical mechanism was used for the SNMOS modeling.
- For the SNMOS 2011 modeling, hourly BCs for the portion of the lateral boundaries of the SNMOS 12-km PGM domain that lies within the larger WAQS 12-km domain were extracted from the WAQS 36-km continental U.S. CAMx modeling.

- Model performance evaluation was conducted for meteorology, ozone, and ozone precursor and product species.
- Diagnostic sensitivity testing was conducted to determine sensitivity of the PGM model estimates to the WRF model configuration and to improve the 2011 base year model performance in simulating ground-level ozone in Southern New Mexico and the surrounding region.
- Future year modeling was used to estimate air quality in 2025 and to conduct attainment tests for Doña Ana County.
- Future year emissions sensitivity modeling was used to evaluate the impacts of emissions reductions on future attainment of the ozone NAAQS.
- Future year CAMx source apportionment modeling was used to quantify the source region and source category contributions to ozone concentrations and ozone design values at ozone monitoring in Dona Ana County.

2.4 Project Participants

The SNMOS was facilitated and managed by the Western States Air Resources Council (WESTAR). RE and UNC-IE conducted the meteorology, emissions, and air quality modeling and analysis. Key contacts and their roles in the SNMOS are listed in Table 2-2.

Table 2-2. SNMOS key contacts.

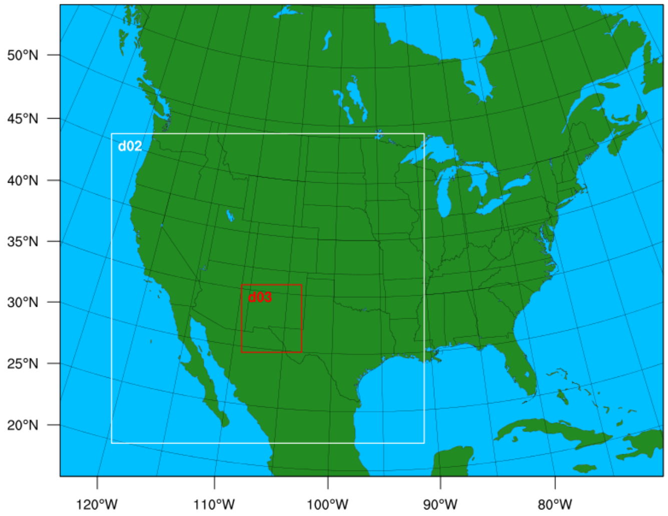
Name	Role	Organization/Contact
Tom Moore	Project Manager	WESTAR c/o CSU/CIRA 1375 Campus Delivery Fort Collins, CO 80523 (970) 491-8837 tmoore@westar.org
Zac Adelman	UNC-IE Lead	University of North Carolina Institute for the Environment 100 Europa Dr., Suite 490, CB 1105 Chapel Hill, NC 27517 (919) 962-8510 zac@unc.edu
Ralph Morris	Ramboll Environ Lead	Ramboll Environ 773 San Marin Drive, Suite 2115 Novato, CA 94998 (415) 899-0708 rmorris@environcorp.com

3.0 SNMOS TASK SUMMARIES

3.1 Task 1: Weather Research Forecast (WRF) Meteorological Modeling

3.1.1 Task Summary

The objective of this task was to simulate and evaluate WRF meteorology for modeling 2011 summer season ozone in Doña Ana County, New Mexico. We coordinated with WRF modelers in the western U.S. to find a candidate model configuration for best simulating ozone in the southwestern U.S. We used the most recent version of WRF (v3.7.1) available at the time of the study to test four different WRF configurations in simulating summer season (April 15-August 30, 2012) meteorology on 33 vertical layer (Table 3-1) 36-km U.S. EPA Continental U.S. (CONUS), 12-km Western U.S. and 4-km SNMOS modeling domains (Figure 3-1). After conducting an operational model performance evaluation on all of the WRF simulations and selecting the best performing configuration, we converted the WRF output to CAMx inputs using the WRFCAMx software. Additional details of the WRF sensitivities, evaluation, and final configuration are provided below.



Parameter	Value
Projection	Lambert-Conformal
1st True Lat	33 degrees N
2nd True Latitude	45 degrees N
Central Lon	97 degrees W
Central Lat	40 degrees N
dX (km)	d01 = 36, d02 = 12, d03 = 4
dY (km)	d01 = 36, d02 = 12, d03 = 4
X-orig (km)	d01 = -2736, d02 = -2196, d03 = -912
Y-orig (km)	d01 = -2088, d02 = -1728, d03 = -828
# cols	d01 = 165, d02 = 256, d03 = 148
# rows	d01 = 129, d02 = 253, d03 = 166

Figure 3-1. WRF modeling domains.

Table 3-1. Vertical layer interfaces for the WRF and CAMx simulations

WRF and CAMx Levels				
WRF Level	**Sigma**	**Pressure (mb)**	**Height (m)**	**Thickness (m)**
33	0.0000	50.00	19260	2055
32	0.0270	75.65	17205	1850
31	0.0600	107.00	15355	1725
30	0.1000	145.00	13630	1701
29	0.1500	192.50	11930	1389
28	0.2000	240.00	10541	1181
27	0.2500	287.50	9360	1032
26	0.3000	335.00	8328	920

WRF and CAMx Levels				
WRF Level	Sigma	Pressure (mb)	Height (m)	Thickness (m)
25	0.3500	382.50	7408	832
24	0.4000	430.00	6576	760
23	0.4500	477.50	5816	701
22	0.5000	525.00	5115	652
21	0.5500	572.50	4463	609
20	0.6000	620.00	3854	461
19	0.6400	658.00	3393	440
18	0.6800	696.00	2954	421
17	0.7200	734.00	2533	403
16	0.7600	772.00	2130	388
15	0.8000	810.00	1742	373
14	0.8400	848.00	1369	271
13	0.8700	876.50	1098	177
12	0.8900	895.50	921	174
11	0.9100	914.50	747	171
10	0.9300	933.50	577	84
9	0.9400	943.00	492	84
8	0.9500	952.50	409	83
7	0.9600	962.00	326	83
6	0.9700	971.50	243	81
5	0.9800	981.00	162	65
4	0.9880	988.60	97	41
3	0.9930	993.35	56	32
2	0.9970	997.15	24	24
1	1.0000	1000	0	

The WRF configuration sensitivity tests that we ran were based on previous WRF modeling studies of the region. Our objective for these tests was to maximize the skill of the model in simulating conditions conducive to surface ozone build up in southern New Mexico. One key issue that we wanted to address was the known performance problem that WRF has in simulating precipitation in the Western U.S. Accurately capturing the timing and location of both convective precipitation events and events driven by the North American monsoon is important in developing a reliable model of ozone formation in the region. The prior WRF modeling studies that we considered in our design for the SNMOS included,

- The Bureau of Land Management’s Montana-Dakotas (BLM-MT/DK) Study examined the sensitivity of WRF model performance in the Montana/Dakotas region for different WRF model configurations used in recent studies (McAlpine et al., 2014). In the initial Montana-Dakotas modeling, WRF overstated precipitation over the 4-km modeling domain during the summer months. The initial WRF run used surface temperature and humidity observation nudging in the 4-km domain. The temperature and humidity observation nudging introduced instabilities in the WRF simulation that resulted in increased convective activity and rainfall. BLM-MT/DK Study sensitivity testing demonstrated that removing temperature and humidity observation nudging and using the Grell-Freitas cumulus parameterization on the 4-km domain for the final WRF simulation improved rainfall, wind speed, and wind direction model performance. The reduction in explicit convective activity allowed WRF to more accurately simulate the observed winds.

- In the San Juan Mercury Modeling (Ramboll Environ and Systech Water Resources, 2015), WRF overpredicted precipitation in a 12-km domain focused on the Four Corners region, but was much more accurate at the 4-km resolution. Observational nudging was applied to the 12-km and 4-km domains for winds, but not for temperature or humidity. Several cumulus parameterizations were evaluated to determine their effect on modeled precipitation.
- The 2011 WRF evaluation for the 3-State Air Quality Study (3SAQS) compared WRF 3.6.1 estimates to monthly PRISM observations (UNC and ENVIRON, 2014). While summertime WRF precipitation was generally too high relative to PRISM and the model did not resolve the local convective features well, there were questions about the PRISM analysis fields and their reliability at capturing isolated convective cells.

In consideration of these studies, we conducted a series of WRF simulations and selected the best performer (lowest bias and error for surface temperature, winds, humidity, and precipitation at sites in the 4-km SNMOS domain) for the operational simulations. The sensitivities were based off of the WAQS (UNC and ENVIRON, 2014) and San Juan Mercury Modeling (Ramboll Environ and Systech Water Resources, 2015) studies. Table 3-2 summarizes the base configuration that we used for the SNMOS WRF sensitivities and compares this configuration to the WAQS WRF modeling. The WRF version 3.7.1 sensitivity simulations that we ran included the following:

- Configuration 1 (NAM KF Mods): Base WRF configuration using settings from the 3SAQS/WAQS 2011 configuration. The key parameters here for the WRF sensitivity tests are the North American Model (NAM) Initial and Boundary Conditions (ICBCs) and the modified Kain-Fritsch (KF) cumulus scheme (Alapaty et al., 2012). The modified convective parameterization scheme provides subgrid-scale cloud fraction and condensate feedback to the shortwave and longwave radiation schemes. The impact of including the subgrid-scale cloud fraction is a reduction in the shortwave radiation, leading to less buoyant energy, thereby alleviating the overly energetic convection and reducing precipitation.

- Configuration 2 (NAM MSKF): Same as Configuration 1 with the multi-scale (grid-aware) Kain-Fritsch (MSKF) cumulus scheme (Alapaty et al., 2014). Additional changes were made to the modified KF scheme to improve the accuracy of precipitation at grey zone resolutions (<10 km). These include scale dependent features of convection such as scale dependent consumption of the convective available potential energy and entrainment of environmental air.

- Configuration 3 (ERA MSKF): Same as Configuration 2 but using the European Centre for Medium-range Weather Forecasts (ECMWF) ERA-Interim analysis as the ICBC fields.

Experience from the San Juan Hg WRF tests indicate that the ERA-Interim ICBC fields may improve simulated precipitation associated with the North American Monsoon.

- Configuration 4 (ERA MSKF No AN): Same as Configuration 3 but based on prior experiences from the San Juan Hg study, analysis nudging was not applied in domain 2.

Table 3-2. Base configuration for the SNMOS WRF sensitivity modeling.

WRF Treatment	3SAQS/WAQS	SNMOS
Microphysics	Thompson	Thompson
Longwave Radiation	RRTMG	RRTMG
Shortwave Radiation	RRTMG	RRTMG
Minutes between radiation physics calls	20	20
Land Surface Model (LSM)	NOAH	NOAH
Planetary Boundary Layer (PBL) scheme	YSU	YSU
Cumulus parameterization	Kain-Fritsch in the 36-km and 12-km domains only.	Multiscale (grid-aware) Kain-Fritsch.
Analysis nudging	Applied to winds (uv), temperature (t) and moisture (q) in the 36-km and 12-km domains	Applied to winds (uv), temperature (t) and moisture (q) in the 36-km and 12-km domains
Analysis nudging coefficients	uv: 5e-4 (d01), 3e-4 (d02) t: 5e-4 (d01), 3e-4 (d02) q: 1e-5 (d01 and d02)	uv: 5e-4 (d01), 3e-4 (d02) t: 5e-4 (d01), 3e-4 (d02) q: 1e-5 (d01 and d02)
Observation Nudging	Applied to surface wind and temperature in the 4-km domain	None
Observation nudging coefficients	uv: 1.2e-3 (d03) t: 6e-4 (d03)	N/A
Initialization Dataset	12-km North American Model (NAM)	12-km (NAM)
Top (mb)	50	50
Vertical Levels (Layers)	37 (36)	33 (32)

We ran the WRF model in 5-day blocks initialized at 12Z every 5 days with a 90-second integration time step. Model results were output every 60 minutes and output files split at 24-hour intervals. Twelve hours of spin-up were included in each 5-day block before the data were used in the subsequent evaluation. The model was run at 36-km, 12-km and 4-km grid resolution from May 15 through September 1, 2011 using one-way grid nesting with no feedback (i.e., the meteorological conditions are allowed to propagate from the coarser grid to the finer grid but not vice versa).

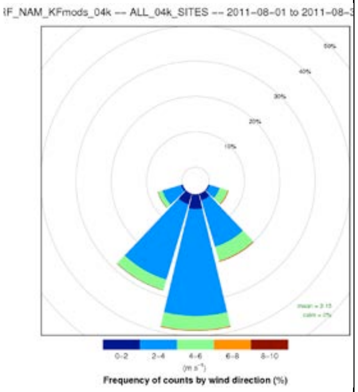
The evaluation for these simulations focused on simulating the North American Monsoon with an emphasis on the timing, location, and magnitude of precipitation in southern New Mexico. The model evaluation approach was based on a combination of qualitative and quantitative analyses. The quantitative analyses were divided into monthly summaries of 2-m temperature, 2-m mixing ratio, and 10-m wind speed using the boreal seasons to help generalize the model bias and error relative to a standard benchmark. We supplemented the WRF evaluation with select diurnal and time series analyses at specific sites in the 4-km SNMOS modeling domain. Additional analysis included a qualitative evaluation of the daily total WRF precipitation fields against PRISM fields. The PRISM data were mapped to the WRF domains and grid resolution. The observed database for winds, temperature, and water mixing ratio used in this analysis were the National Oceanic and Atmospheric Administration (NOAA) Earth System Research Laboratory (ESRL) Meteorological Assimilation Data Ingest System (MADIS).

Table 3-3 shows the 4-km domain average performance statistics for temperature, moisture, and winds. The performance trends illustrate that initializing WRF with the North American Model (NAM) produces a WRF model that has a warm and dry bias with underestimated wind speeds. The ERA initialization produces a WRF model with a warm and wet bias that also underestimates the wind speeds. Including the MSKF convective cloud module slightly improved the moisture bias in the model and we found that the performance of this option was sensitive to the initialization dataset that we selected.

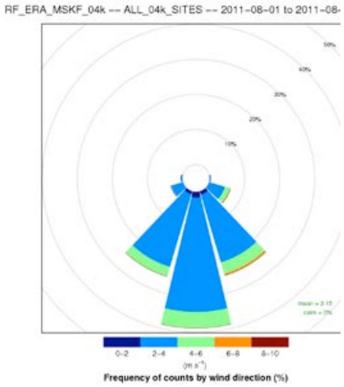
Table 3-3. 4-km domain average model performance statistics

	Temperature (deg K)		**Mixing Ratio (g/kg)**		**Wind Speed (m/s)**		**Wind Direction (degrees)**	
	Bias	Error	Bias	Error	Bias	RMSE	Bias	Error
Benchmark: Simple	≤ ±0.5	≤ 2.0	≤ ±0.5	≤ 1.0	≤ ±0.5	≤ 2.0	≤ ±5	≤ 40
Benchmark: Complex	≤ ±1.0	≤ 3.0	≤ ±1.0	≤ 2.0	≤ ±1.0	≤ 3.0	≤ ±10	≤ 80
NAM KFmods	**0.21**	**1.77**	-0.53	1.05	**-0.30**	2.12	5.46	43.6
NAM MSKF	0.22	**1.77**	-0.46	**1.03**	-0.34	2.12	5.02	43.9
ERA MSKF	0.24	1.87	**0.14**	1.12	-0.43	**2.08**	**3.95**	**42.8**
ERA MSKF no AN	0.40	2.05	-0.39	1.18	-0.34	2.28	4.73	49.1

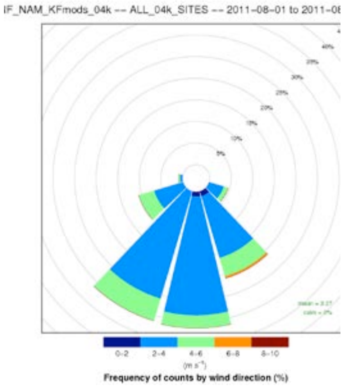
Figure 3-2 shows August 2011 wind roses, indicating the mean monthly wind direction and speeds, for all sites in the 4-km SNMOS modeling domain. The figures in this plot compare the wind data for observations relative to the four WRF configurations that we tested. Figure 3-3 is a plot of PRISM precipitation observations compared to the WRF modeling results. We generated and evaluated many of these types of plots for all simulation months, for days during high ozone episodes, and where applicable, for each meteorological observation site in southern Doña Ana County. Additional evaluation plots included time series plots, bias-error (soccer) plots, temperature spatial plots with wind vector overlays, and scatter plots.



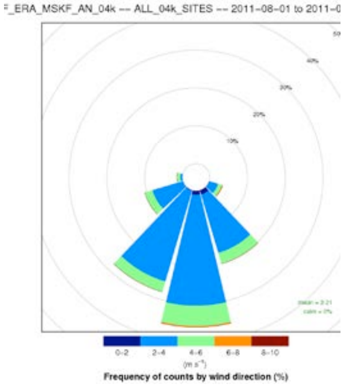
Obs



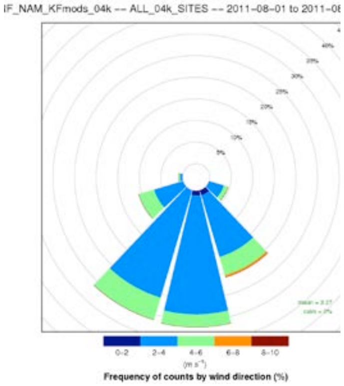
ERA-MSKF



NAM-MSKF



ERA-MSKF No AN



NAM-KF Mods

Figure 3-2. August 2011 wind roses, all sites in the 4-km domain

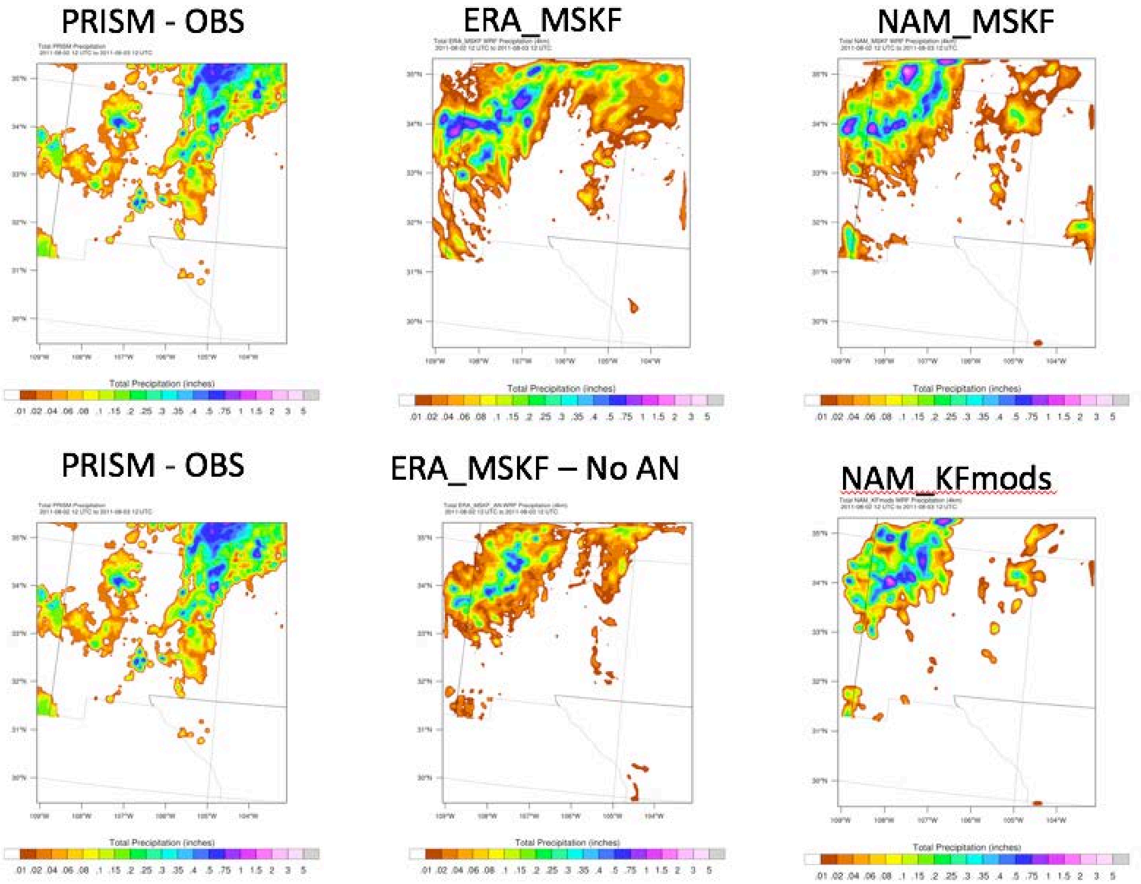


Figure 3-3. August 3, 2011 PRISM precipitation plots.

We ultimately selected NAM as the initialization dataset for the SNMOS WRF modeling. While NAM and ERA had comparable performance in simulating winds, we selected the NAM configuration with the MSKF convection cloud option because it tended to be dryer than ERA and exhibited better skill at simulating temperature. We judged that for ozone simulations, it was better to have simulated meteorology with a dry rather than wet bias in order to allow more solar insolation for ozone production.

Additional details about the WRF evaluation and configurations are available in the final Power Point deliverable for this task (UNC-IE and Ramboll Environ, 2015).

3.1.2 Significant Findings

The North American Model (NAM) and the European Centre for Medium Range Weather Forecasts model (ERA) initialization datasets provided comparable performance for WRF simulations of warm season meteorology in Southern New Mexico. While WRF performance was improved using the Multiscale (grid-aware) Kain-Fritsch cumulative cloud scheme, the model was still unable to consistently simulate precipitation patterns related to the North American monsoon. With the focus of the SNMOS on warm season ozone, we selected the NAM configuration with the multiscale Kain-Fritsch option because it tended to be dryer than ERA and exhibited better skill at simulating temperature. We judged that for ozone simulations, it was better to have simulated meteorology with a dry rather than wet bias in order to allow more solar insolation for ozone production.

3.1.3 Milestones and Deliverables

- Prepare a work plan for the WRF modeling and other aspects of study. (Completed 11/30/2015)

- Power Point Presentation of WRF Results/Recommendations (Completed 11/30/2015)

3.2 Task 2: Permian Basin Oil & Gas Inventory

3.2.1 Task Summary

Ramboll Environ reviewed available Permian Basin oil and gas (O&G) inventories and recommended 2011 and future year inventories for the SNMOS. Figure 3-4 shows Permian Basin active O&G well locations circa-2014 in New Mexico and Texas. The Doña Ana study base and future year Permian Basin emission inventories were based on the 2011NEIv2-based Platform (2011v6.2). The 2011NEIv2-based Platform base year emission inventory is for 2011, the base year of the Doña Ana County study; it includes the 2011 TCEQ well site emission inventory for Texas, and is consistent with the latest available well site emission inventory inputs for the Permian Basin in New Mexico. 2011 base year emissions from the 2011NEIv2-based Platform and 2025 2011NEIv2-based Platform emission inventories were used as is.

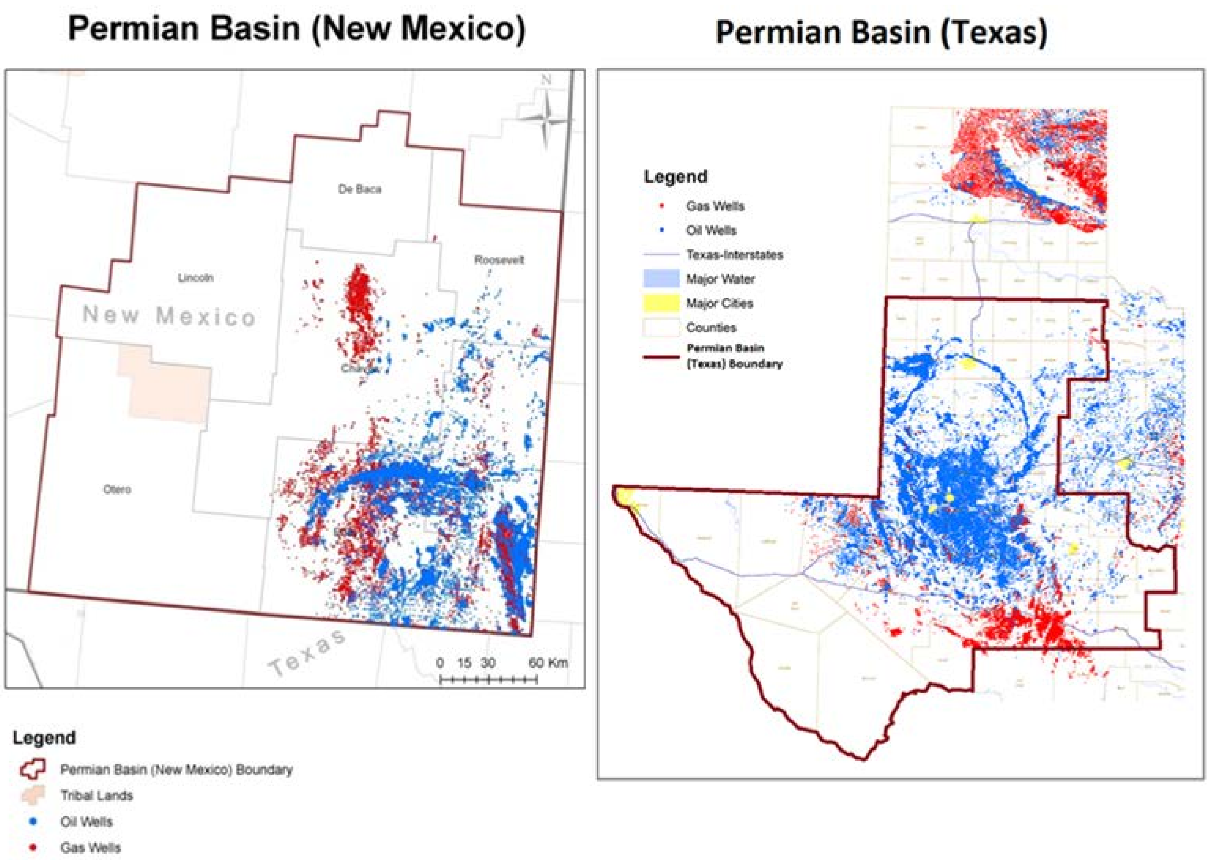


Figure 3-4. Permian Basin Well Locations (circa 2014). Source: Adapted from TCEQ Texas Oil and Gas Wells Map[1].

Figure 3-5 shows 2011 Permian Basin NOx and VOC Emissions broken down by state. NOx emissions totalled 99,577 tpy; 60% of the NOx emissions were from area sources and 40% were from point sources. Of the area source emissions (59,275 tpy), 50% were from compressor engines, 26% from artificial lift engines, 15% from heaters, and 7% from drill rigs (Figure 3-6). The sum of the other remaining categories was <3% of the emissions total. Texas was the source of 71% of the NOx emissions, and 29% of NOx emissions were from New Mexico (Figure 3-5).

Permian Basin 2011 VOC emissions were 507,813 tpy, and nearly all (99 %) emissions were from area sources, and 1% were from point sources. The largest category of VOC area sources (498,889 tpy) was oil tanks (55%) followed by wellhead venting (18%). Pneumatic devices, truck loading, and produced water each contributed 4% of area source VOC emissions and the remaining categories total <11%. Like NOx emissions, VOC emissions were heavily concentrated in Texas (83%) with New Mexico contributing the other 17% of emissions.

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[1] http://www.tceq.state.tx.us/assets/public/implementation/barnett_shale/bs_images/txOilGasWells.png

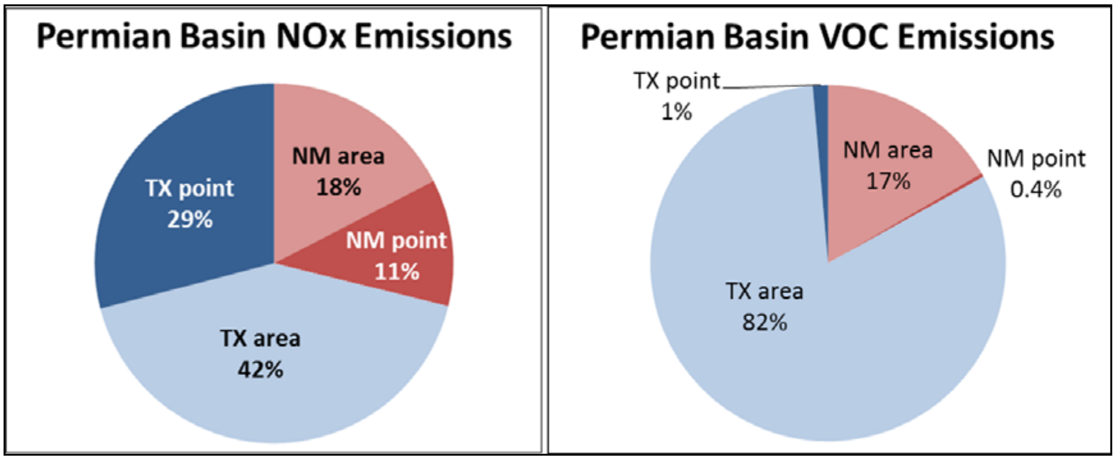

Figure 3-5. Permian Basin 2011 NOx and VOC emissions breakdown by state.

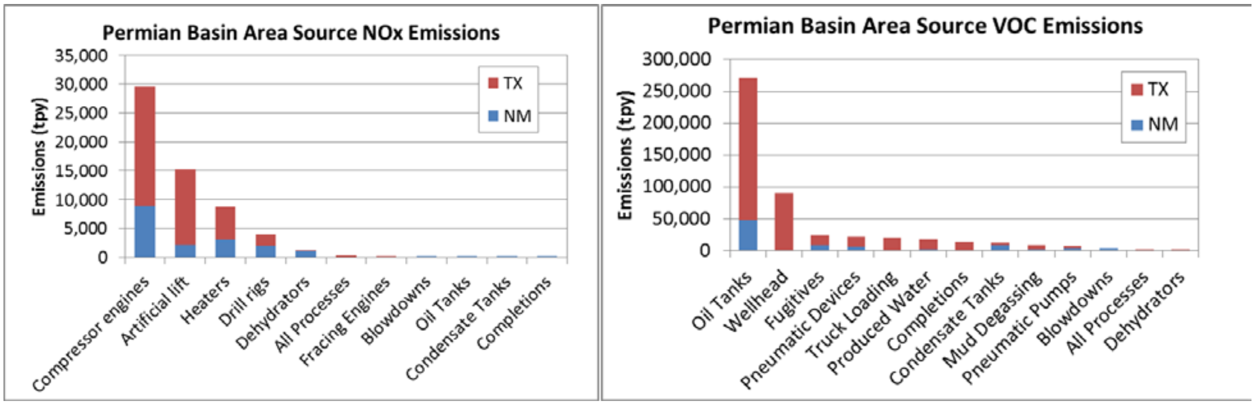

Figure 3-6. Permian Basin 2011 NOx and VOC emissions breakdown by emissions source category.

2011 point source emissions sources (40,302 tpy) were comprised of emissions from gas plants (59%), compressor stations (39%) and other sources such as tank batteries (3%) (Figure 3-7). A summary of Permian Basin-wide emissions for 2011 is given in Table 3-4.

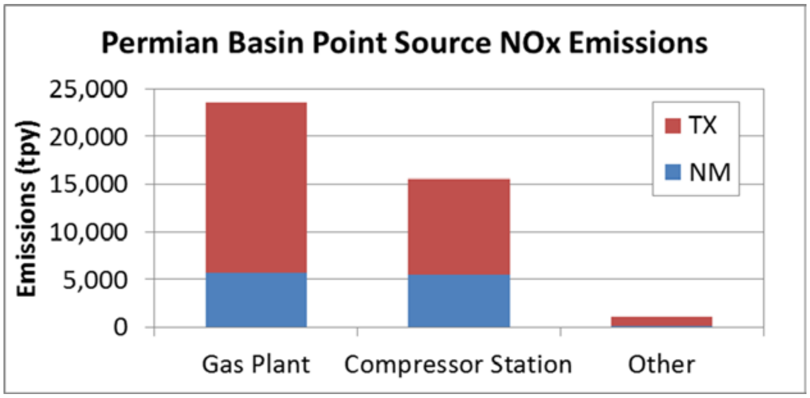

Figure 3-7. Permian Basin 2011 NOx point source emissions breakdown by state and emissions source category.

Table 3-4. Permian Basin 2011 inventory criteria pollutant emissions summary.

State	Type	2011 Permian Basin O&G Emissions (tpy)					
		NOX	VOC	CO	SO_2	PM_{10}	$PM_{2.5}$
NM	area	17,354	84,140	20,694	190	518	516
	point	11,367	1,887	5,428	12,340	171	170
NM Total		***28,721***	***86,027***	***26,123***	***12,530***	***689***	***686***
TX	area	41,921	414,749	36,820	2,728	707	705
	point	28,935	7,036	16,699	5,136	935	920
TX Total		***70,856***	***421,786***	***53,519***	***7,864***	***1,642***	***1,626***
Grand Total		**99,577**	**507,813**	**79,642**	**20,395**	**2,331**	**2,312**

For the SNMOS future year emissions modeling, activity growth for the Permian Basin was forecast. O&G activity growth factors for each play within the Permian Basin were based on the U.S. Energy Information Administration's Annual Energy Outlook (AEO) for 2014[2] (Figure 3-8). Southwest region growth factors were used outside of the specified plays. Table 3-5 shows the ratio of 2025:2011 sources for oil, gas and oil/gas wells. For all three defined plays within the Permian Basin and the Southwest Region, the number of oil, gas and oil/gas wells is forecast to increase.

AEO 2014 forecasts were released in April 2014, when the Cushing, Oklahoma (OK) West Texas Intermediate (WTI) crude oil price was about $100 per barrel. In August 2014, crude oil prices began to decline sharply and since November 2014, the Cushing, OK WTI crude oil price has

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[2] http://www.eia.gov/forecasts/aeo/pdf/0383(2014).pdf

remained between $40 and $60 per barrel[3]. The AEO 2015 forecast for the Cushing, OK WTI crude oil price for calendar year 2025 is 12% lower than the AEO 2014 estimate; AEO 2015 forecasts overall Southwest Region oil production to be 21% higher than the AEO 2014. While any oil and gas production forecasts are uncertain, the consistency in forecast crude oil production increases for the AEO 2014 and AEO 2015 indicate that the sharp increases in EPA's forecasts based on the AEO 2014 are reasonable, even with marked decreases in crude oil prices since August 2014.

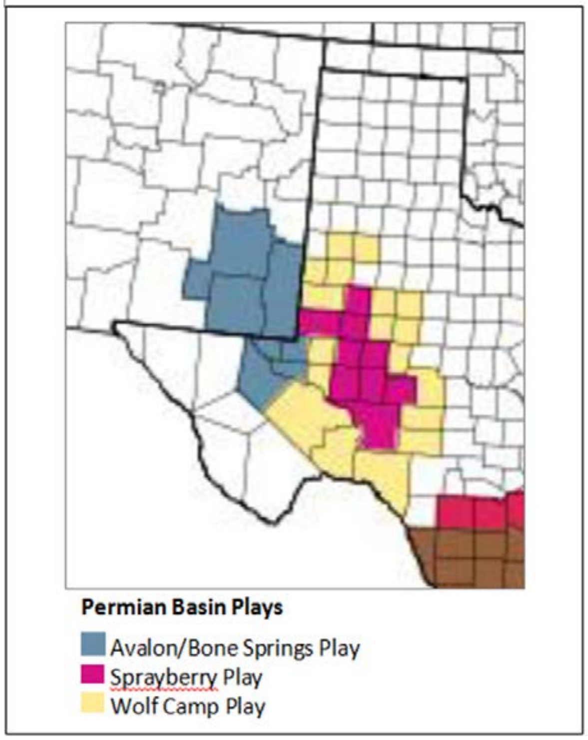

Figure 3-8. Permian Basin plays. Source: 2011v6.2 Modeling Platform TSD, excerpt from Figure 4-1.

Table 3-5. Permian Basin growth forecast by play.

Play / US Region	Oil Well Sources	Gas Well Sources	Oil and Gas Well Sources
Ratio 2025:2011			
🟪 Sprayberry Play	2.500	2.500	2.500
🟨 Wolfcamp Play	2.500	2.500	2.500
🟦 Avalon/Bone Springs Play	1.862	1.571	1.841
☐ Southwest Region	1.448	1.384	1.006

In addition to the effects of activity growth, EPA considers the control effects of on-the-books regulations for the O&G sector (EPA, 2015) when developing emissions forecasts. The control

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[3] Spot Prices for Crude Oil and Petroleum Products, http://www.eia.gov/dnav/pet/PET_PRI_SPT_S1_M.htm

effects of the following rulemakings are considered in the 2011NEIv2-based Platform 2017 and 2018 forecasts:

- New Source Performance Standards (NSPS) Subpart OOOO (area and point sources)
- Reciprocating internal combustion engine (RICE) NSPS Subparts JJJJ and IIII and NESHAP Subpart ZZZZ (area and point sources)
- Industrial/Commercial/Institutional Boilers and Process Heaters Maximum Achievable Control Technology (MACT) Rule (point sources)
- Standards of Performance for Turbines 40 CFR Part 60 - Subpart KKKK (point sources)
- Process Heaters NSPS (point sources)

3.2.2 Significant Findings

Emissions for the Permian Basin for 2011 and 2025 were developed using 2011NEIv2-based platform, growth based on the U.S. EIA AEO for 2014 and controls from pertinent rulemakings. Growth in activity is projected for the Permian Basin between 2011 and 2025; therefore, emissions of ozone precursors are projected to increase in 2025 relative to 2011.

3.2.3 Milestones and Deliverables

- Power Point Presentation on Permian Basin oil and gas 2011 and future year emission update (Completed 11/30/2015)
- Memo on available Permian Basin oil and gas 2011 and future year emissions data (Completed 11/10/2015)

3.3 Task 3: Juárez and Mexico Border Inventory (Current and Future Years)

3.3.1 Task Summary

The objective of this task was to recommend 2011 and future year emission inventory data covering the Mexico Border States and Ciudad Juárez for use in the SNMOS. We coordinated with NMED and the U.S. EPA to gather the best available data. We reviewed the available emissions data for these regions, including both inventories and ancillary data, and determined that the 2008-based Mexico National Emission Inventory (MNEI) were the best available data and the most appropriate of the available data to use for the SNMOS. These data were available as part of the U.S. EPA 2011v6.2 National Emissions Inventory (NEI) Emissions Modeling Platform (EMP).

The U.S. EPA distributed Mexico emissions data as part of the 2011v6.0 and 2011v6.2 EMPs. The 2011v6.0 EMP included a 1999-based version of the MNEI with projections to 2008, 2012, and 2030 (USEPA, 2014; Wolf et al., 2009). The 2011v6.2 EMP included a 2008-based version of the MNEI with projections to 2018 and 2025 (ERG, 2014). Figure 3-9 shows state total comparisons of the two Mexico inventories for the three major inventory sectors: on-road mobile, nonpoint, and point sources.

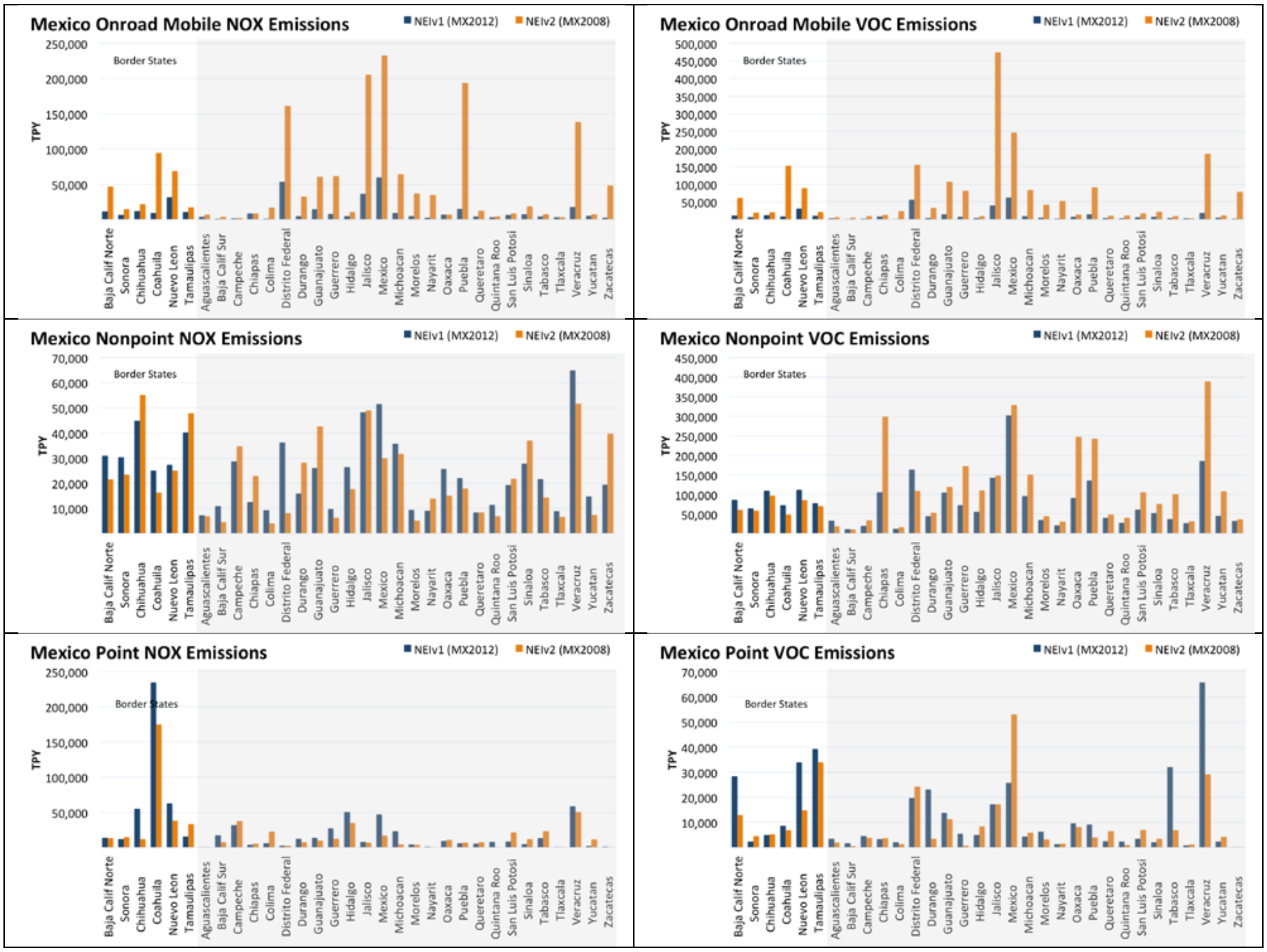

Figure 3-9. Mexico state inventory comparisons

As the 2008-based MNEI uses the most recent activity data that are publically available for Mexico, we decided with NMED that we would use these data for the SNMOS ozone modeling. We determined that this version of the MNEI, which is distributed with the U.S. EPA 2011v6.2 EMP, is the best available anthropogenic emissions data for Mexico. We used the 2008 MNEI as is for the 2011 SNMOS modeling and the 2025 projections for the future year SNMOS modeling. Natural emissions sources in Mexico were estimated using the same data and approaches used to estimate these emissions for the U.S. (see Task 5).

Our analyses of the MNEI anthropogenic emissions data included comparisons of the emissions totals between 2008 and 2025 at the state level (Figure 3-10) and for the municipalities in the immediate vicinity of Doña Ana County.

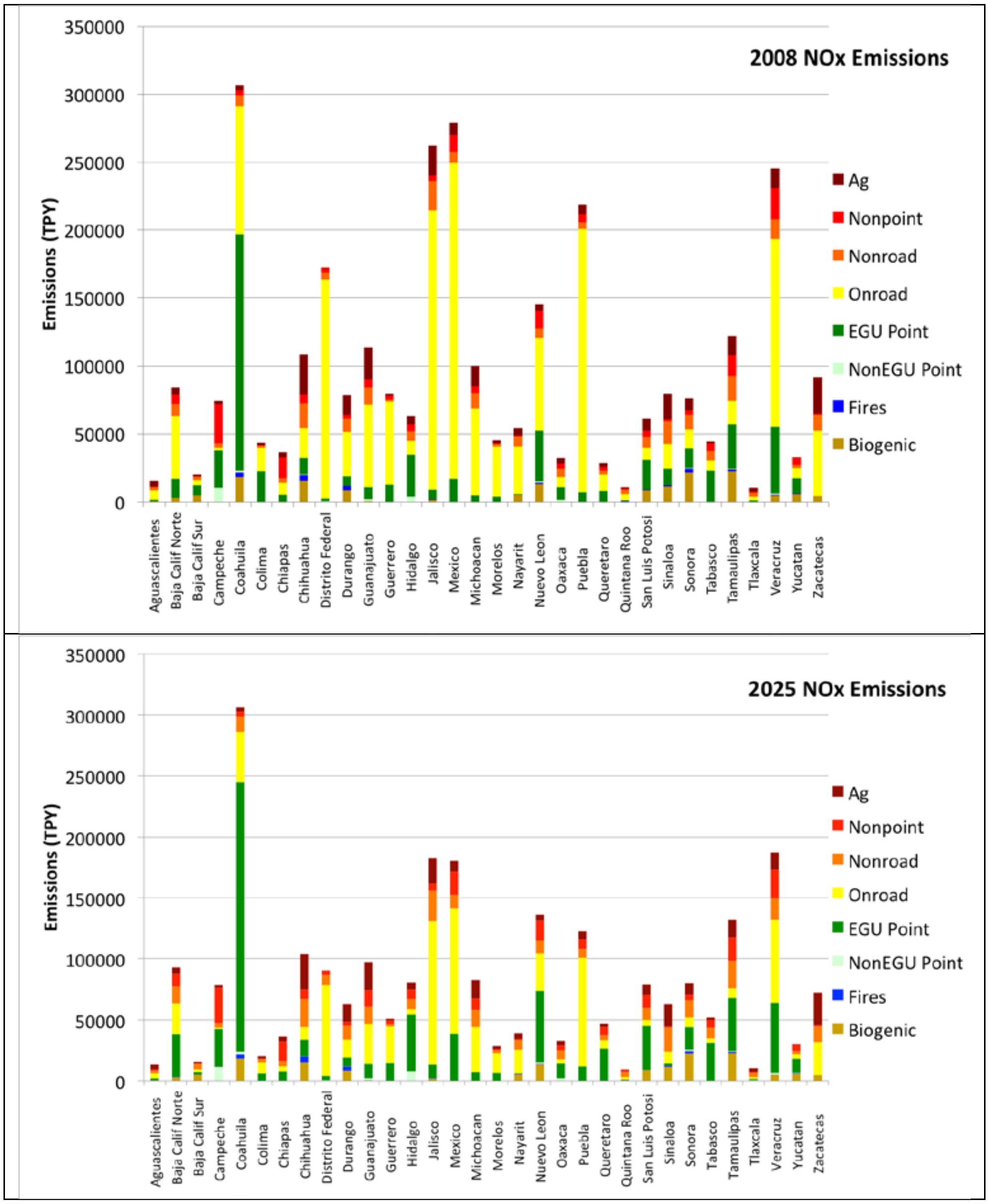

Figure 3-10. 2008 (top) and 2025 (bottom) Mexico state total NOx emissions

Additional details about the Mexico emissions data evaluation are available in the final Power Point deliverable for this task (UNC-IE and Ramboll Environ, 2015).

3.3.2 Significant Findings

The 2008-based Mexico NEI, which is distributed with the U.S. EPA 2011v6.2 emissions modeling platform, is the best available database of current and future year emissions estimates for Mexico. The 2008 base year emissions and 2025 emissions projections for Mexico were selected for the SNMOS.

3.3.3 Milestones and Deliverables

- Power Point presentation on Mexico emissions to be used in 2011 base and future year modeling (Completed 11/30/2015).

3.4 Task 4: Prepare Base Year Emissions with SMOKE

3.4.1 Task Summary

We developed anthropogenic emissions estimates for the SNMOS from the WAQS 2011 version B (2011b) emissions modeling platform available from the IWDW[4]. The data sources for the WAQS 2011b emissions estimates included the U.S. EPA, Ramboll Environ, and the states of Colorado, Utah, and Wyoming. As part of the WAQS, UNC-IE formatted the data for input to the Sparse Matrix Operator Kernel Emissions (SMOKE[5]) system, processed the data into CAMx input files with SMOKE, and performed quality assurance and quality control (QA/QC) on the emissions data and modeling.

We used all of the anthropogenic emissions data (e.g., non-road mobile, nonpoint, electricity generating units) collected and prepared for the WAQS 2011b simulation to generate CAMx-ready emissions for the SNMOS. The significant effort invested in the WAQS in collating and quality assuring these data was inherited by the SNMOS through adaptation of the WAQS 2011b modeling platform. As the modeling domains and meteorology data are different between the studies, adapting the WAQS data involved generating emissions for the SNMOS modeling domains and time period.

The SNMOS used 12-km and 4-km modeling domains focused on southern New Mexico. The standard continental U.S. (CONUS) Lambert Conformal Conic Projection (LCP) was used in the SNMOS for the domains shown in Figure 3-11 and described below.

- The SNMOS WESTUS12 CAMx domain encompasses all of New Mexico, extends west to include the metropolitan area of Phoenix, east to include West Texas, and South to include the Carbon II power plant in Coahuila, Mexico. This facility is a large source of NOx emissions and lies in a region that was sometimes upwind of Doña County on high ozone days during 2011. The SNMOS WESTUS12 domain was designed as a trade-off between computational efficiency and the need to model transport from sources likely to influence Doña Ana County at 12-km resolution.
- The SNMOS 4-km Doña Ana County domain focuses on Southern New Mexico and the major source regions in the immediate vicinity, including Ciudad Juárez, Mexico and El Paso, TX.

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[4] http://views.cira.colostate.edu/tsdw

[5] http://www.smoke-model.org

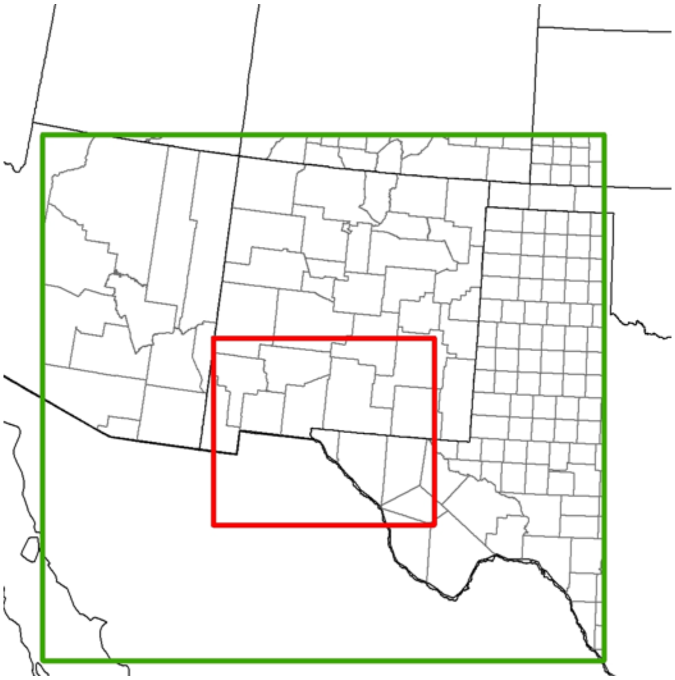


Figure 3-11. SNMOS 12-km (green) and 4-km (red) nested CAMx modeling domains.

We prepared emissions on these domains for April 15 through August 30, 2011 using SMOKE version 3.7. The first 15 days of emissions (April 15-30) were prepared to initialize the CAMx simulation for the air quality analysis period beginning on May 1.

Consistent with the WAQS 2011b emissions modeling platform, all of the non-O&G anthropogenic emission inventories for the SNMOS base year 2011 simulations were taken from the U.S. EPA National Emission Inventory (NEI). EPA publically released the 2011v6 platform in February 2014 and updated it twice, version 6.2 being the most recent. Details of the inventory, sectors, and preparation procedures for these data are available in the NEI2011v6.2 Technical Support Document (US EPA, 2015). The exception was the O&G inventories for most of the basins in Northern New Mexico, Colorado, Utah, and Wyoming, which were provided by Ramboll Environ. Ramboll Environ also developed emissions estimates for natural emissions sources for the SNMOS, including fires, biogenics and lightning (see Task 5 summary).

In coordination with NMED, we determined that the 2008 Mexico National Emission Inventory (MNEI), which is packaged with the NEI2011v6.2, was the most appropriate publically available Mexico inventory to use for the SNMOS (see Task 3 summary).

Ramboll Environ also conducted a review of the available Permian Basin O&G inventories and determined that the inventory and ancillary emissions data that are part of the NEI2011v6.2 are the best available data for these sources (Grant and Kemball-Cook, 2015; and see Task 2 summary).

The SNMOS project used MOVES to estimate on-road mobile emissions for U.S. sources. The U.S. EPA provided MOVES input emission-factors for 2011. The SMOKE-ready on-road mobile inventory data are a combination of county-level activity data and emissions factor look-up tables output from MOVES for representative counties. The on-road mobile activity data included county-level vehicle miles travelled (VMT), vehicle population (VPOP), and averaged speed profiles by vehicle type and road class. The look-up tables for representative counties, which are output from MOVES emissions rate mode simulations, contained county-level emissions factors as a function of temperature, relative humidity, and speeds. Land cover data and biogenic emissions factors by land cover type were used to estimate biogenic emissions fluxes. We used non-inventory, or ancillary emissions data provided by the U.S. EPA, to convert the inventories into the format required by CAMx.

Part of the preparation process for the inventory data included splitting the inventories into detailed subsectors. We split up many of the U.S. EPA NEI inventories to support the application of source-specific parameterizations of temporal and spatial patterns, to facilitate source-based emissions sensitivities, and to support targeted quality assurance of important inventory sectors. Although anthropogenic inventories can be generally classified as point, non-point, or mobile sources, we used over 20 individual anthropogenic inventory sectors in the SNMOS modeling. Table 3-6 is a listing of the inventory processing sectors used for the SNMOS. The table lists the inventory processing sectors, the source of the inventory data, the type of inventory (i.e., point, nonpoint, or gridded), the inventory year, and brief descriptions of the inventory sources included in the sector.

Table 3-6.SNMOS emissions processing sectors

Sector	Source	Type	Inventory Period and Year	Description
Locomotive/ marine	NEI 2011v6.2	Point and Nonpoint	Annual 2011 and 2025	The locomotive/marine sector is a subset of the non-point/area sector. It includes county-level emissions for line haul locomotives (nonpoint), train yards (point), and class 1 and 2 in- and near-shore commercial marine.
Off-road mobile	NEI 2011v6.2	Nonpoint	Monthly 2011 and 2025	NMIM county-level inventories for recreational vehicles, logging equipment, agricultural equipment, construction equipment, industrial equipment, lawn and garden equipment, leaf and snow blowers, and recreational marine. The CA and TX NONROAD estimates were normalized to emissions values provided by these states.
On-road mobile (US)	NEI 2011v6.2	MOVES	Annual and Daily 2011 and 2025	EPA ran MOVES2014 for 2011 in emissions factor mode. The MOVES lookup tables include on-network (RPD), on-network for CA (RPD_CA), off-network starts/stops (RPV), off-network starts/stops for CA (RPV_CA), off-network vapor venting (RPP), off-network vapor venting sources for CA (RPP_CAT, off-network hotelling (RPH). These data include the reference county and reference fuel month assignments that EPA used for the MOVES

Sector	Source	Type	Inventory Period and Year	Description
				simulations. The CA MOVES estimates were normalized to emissions values provided by these states.
Non-point/ Area	NEI 2011v6.2	Nonpoint	Annual 2011 and 2025	County-level emissions for sources that individually are too small in magnitude or too numerous to inventory as individual point sources. Includes small industrial, residential, and commercial sources; broken out into nonpoint, residential wood combustion, livestock, and fertilizer processor sectors.
Refueling	NEI 2011v6.2	Nonpoint	Annual 2011 and 2025	Nonpoint, gasoline stage 2 refueling.
Area Oil & Gas	WAQS 2011 and NEI 2011v6.2	Nonpoint	Annual 2011 and 2020	Non-point oil and gas sources are survey-based and typically unpermitted sources of emissions from up-stream oil and gas exploration, development, and operations. The non-point O&G sector consists of the WAQS Phase II and the NEI 2011v6.2 inventory for all basins outside of the WAQS inventory coverage area.
Point Oil & Gas	WAQS 2011 and NEI 2011v6.2	Point	Annual 2011 and 2020	Point oil and gas sources are permitted sources of emission from up-stream oil and gas exploration, development, and operations. The point O&G sector consists of the WAQS Phase II and the NEI 2011v6.2 inventory for all areas outside of the WAQS inventory coverage area.
CEM Point	2011v6.2 and CAMD	Point	Hourly 2011 and 2025	2011 Clean Air Markets Division (CAMD) hourly Continuous Emissions Monitor (CEM) data and Integrated Planning Model (IPM) projections to 2025.
non-CEM Point	2011v6.2	Point	Annual 2011 and 2025	Elevated and low-level combustion and industrial sources, airports, and offshore drilling platforms.
Offshore Shipping	2011v6.2	Point	Annual 2011 and 2025	Elevated point C3 commercial marine sources in offshore commercial shipping lanes.
Fires	PMDETAIL	Point	Daily 2011	PMDETAIL version 2 wildfire, prescribed burns and agricultural burning open land fires.
Canada Sources	NPRI 2010	Nonpoint and Point	Annual 2010	Canadian 2010 National Pollutant Release Inventory; there are no future year projections from the 2010 NPRI.
Mexico Sources	MNEI 2012	Nonpoint and Point	Annual 2008 and 2025	Mexican NEI 2008 and projections to 2025.
Biogenic	MEGAN v2.10	Gridded	Hourly 2011	MEGANv2.10 estimated with 2011 meteorology.
Lightning	Ramboll Environ	Gridded	Daily 2011	Lightning NOx emissions estimated with 2011 meteorology.

Several gridded emissions datasets were used for either directly estimating air emissions or as ancillary data for processing/adjusting the emissions data. The following datasets are key gridded data used in the SNMOS. We included neither sea salt nor windblown dust emissions in the SNMOS because of the study emphasis on O_3.

In addition to the inventory and gridded emissions data, ancillary datasets provide temporal, chemical, and spatial allocation specifications to the emissions. The ancillary data for SNMOS were taken directly from the WAQS 2011b modeling, which was derived primarily from the EPA 2011v6.2 modeling platform.

Additional details about the U.S. emissions data used for the SNMOS is available in the final emissions modeling memo for this task (Adelman and Baek, 2016).

3.4.2 Significant Findings

The Western Air Quality Study 2011b emissions modeling platform was used to develop summer season 2011 emissions for the SNMOS. On an annual basis, on-road mobile sources were the largest source of NOx and biogenic sources the largest source of VOC in Doña Ana County in 2011. In the immediate vicinity of Doña County, El Paso County, TX was the largest source NOx and Ahumada Municipality the largest source of VOC in 2011.

3.4.3 Milestones and Deliverables

- Technical memo for 2011 base year emission modeling with SMOKE (Completed 2/29/2016)
- CAMx-ready 2011 base year emissions on the project 12-km and 4-km modeling domains (Completed 2/29/2016)

3.5 Task 5: Prepare Natural Emissions for the Project Modeling

3.5.1 Task Summary

Ramboll Environ prepared natural emissions for the SNMOS 2011 Base Case 12/4 km domain CAMx modeling. Natural emissions are unrelated to human activities and for SNMOS, the natural emission inventory consisted of biogenic emissions and emissions from fires and lightning.

3.5.1.1 Biogenic Emissions Modeling

The Model of Emissions of Gases and Aerosols in Nature (MEGAN) is a modeling system for estimating the net emission of gases and aerosols from terrestrial ecosystems into the atmosphere (Guenther et al., 2006; Guenther et al., 2012). Driving variables include land cover, weather, and atmospheric chemical composition. MEGAN is a global model with a base resolution of ~1 km and so is suitable for regional and global models. A FORTRAN code is available for generating emission estimates for the CAMx regional air quality model. WRAP has recently updated the MEGAN biogenic emissions model using western U.S. data and higher resolution inputs (Sakulyanontvittaya et al., 2012). MEGAN v2.1 was used for the SNMOS biogenic emissions modeling

MEGAN generates hourly, gridded biogenic emissions and requires gridded inputs. Land cover data specify the type of plants present in each model grid box as well as the density of the foliage. Global distributions of land cover variables (Emission Factors, Leaf Area Index, and Plant

Functional Types) are available for spatial resolutions ranging from ~ 1 to 100 km. Leaf Area Index (LAI) quantifies the amount of foliage at a given location and the age of the foliage and is derived from satellite measurements. Satellite-observed radiances at several wavelengths are related to chlorophyll activity and leaf area. The LAI variable defines the number of equivalent layers of leaves relative to a unit of ground area. The data are composited every 8 days at 1-kilometer resolution. Plant functional type data are developed from high resolution satellite land cover/crop data and species composition is averaged over ecoregion. The National Land Cover Database (NLCD) includes three products that are used in the development of the MEGAN land cover: tree-cover fraction impervious cover fraction, and a land cover dataset.

Weather determines how active the plants are. MEGAN requires gridded hourly temperature, solar radiation and soil moisture data, which were supplied by the SNMOS 2011 WRF MSKF NAM meteorological model run outputs. The final input data for MEGAN are emission factor maps which are based on vegetation species composition.

Ramboll Environ ran MEGAN for the SNMOS 2011 episode and performed quality assurance of the MEGAN emissions. We prepared county-level emission summaries for NOx, CO and VOC and reviewed spatial maps of the biogenic emissions. The review focused on whether the pattern of emissions appeared reasonable. For example, we expect to see higher biogenic emissions over heavily vegetated regions and that urban areas and deserts should have lower biogenic emissions. Figure 3-12 is an example of the spatial quality assurance of the biogenic emission inventory and shows the episode average isoprene emissions on the 4-km grid. The isoprene emissions show minima in emissions where there is little vegetation (urban areas, deserts) and maxima in emissions in forested areas such as the Lincoln National Forest. Overall, isoprene emissions are larger in Mexico than in the U.S. There is a discontinuity in emissions at the U.S.-Mexico border (white arrow) that is not apparent in the vegetation distribution in the Google Earth satellite imagery. This suggests that there is uncertainty in biogenic emission inventory related to differences in MEGAN inputs for the U.S. and Mexico.

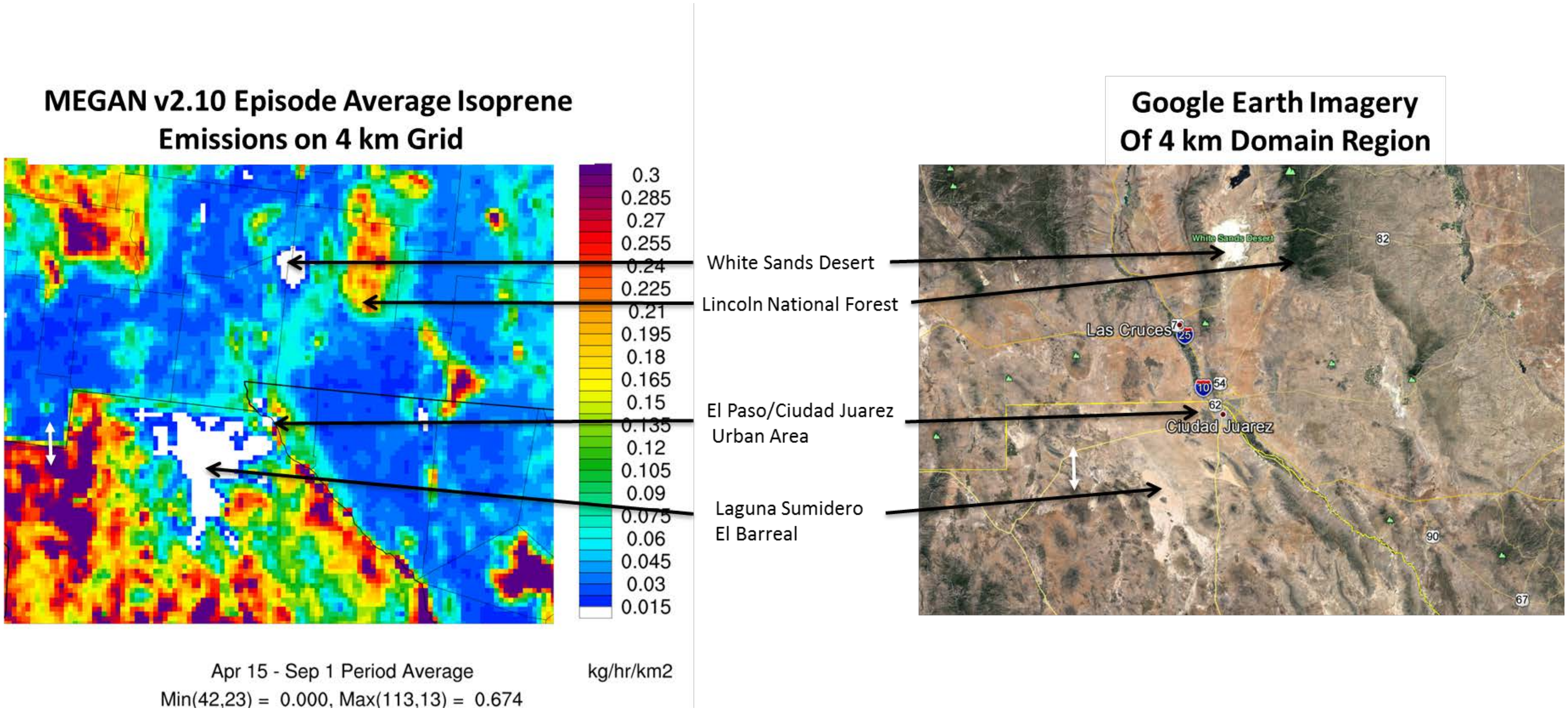


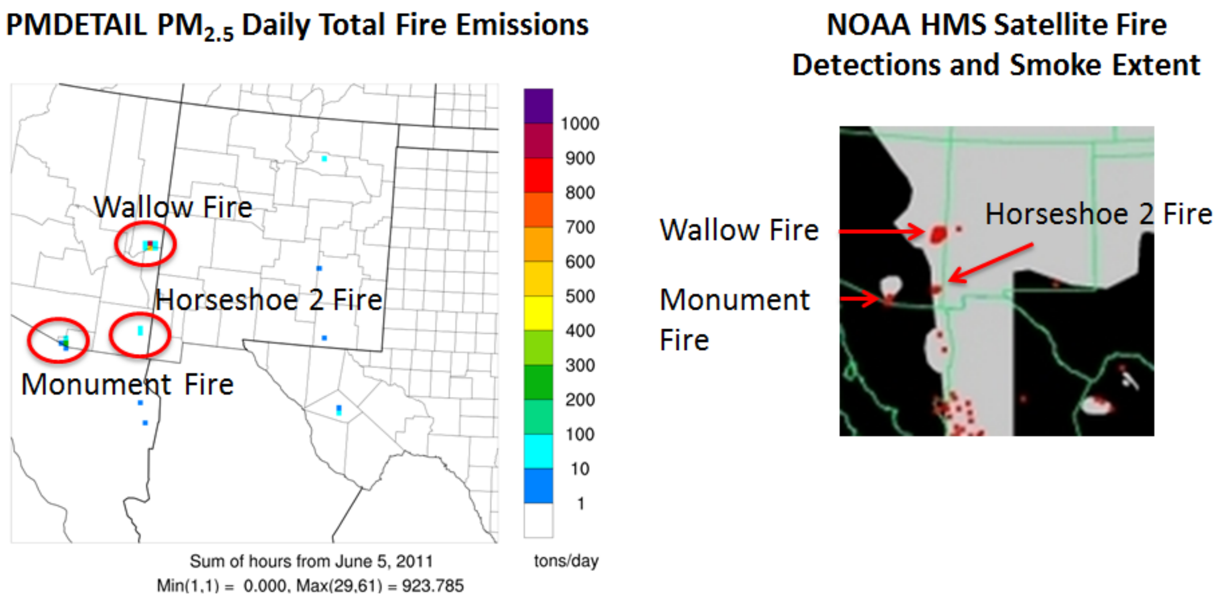
Figure 3-12. Example of biogenic emissions quality assurance. Left panel: SNMOS MEGAN v2.10 2011 episode average isoprene emissions on the 4-km grid. Right panel: Google Earth visible imagery of the region shown in the left panel.

3.5.1.2 Fire Emissions Modeling

Open biomass burning makes up an important part of the total global emissions of greenhouse gases, reactive trace gases, and particulate matter. Although episodic in nature and highly variable, open biomass burning emissions can contribute to local, regional, and global air quality problems and climate forcing. The SNMOS used fire emissions for 2011 that were generated by the Particulate Matter Deterministic and Empirical Tagging and Assessment of Impacts on Levels (PMDETAIL) study. PMDETAIL developed 2011 fire emission using satellite data and ground detect and burn scar, in addition to other data, with a slight modification (Mavko, 2014) to the methodology used in the Deterministic and Empirical Assessment of Smoke's Contribution to Ozone Project (DEASCO3) study for the 2008 modeling year (DEASCO3, 2013). We used a similar plume rise approach as PMDETAIL/DEASCO3 where plume rise depends on fire size and type (Mavko and Morris, 2013). The PMDETAIL 2011 fire inventory was selected over the 2011 Fire INventory from NCAR (FINN) and Smartfire 2011 inventory because it uses a more complete satellite and surface fire dataset.

Day-specific FETS fire activity data was used for all wildfire, agricultural, and prescribed fires within the 12/4 km modeling domain. FETS data included size, location, timing, fuel loading, moisture, and emission fluxes and chemical parameters. Fire emissions were gridded to the SNMOS modeling domains and speciated for the CAMx CB6r2 chemical mechanism. The plume characteristics for each fire event were prescribed based on the fire type and size. Plume rise is weather-dependent is and is characterized by smoldering fraction, plume bottom and plume top. Once PMDETAIL fire emissions were developed for the SNMOS Base Case 2011 modeling period, we developed separate county-level emissions summaries for agricultural burns, wildfires, and prescribed fires. We also made spatial plots of the daily fire emissions and performed spot checks to ensure that the PMDETAIL fire locations matched satellite fire detections from NOAA's Hazard Mapping System (HMS) Fire and Smoke Analysis Product. The HMS product uses data from the GOES Imager, the AVHRR (Advanced Very High Resolution Radiometer) instrument, and MODIS (Moderate Resolution Imaging Spectroradiometer). Fire locations derived by thee algorithms based on different satellite retrievals reviewed by an analyst, who removes false detections and reconciles the three fire location data sets. The analyst outlines the locations of smoke plumes inferred from satellite aerosol optical depth retrievals.

Figure 3-13 shows an example of the fire emissions quality assurance for June 5, 2011. On this day, there were several large fire complexes burning in the 4-km domain. The Wallow Fire in eastern Arizona, the Horseshoe 2 fire in southeastern Arizona and the Monument Fire on the U.S.-Mexico border are shown in the fire emissions plot in the left hand panel and match the satellite fire detections shown in the HMS product.


PMDETAIL $PM_{2.5}$ Daily Total Fire Emissions

NOAA HMS Satellite Fire Detections and Smoke Extent

Figure 3-13. Example of fire emissions quality assurance. Left panel: June 5, 2011 PMDETAIL daily total $PM_{2.5}$ emissions HMS product showing fire locations (red dots) and smoke plume (gray area).

3.5.1.3 Lightning Emissions Modeling

NO_x is formed in lightning channels as the heat released by the electrical discharge causes the conversion of N_2 and O_2 to NO. Lightning NOx emissions (LNOx) can be estimated directly based on the number of lightning flashes, the intensity of each flash, the lightning type (cloud-to-ground vs. cloud-to-cloud), and the amount of NOx emitted per flash. Because formation of LNOx is associated with deep convection in the atmosphere, LNOx production is typically parameterized in terms of the modeled convective activity. LNOx production is often assumed to be related to cloud top height or convective rainfall. The modified lightning NOx emissions model of Koo et al. (2010) was used to estimate lightning NOx emissions for the SNMOS. Koo et al. use a hybrid approach that preserves the consistency of the WRF modeled convection and the location of LNOx emissions, but also attempts to constrain the LNOx emissions to match observed distributions of lightning or an estimate of total emissions. Additional details on the development and evaluation of the lightning emissions processor used in the SNMOS are available in the WestJumpAQMS Sea Salt and Lightning memo (Morris et al., 2012) [6]. LNOx emissions were allocated to WRF grid columns where modeled convection occurred using WRF convective precipitation as a proxy for lightning activity. LNOx emissions were distributed in the vertical using profiles derived from aircraft measurements and cloud-resolving models. LNOx emissions were modeled as point sources with zero plume rise in appropriate layer.

Once the LNOx emissions had been generated, we performed quality assurance of the emissions by comparing maps of vertically integrated LNOx emissions with WRF modeled precipitation. An example of this quality assurance is shown in Figure 3-14, which compared

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[6] http://www.wrapair2.org/pdf/memo_12_seasalt_lightning_june25_2012_final.pdf

the daily total precipitation from WRF (left panel) with the column-integrated LNOx emissions for a 24-hour period in July 2011. The locations of locally intense (convective) rainfall align well with the maxima in the LNOx emissions, which indicates that the LNOx emissions have been correctly allocated in space.

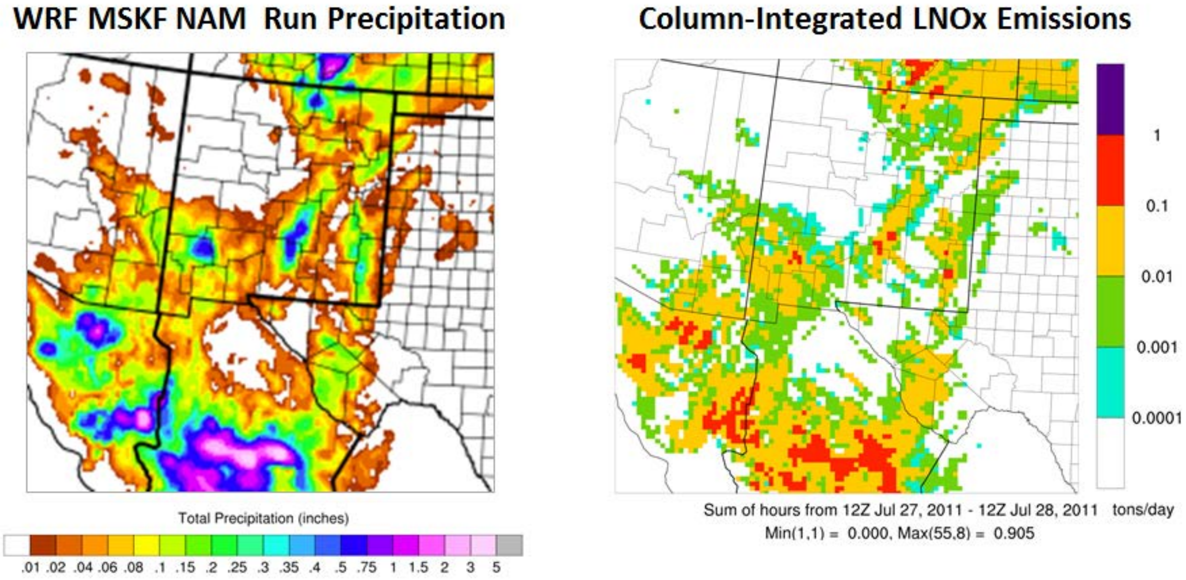


Figure 3-14. LNOx emissions quality assurance for July 27-28, 2011. Left panel: daily total precipitation from the WRF MSKF NAM model run. Right panel: column-integrated LNOx emissions for the July 27-28 period matched in time to the precipitation total shown in the left panel.

3.5.2 Significant Findings

The results of the quality assurance for the natural emissions suggest that the emissions modeling was correctly executed. However, there are significant uncertainties in all three components of the natural emission inventory. For the biogenic inventory, there is a discontinuity in emissions at the U.S.-Mexico border and emissions are larger over Mexico than the U.S. for environments that appear from Google Earth imagery to have comparable vegetation cover. Further investigation of differences in MEGAN inputs for the U.S. and Mexico should be undertaken to understand these differences and to ensure that the most accurate inventories possible are used on both sides of the border. Modeling of fire and lightning emissions are active areas of scientific research, and the SNMOS emission inventories should be considered to have considerable uncertainty associated with them.

3.5.3 Milestones and Deliverables

- Prepared gridded, CAMx ready MEGAN version 2.10 biogenic emissions. (Completed 1/12/2016)
- Prepared gridded, CAMx ready lightning NOx emissions. (Completed 1/15/2016)
- Prepared gridded, CAMx ready PMDETAIL fire emissions. (Completed 1/18/2016)

- Provided natural emissions on the 12/4 km grids to UNC for SMOKE emissions modeling/merge (Completed 1/18/2016)
- PowerPoint presentation on results of natural emissions modeling. (Completed 2/16/2016)

3.6 Task 6: Base Year Air Quality Modeling

3.6.1 Task Summary

The SNMOS performed photochemical grid modeling for the year 2011 using the Comprehensive Air Quality Model with Extensions (CAMx) version 6.20. The SNMOS Work Plan for the 2011 Modeling Year (Adelman et al., 2015a) details the CAMx configuration and justification for the model's selection for the SNMOS. CAMx was run for April–October, 2011 and configured as in the WAQS 2011b study. The model configuration is summarized in Table 3-7.

The SNMOS CAMx modeling grids are shown in Figure 3-15. The 3SAQS 36-km grid 3D CAMx output fields were used as BCs for the SNMOS 12-km grid. While the SNMOS modeling leveraged the WAQS/3SAQS modeling platforms, some changes to the WAQS/3SAQS modeling grids were required simulate ozone in Southern New Mexico as accurately as possible. The brown rectangle in Figure 3-15 shows the extent of the 3SAQS 12-km modeling grid. The SNMOS 12-km modeling domain, shown in green, is smaller than the 3SAQS 12-km grid and is focused on the region surrounding southern New Mexico. The southern boundary of the SNMOS 12-km grid was extended southward beyond the southern boundary of the 3SAQS 12-km grid in order to encompass the NOx emissions sources that are most important to ground-level ozone formation in southern New Mexico (Figure 2-1). The SNMOS 12-km grid boundary lies south of the Carbon II power plant in Coahuila, Mexico. This facility is a large source of NOx emissions and lies in a region that was sometimes upwind of Doña Ana County on high ozone days during 2011. The spatial extent of the SNMOS 12-km domain strikes a balance between computational efficiency and the need to model transport from sources likely to influence Doña Ana County at 12-km resolution. The SNMOS 4-km Doña Ana County domain (shown in red in Figure 3-15) focuses on Southern New Mexico and the major emissions source regions in the immediate vicinity, including Ciudad Juárez, Mexico and El Paso, TX. The 12-km domain provided the BCs for the 4-km domain.

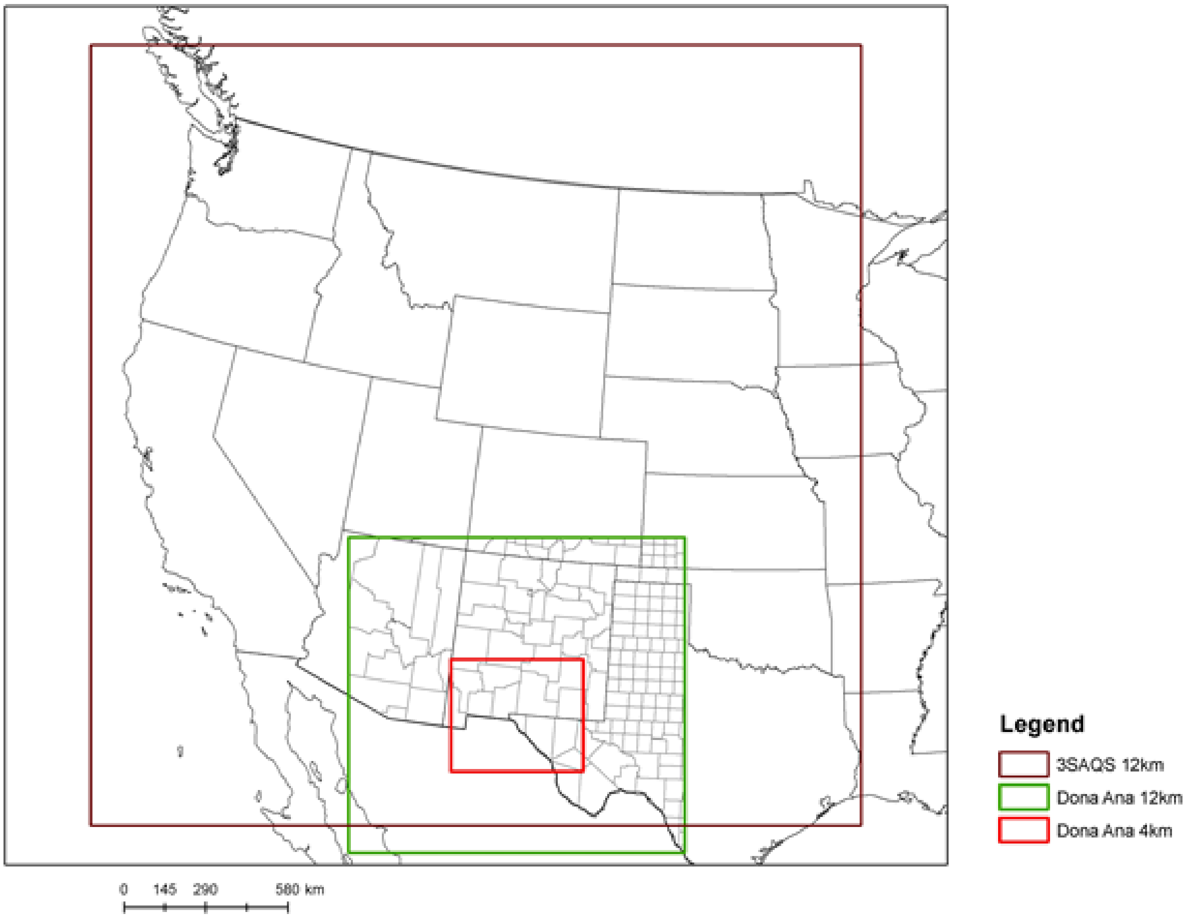


Figure 3-15. CAMx Modeling Domains and Boundary Conditions.

Table 3-7. SNMOS CAMx version 6.20 configuration.

Science Options	Configuration	Details
Model Codes	CAMx V6.20 – March 2015 Release	
Horizontal Grid Mesh	36/12/4 km	
36-km grid	148 x 112 cells	36-km CONUS domain
12-km grid	99 x 93 cells	12-km SNMOS WESTUS12 regional domain
4-km grid	117 x 99 cells	4-km Dona Ana domain
Vertical Grid Mesh	34 vertical layers defined by WRF; no layer collapsing	Layer 1 thickness ~12 m. Model top at ~19-km above MSL
Grid Interaction	12/4-km two-way nesting for CAMx (2011) 36/12/4-km two way nesting for CAMx (2025)	
Initial Conditions	10 day spin-up on 12/4 km grid before first day with MDA8 ozone>70 ppb at any Doña Ana County monitor (2011) 14 day spin-up on 36/12/4 km grid (2025)	Clean initial conditions
Boundary Conditions	12-km SNMOS grid from 36/12-km WAQS modeling (2011) 36-km grid from global chemistry model (2025)	MOZART GCM data for 2011; zero out dust and sea salt.
Emissions		
Baseline Emissions Processing	SMOKE, MOVES and MEGAN	
Sub-grid-scale Plumes		
Chemistry		
Gas Phase Chemistry	CB6r2	Active methane chemistry and ECH4 tracer species
Meteorological Processor	WRFCAMx	Compatible with CAMx V6.20
Horizontal Diffusion	Spatially varying	K-theory with Kh grid size dependence
Vertical Diffusion	CMAQ-like in WRF2CAMx	
Diffusivity Lower Limit	Kz_min = 0.1 to 1.0 m^2/s or 2.0 m^2/s	Land use dependent
Deposition Schemes		
Dry Deposition	Zhang dry deposition scheme (CAMx)	Zhang 2003
Wet Deposition	CAMx-specific formulation	rain/snow/graupel/virga
Numerics		
Gas Phase Chemistry Solver	Euler Backward Iterative (EBI) -- Fast Solver	
Vertical Advection Scheme	Implicit scheme w/ vertical velocity update	

Science Options	Configuration	Details
	(CAMx)	
Horizontal Advection Scheme	Piecewise Parabolic Method (PPM) scheme	Collela and Woodward (1984)
Integration Time Step	Wind speed dependent	~0.1-1 min (4-km), 1-5 min (1 -km), 5-15 min (36 km)

3.6.2 Significant Findings

The CAMx modeling of 2011 was completed successfully.

3.6.3 Milestones and Deliverables

- 2011 base year air quality modeling presentation (Completed 2/22/2016)
- Carry out SNMOS 2011 Base Case CAMx modeling (Completed 3/25/2016)

3.7 Task 7: Model Performance Evaluation and Sensitivity Modeling

3.7.1 Task Summary

Following the completion of the SNMOS 2011 base case modeling, we performed a CAMx model performance evaluation (MPE) for the entire modeling episode. In this section, we present the evaluation of CAMx model performance against concurrent measured ambient concentrations using graphical displays of model performance and statistical model performance measures. We compared these measures against established model performance goals and criteria following the procedures recommended in EPA's photochemical modeling guidance documents (EPA, 2014).

Model performance was evaluated in New Mexico and surrounding regions for two CAMx runs that used different meteorological inputs, but were otherwise identical. UNC-IE carried out a series of Weather Research and Forecasting Model (WRF; Skamarock et al., 2005) meteorological model simulations of the SNMOS modeling episode and compared model performance in each run against observed weather data (Section 3.1; UNC-IE and Ramboll Environ, 2015). The WRF model runs differed in their cumulus parameterizations and the datasets used for initial conditions and analysis nudging. The two WRF runs that produced the best model performance over the SNMOS WRF 12/4 km modeling domains used the MSKF cumulus scheme (Alapaty et al., 2014; Herwehe et al., 2014). One of the MSKF WRF runs used the NCEP NAM analysis for initial conditions and analysis nudging, while the other MSKF run used the ECMWF ERA-Interim analysis. We refer to the two WRF simulations hereafter as the WRF ERA and WRF NAM runs and the two CAMx runs that used these WRF runs as the CAMx ERA and CAMx NAM runs.

For both CAMx runs, model performance was acceptable for daily maximum 8-hour average (MDA8) ozone based on comparison with EPA statistical performance benchmarks (Figure 3-16). Both CAMx runs had an overall high bias when all episode days were considered, but underestimated ozone on high ozone days, which were defined to be days with observed MDA8 ozone > 60 ppb. The CAMx run using ERA WRF meteorology performed slightly better than CAMx with NAM WRF meteorology on days when MDA8 > 60 ppb (Figure 3-16). The CAMx NAM run performed slightly better when all days were considered (i.e., on lower MDA8 ozone days) (Figure 3-16; Figure 3-17).

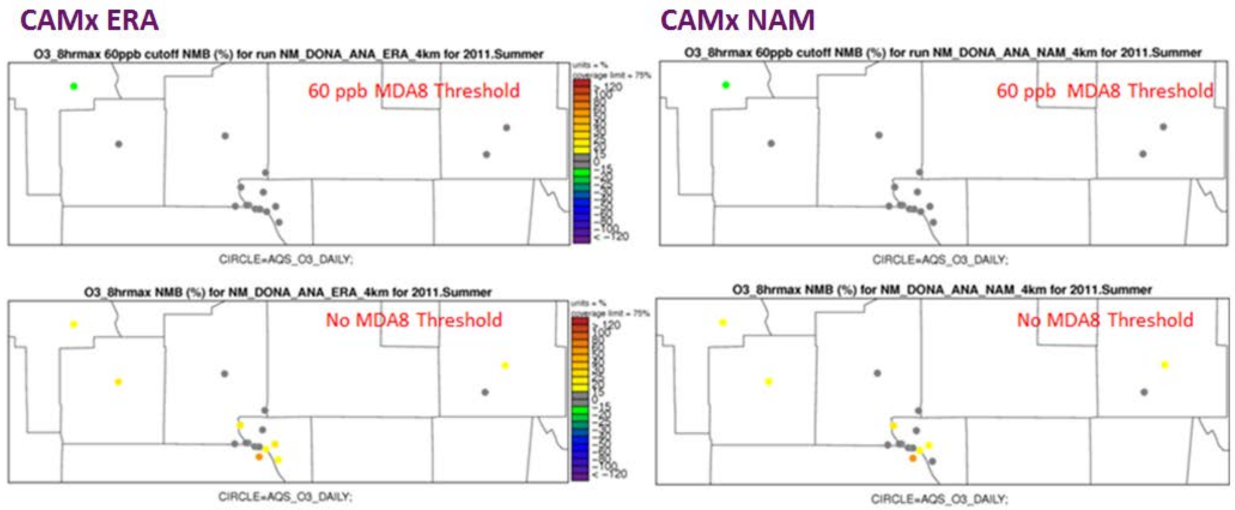


Figure 3-16. Comparison of NMB for the CAMx ERA (left) and CAMx NAM (right) model runs. Upper figures have 60 ppb MDA8 threshold and no threshold was used for the lower figures.

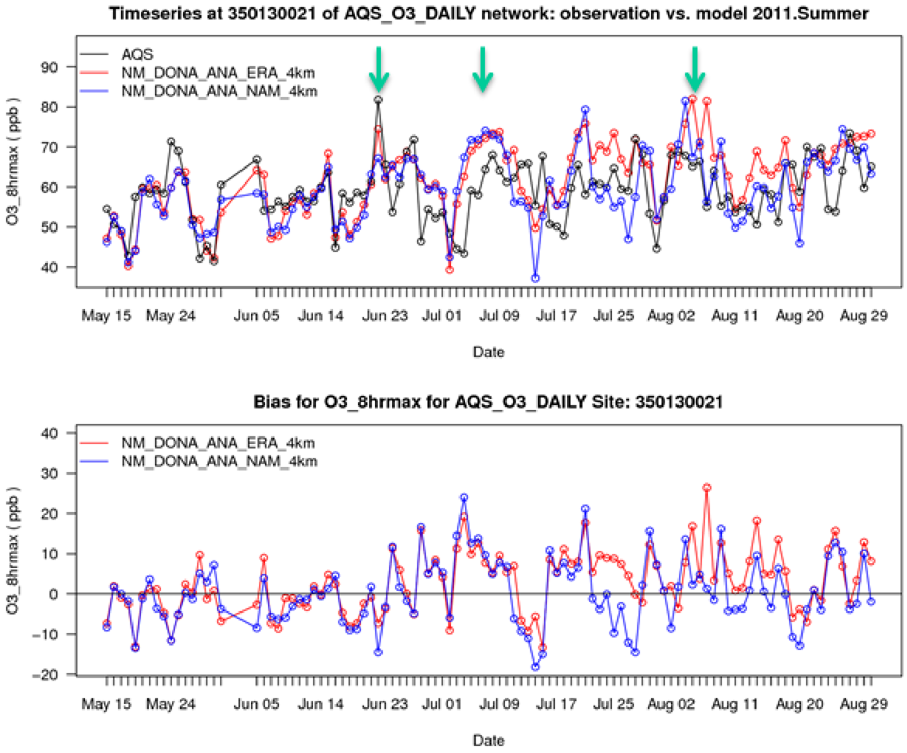
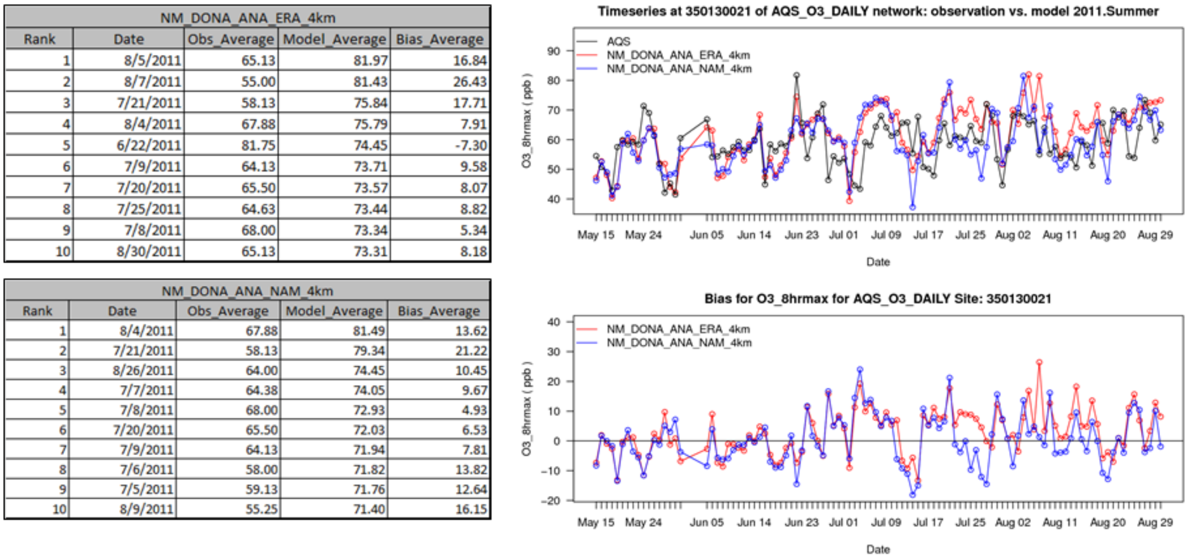


Figure 3-17. Upper panel: time series of observed (black) and modeled MDA8 ozone for the CAMx ERA (red) and CAMx NAM (blue) runs at the Desert View monitor. Lower panel: Model bias in MDA8 ozone for the CAMx ERA (red) and CAMx NAM (blue) runs at the Desert View monitor. Left green arrow shows a day when the model underestimated high values of observed ozone (June 22). Center and right green arrows show examples of July and August periods when the model had a persistent regional high bias for ozone.

We examined performance at the ground level ozone monitors within Doña Ana County in light of the form of the NAAQS for ozone and the EPA's recommended method for performing modeled attainment demonstrations (EPA, 2014) using the Modeled Attainment Test Software (MATS). The MPE focused on the MDA8 ozone on the highest modeled days because the modeling plan called for a modeled attainment demonstration for Doña Ana County using the 2011 base case model and the 2025 future year model. In carrying out the base case model performance, we considered how CAMx performance in the 2011 base year runs would affect the modeled attainment demonstration and selected the CAMx model run that would provide the more reliable future year ozone projection.

Figure 3-18 presents ranked lists of the 10 days with the highest modeled values of modeled MDA8 ozone at the Desert View, NM monitor for the CAMx ERA and CAMx NAM runs. The highest modeled MDA8 ozone days do not correspond well to high observed MDA8 ozone in either CAMx run. In general, the highest modeled days are days on which the model greatly overestimates the observed MDA8 ozone. For example, on the highest modeled MDA8 ozone day in the CAMx ERA run, the modeled MDA8 ozone was 82 ppb, while the observed MDA8 ozone was 65 ppb, corresponding to a model bias of 17 ppb in the MDA8. There was only one day out of the 10 highest modeled days in the CAMx ERA run that corresponded to a day when the observed MDA8 ozone exceeded 70 ppb: June 22. The CAMx ERA bias on June 22 was -7 ppb, consistent with the MPE statistical analysis that showed that CAMx ERA tended to underestimate observed ozone on high observed ozone days.



NM_DONA_ANA_ERA_4km				
Rank	Date	Obs_Average	Model_Average	Bias_Average
1	8/5/2011	65.13	81.97	16.84
2	8/7/2011	55.00	81.43	26.43
3	7/21/2011	58.13	75.84	17.71
4	8/4/2011	67.88	75.79	7.91
5	6/22/2011	81.75	74.45	-7.30
6	7/9/2011	64.13	73.71	9.58
7	7/20/2011	65.50	73.57	8.07
8	7/25/2011	64.63	73.44	8.82
9	7/8/2011	68.00	73.34	5.34
10	8/30/2011	65.13	73.31	8.18

NM_DONA_ANA_NAM_4km				
Rank	Date	Obs_Average	Model_Average	Bias_Average
1	8/4/2011	67.88	81.49	13.62
2	7/21/2011	58.13	79.34	21.22
3	8/26/2011	64.00	74.45	10.45
4	7/7/2011	64.38	74.05	9.67
5	7/8/2011	68.00	72.93	4.93
6	7/20/2011	65.50	72.03	6.53
7	7/9/2011	64.13	71.94	7.81
8	7/6/2011	58.00	71.82	13.82
9	7/5/2011	59.13	71.76	12.64
10	8/9/2011	55.25	71.40	16.15

Figure 3-18. Upper (lower) left panel: Ranked list of the 10 days with the highest modeled values of modeled MDA8 ozone (ppb) at the Desert View, NM monitor for the CAMx ERA (NAM) run. Also shown are date, observed MDA8 (ppb) and the model bias (ppb). Upper right panel: time series of observed (black) and modeled MDA8 ozone for the CAMx ERA (red) and CAMx NAM (blue) runs at the Desert View monitor. Lower right panel: Model bias in MDA8 ozone for the CAMx ERA (red) and CAMx NAM (blue) runs at the Desert View monitor.

In the CAMx NAM run, none of the 10 highest modeled days corresponded to a day with observed MDA8 exceeding 70 ppb. The CAMx NAM run bias was positive on all 10 of the highest modeled days. For both the CAMx ERA and CAMx NAM runs, the 10 highest modeled days occurred mainly during July and August, which are periods when both runs saw persistent overestimates of MDA8 ozone at the Desert View monitor.

For both CAMx runs, the 10 highest MDA8 ozone days that would form the relative reduction factor (RRF) in the design value calculation for Doña Ana County monitors had significant regional overestimates of ozone, and most of the 10 highest modeled MDA8 ozone days did not have high observed ozone. It is therefore uncertain whether either model run could provide useful results for analyzing local emissions control strategies for Doña Ana County using the EPA MATS default RRF method. Local controls would not be predicted to reduce Doña Ana County ozone if the RRF is formed from days when modeled ozone is driven by an overestimated regional background.

Therefore, we evaluated use of an ozone model performance criterion in selecting days for making RRFs and future year design value projections and using this procedure to determine whether the CAMx NAM or CAMx ERA run should be used as the 2011 base case in the SNMOS. We used only modeled days in which the observed and modeled MDA8 ozone are within a specified % bias of each other. We therefore formed RRFs based on more days with observed high ozone and better model performance. Days on which the model performed poorly would not be used in the RRF. There are precedents for using an MPE filter in selecting days for use in RRFs in making future year ozone projections including modeling done in California (e.g., SCAQMD AQMP[7]).

To illustrate the procedure, we apply a ±10% bias criterion to the 10 highest modeled MDA8 ozone days at the Desert View monitor. If we were to apply the default MATS method to calculate the RRF, the days shaded in blue in Figure 3-19 would be selected. Only one of the top 10 observed MDA8 ozone days (shaded yellow) at the Desert View monitor would be included using this method.

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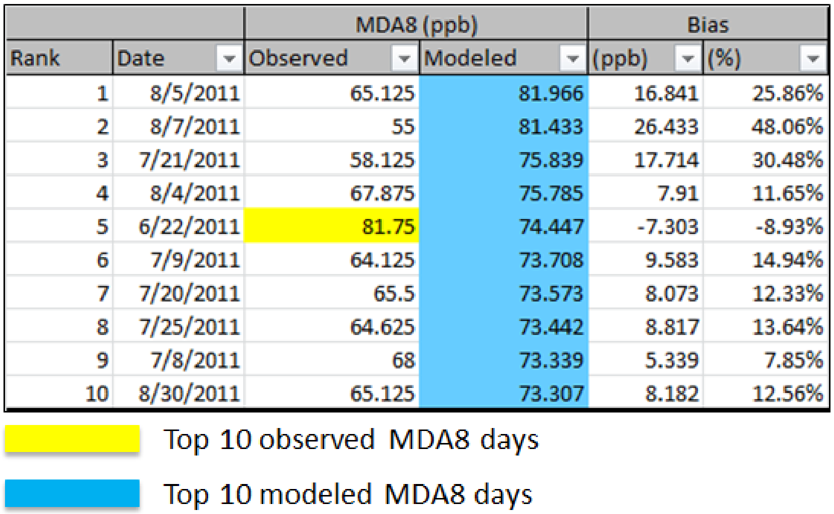
[7] http://www.aqmd.gov/docs/default-source/clean-air-plans/air-quality-management-plans/2012-air-quality-management-plan/final-2012-aqmp-(february-2013)/appendix-v-final-2012.pdf

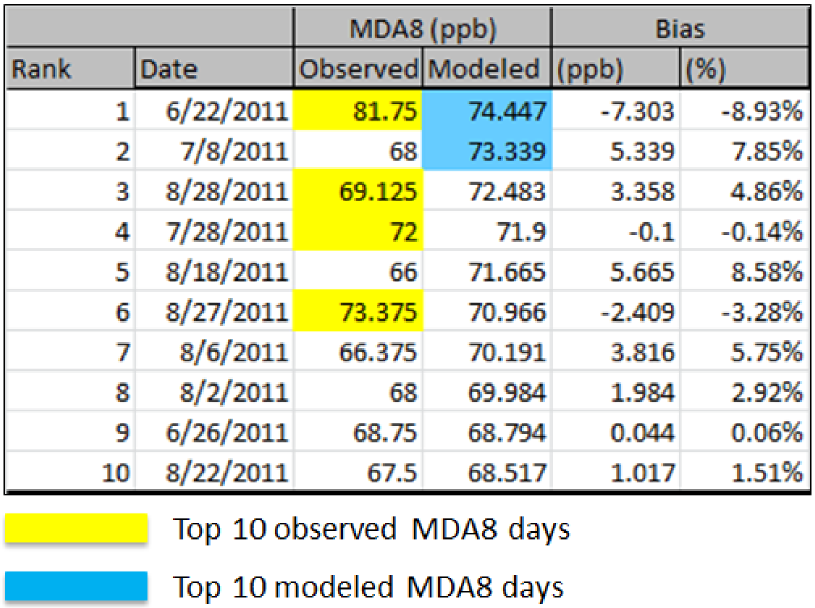


		MDA8 (ppb)		Bias	
Rank	Date	Observed	Modeled	(ppb)	(%)
1	8/5/2011	65.125	81.966	16.841	25.86%
2	8/7/2011	55	81.433	26.433	48.06%
3	7/21/2011	58.125	75.839	17.714	30.48%
4	8/4/2011	67.875	75.785	7.91	11.65%
5	6/22/2011	81.75	74.447	-7.303	-8.93%
6	7/9/2011	64.125	73.708	9.583	14.94%
7	7/20/2011	65.5	73.573	8.073	12.33%
8	7/25/2011	64.625	73.442	8.817	13.64%
9	7/8/2011	68	73.339	5.339	7.85%
10	8/30/2011	65.125	73.307	8.182	12.56%

🟨 Top 10 observed MDA8 days

🟦 Top 10 modeled MDA8 days

Figure 3-19. Desert View monitor: default MATS method for selecting 10 highest modeled days for the RRF.



		MDA8 (ppb)		Bias	
Rank	Date	Observed	Modeled	(ppb)	(%)
1	6/22/2011	81.75	74.447	-7.303	-8.93%
2	7/8/2011	68	73.339	5.339	7.85%
3	8/28/2011	69.125	72.483	3.358	4.86%
4	7/28/2011	72	71.9	-0.1	-0.14%
5	8/18/2011	66	71.665	5.665	8.58%
6	8/27/2011	73.375	70.966	-2.409	-3.28%
7	8/6/2011	66.375	70.191	3.816	5.75%
8	8/2/2011	68	69.984	1.984	2.92%
9	6/26/2011	68.75	68.794	0.044	0.06%
10	8/22/2011	67.5	68.517	1.017	1.51%

🟨 Top 10 observed MDA8 days

🟦 Top 10 modeled MDA8 days

Figure 3-20. Desert View monitor: alternate method for selecting 10 highest modeled days for the RRF.

If we select only the top 10 modeled MDA8 ozone days on which the bias was < ±10%, we obtain a different population of days (Figure 3-20). The 10 days to be used in the RRF now include 4 of the 10 highest observed days at Desert View, and model performance is reasonably good on all days that would go into the RRF. Observed and modeled MDA8 values are now closer to the observed base year design value than would be the case using the default MATS method shown in Figure 3-19.

We tested this procedure using bias thresholds ranging from 5% to 20% for the CAMx ERA and CAMx NAM runs. For each bias threshold, we determined the number of modeled MDA8 ozone days in the RRF (top 10 days) that were also among the 10 highest observed MDA8 ozone days. For all values of the bias threshold, using the CAMx ERA run produced a higher number of days in the ranked list of the 10 highest modeled MDA8 ozone days that also corresponded to days that were among the top 10 observed MDA8 ozone days at the Doña Ana County monitors. Therefore, the CAMx ERA run was better suited for making future year ozone projections and for emissions control strategy development. The bias threshold that produced the highest number of top 10 observed MDA8 ozone days in the list of 10 highest modeled MDA8 ozone days was the 10% threshold, and we recommended that this threshold be used in making future year ozone projections in the SNMOS in addition to the default method outlined in the EPA Modeling Guidance (EPA, 2014).

Once the ozone MPE was completed, we conducted a model performance evaluation for the CAMx ERA run for ozone precursors and fine particulate matter ($PM_{2.5}$) and its component species with a focus on the modeling results for Doña Ana County. We evaluated the ozone precursors carbon monoxide (CO) and nitrogen dioxide (NO_2), but did not include volatile organic compound (VOC) species due to lack of observed data. Although the main focus of this study was ozone, the $PM_{2.5}$ evaluation included total $PM_{2.5}$ along with the component species sulfate (SO_4), nitrate (NO_3), ammonium (NH_4), elemental carbon (EC), and organic carbon (OC).

NO_2 and CO performance are typical of photochemical model simulations of the Western U.S. and are comparable to performance noted in the WAQS 2011b modeling (Adelman et al., 2016) and the Three State Air Quality Study (3SAQS; Adelman et al., 2015b). The SNMOS PM performance evaluation showed that $PM_{2.5}$ was underestimated across the New Mexico and the surrounding region and that the underestimate of total $PM_{2.5}$ was consistent with modeled underestimates of several of its component species including NH_4, NO_3, and SO_4. While there were shortcomings in model performance for the CAMx ERA simulation of $PM_{2.5}$ and its component species, performance was roughly comparable to that of other similar studies in the western U.S. such as the WAQS and 3SAQS. PM performance was not the main focus of the SNMOS, and so no effort was expended to try to diagnose and improve model performance for PM. We noted the reasonable model performance and concluded that the CAMx 2011 SNMOS model was functioning as expected.

3.7.2 Significant Findings

CAMx base year 2011 model performance was evaluated on the 12/4 km SNMOS domains for two CAMx runs that used different meteorological inputs. For both CAMx runs, model performance for MDA8 ozone was acceptable based on comparison with EPA statistical performance benchmarks.

In both runs, CAMx had an overall high bias when all days were considered, but underestimated ozone on days with observed MDA8 ozone > 60 ppb. The CAMx run using ERA WRF meteorology performed slightly better than CAMx with NAM WRF meteorology when MDA8 ozone > 60 ppb. The CAMx NAM run performed slightly better when all days were considered.

For both CAMx runs, many of the 10 highest MDA8 ozone days that would be used to form an RRF for future year design value projections for Doña Ana County monitors had significant region-wide overestimates of ozone. Most of the 10 highest modeled MDA8 days did not have high observed MDA8 ozone. We proposed an alternate method of making future year projections using a model performance criterion that selects only days when modeled ozone is high and model performance is within acceptable bias limits. When this alternate procedure was used, the CAMx ERA run used more of 10 highest observed days corresponding to high modeled MDA8 ozone days in the projection calculation. In a perfect model run, the 10 highest model days would correspond to the 10 highest observed days, so we selected the run that came closer to this ideal.

We therefore selected the CAMx ERA run as the SNMOS 2011 base year run due to its better performance within the 4-km and 12-km domain on days where observed MDA8 ozone > 60 ppb as well as the fact that RRFs formed with this run had a better correspondence between high modeled and high observed MDA8 days.

In summary, we conclude that model performance for ozone, ozone precursors NO_2 and CO and PM was adequate for the SNMOS in the CAMx ERA run.

3.7.3 Milestones and Deliverables

- Base case modeling and model performance evaluation report. (Completed 4/17/2016)

3.8 Task 8: Prepare Future Year Emissions with SMOKE

3.8.1 Task Summary

The objective of this task was to combine the U.S. EPA 2011v2 modeling platform 2025 projection inventory, WAQS future year O&G inventories, and future year Mexico inventories to estimate future year emissions for the SNMOS. For this task we collected the 2025 emissions inventory and ancillary data from the US EPA 2011v6.2 modeling platform (US EPA, 2015). We applied the same version and configuration of SMOKE used for the SNMOS base year modeling to prepare future year, CAMx-ready emissions on the project 12-km and 4-km modeling domains. All of the natural source emissions and ancillary data were held constant with the 2011 base year modeling. Table 3-8 lists the emissions data used for the SNMOS future year modeling. We summarized the future year emissions inventories and processing results in a series of plots and developed a Power Point presentation on future year emissions modeling.

Table 3-8. SNMOS future year emissions data summary

Category	Data Source	Projection Year	Notes
Non-oil and gas	EPA 2011NEIv6.2	2025	Same categories as base year.
Oil and gas	Ramboll Environ and WAQS	2020 (Phase 2)	Permian basin projections for 2025 from NEI2011v6.2.
Mexico	ERG and EPA	2025	

	2011NEIv6.2		
Biogenic	SNMOS	Same as base year	No projection.
Fires	PMDETAIL version 2	Same as base year	No projection.
Lightning	SNMOS	Same as base year	No projection.
Ancillary Data	WAQS	Same as base year	No projection.

Figure 3-21 through Figure 3-26 summarize the New Mexico county base and future year NOx and VOC emissions. Figure 3-22 illustrates that Doña Ana County is projected to experience a 59.6% decrease in NOx emissions from 2011 to 2025, the majority of which will come from reductions in on-road mobile source emissions. Figure 3-25 shows that Doña Ana County is projected to experience a 42.1% decrease in VOC emissions, also primarily from decreases in on-road mobile emissions.

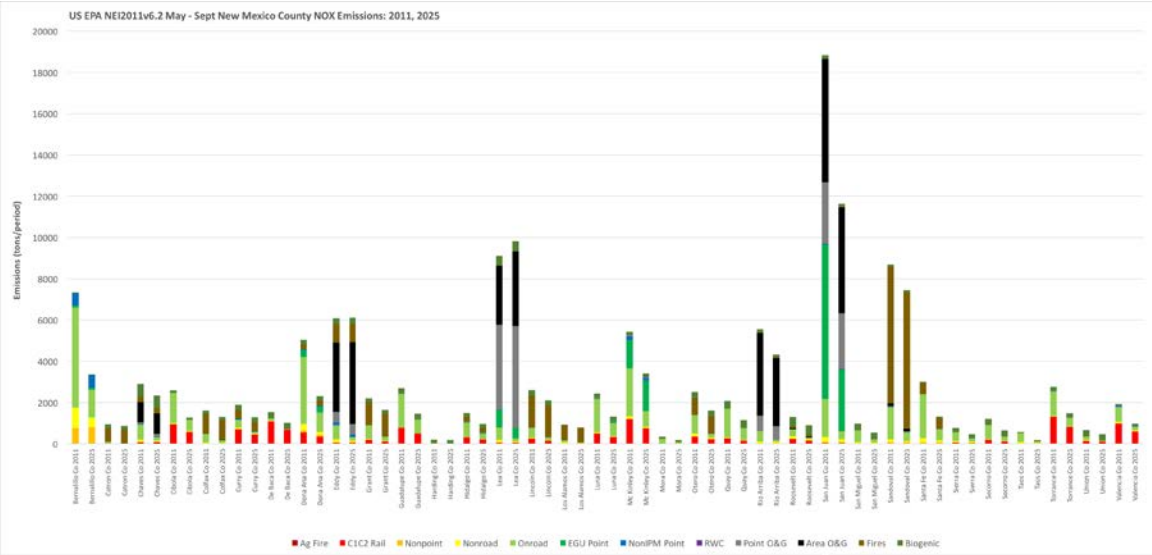


Figure 3-21.New Mexico county 2011 and 2025 NOx emissions.

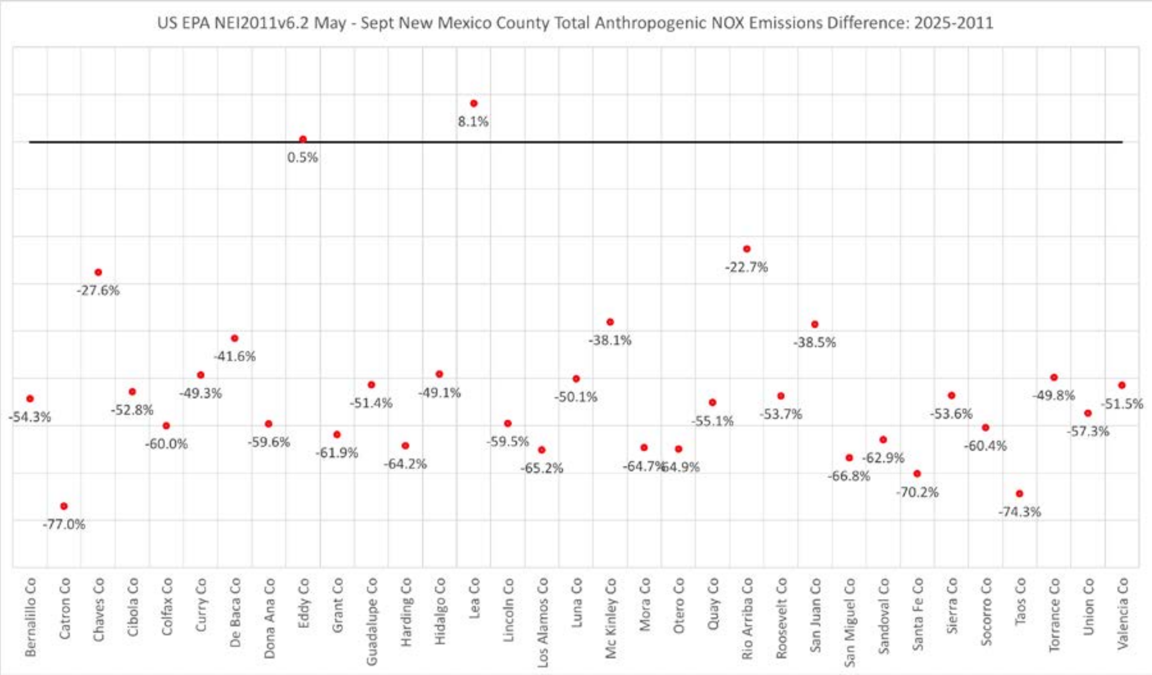


Figure 3-22. New Mexico county total anthropogenic NOx emissions change.

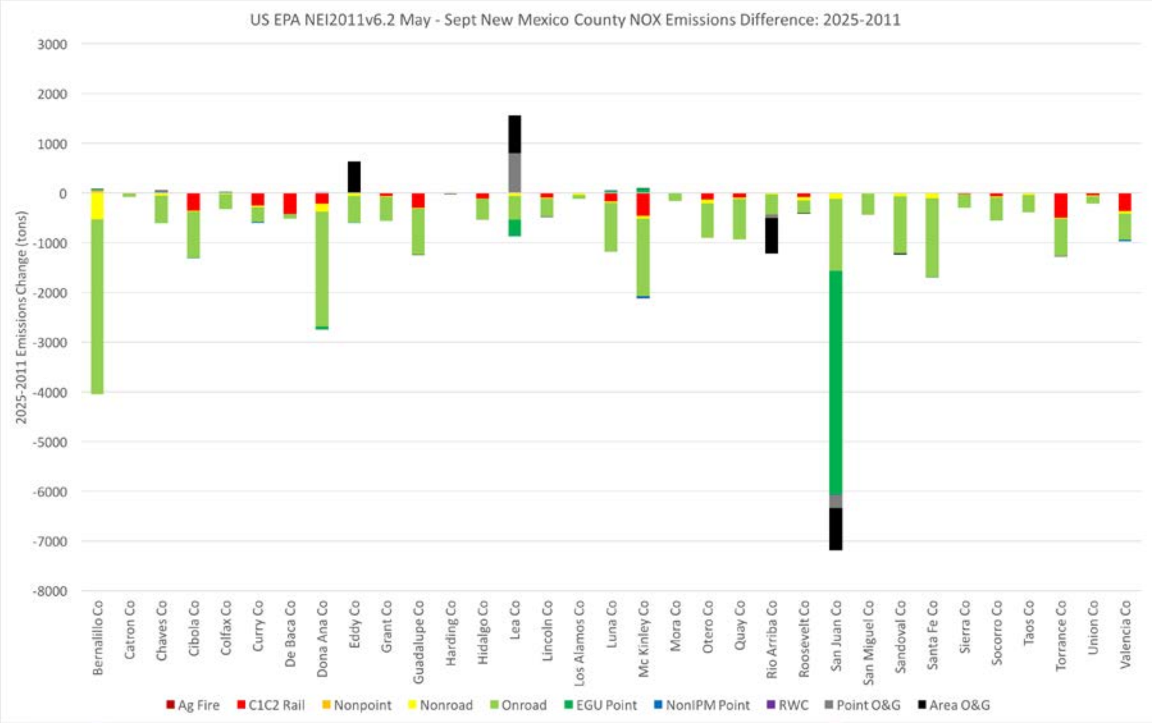


Figure 3-23. New Mexico 2011 and 2025 NOx emissions differences.

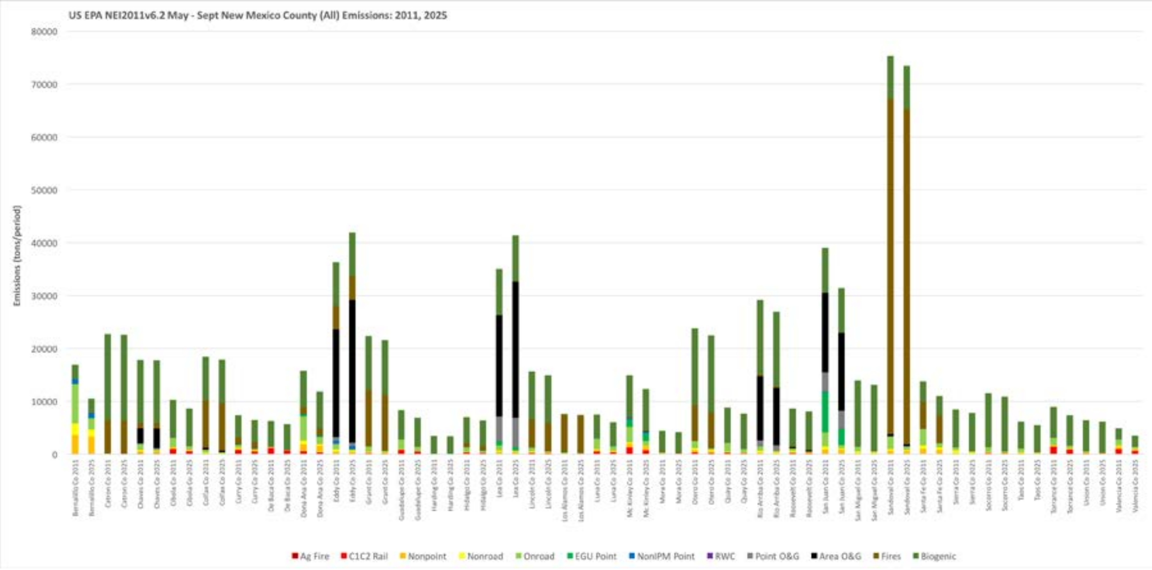


Figure 3-24. New Mexico county 2011 and 2025 VOC emissions.

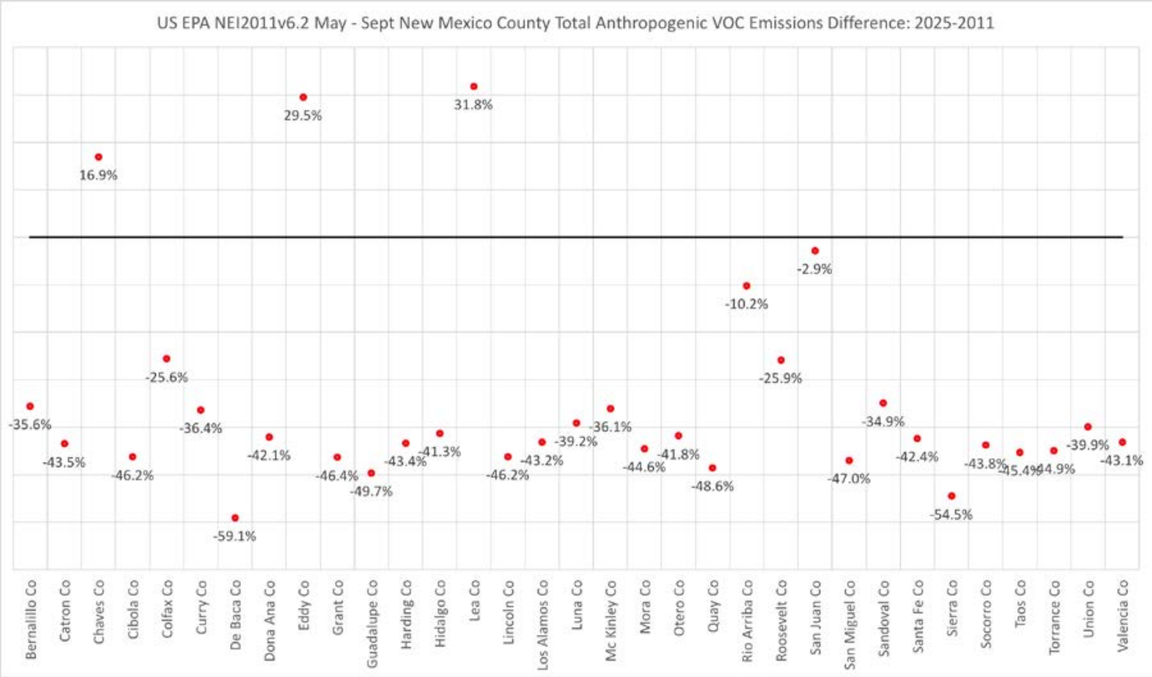


Figure 3-25. New Mexico county total anthropogenic VOC emissions change.

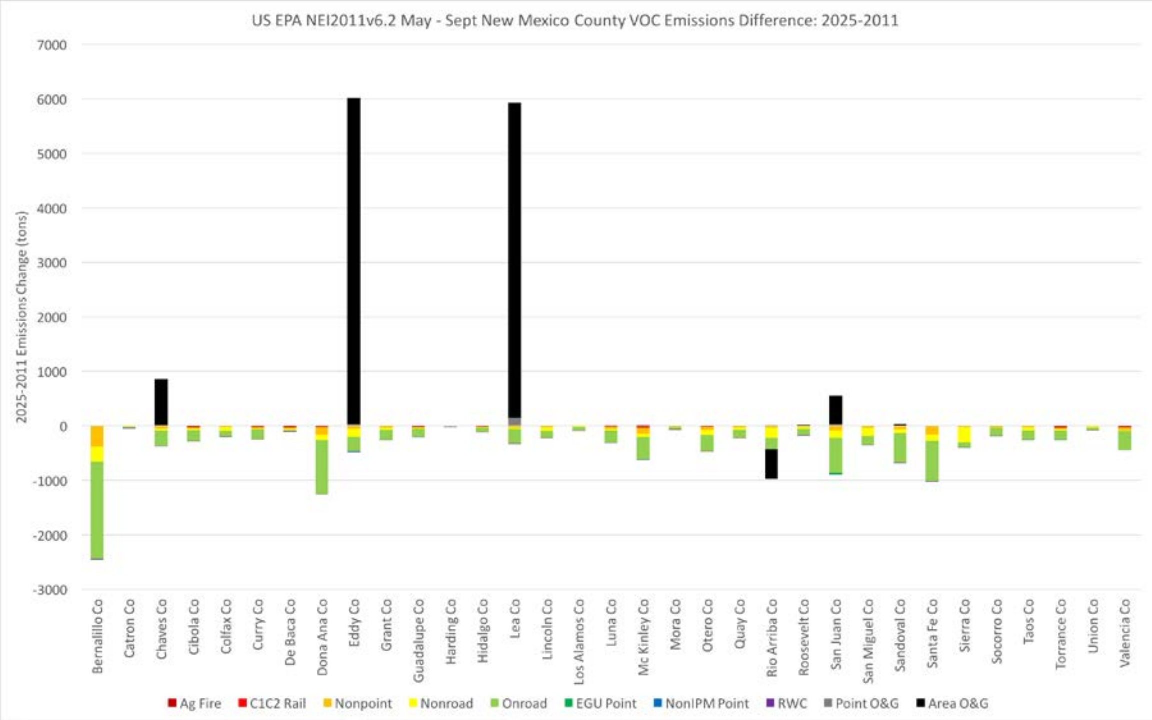


Figure 3-26. New Mexico 2011 and 2025 VOC emissions differences.

Additional details about the future year emissions data used for the SNMOS is available in the final Power Point presentation for this task (UNC-IE and Ramboll Environ, 2016a).

3.8.2 Significant Findings

In most of the New Mexico counties, ozone precursor (NOx and VOC) emissions are projected to decrease in 2025 relative to 2011. The exceptions are the oil and gas counties in the Permian Basin, which are projected to experience increases in both NOx and VOC emissions. Doña Ana County ozone precursor emissions are projected to decrease in 2025 relative to 2011, primarily as a result of ~70% reductions in on-road mobile NOx and VOC emissions.

3.8.3 Milestones and Deliverables

- Summarize the future year emissions inventories and processing results (Completed 4/30/2016)
- Power Point Presentation on future year emissions modeling (Completed 4/30/2016)
- CAMx-ready 2025 base year emissions on the project 12-km and 4-km modeling domains (Completed 4/30/2016)

3.9 Task 9: Future Year Air Quality Modeling

3.9.1 Task Summary

The objective of this task was to simulate future year summer season air quality using CAMx. In coordination with NMED we selected 2025 as the future year. We ran CAMx using the same configuration and, with the exception of the emissions, input data as the SNMOS 2011 CAMx simulation (see Task 6). We prepared the 2025 future year emissions estimates in Task 8. Upon completion of the CAMx simulation, we compared the 2025 ozone air quality projections with the 2011 estimates at the locations of ozone air quality monitors in Doña Ana County. The results of the simulation and the comparison to the base year were summarized in a final PowerPoint presentation.

Figure 3-27 compares differences between the CAMx estimates of 2025 and 2011 air quality. This figure also shows differences in the corresponding primary emissions (NOx and VOC) that drive ozone formation. As seen in this figure, CAMx predicted that ozone concentrations will generally decrease across the modeling domain in the entire summer season in 2025 relative to 2011. Large projected decreases in NOx and VOC emissions from on-road mobile sources appeared to be the factor driving the ozone reductions in 2025. Projected increases in oil and gas source emissions in the Permian basin were not predicted to impact future year air quality in Doña Ana County.

Additional details about the future year air quality modeling are available in the final Power Point presentation for this task (UNC-IE and Ramboll Environ, 2016b).

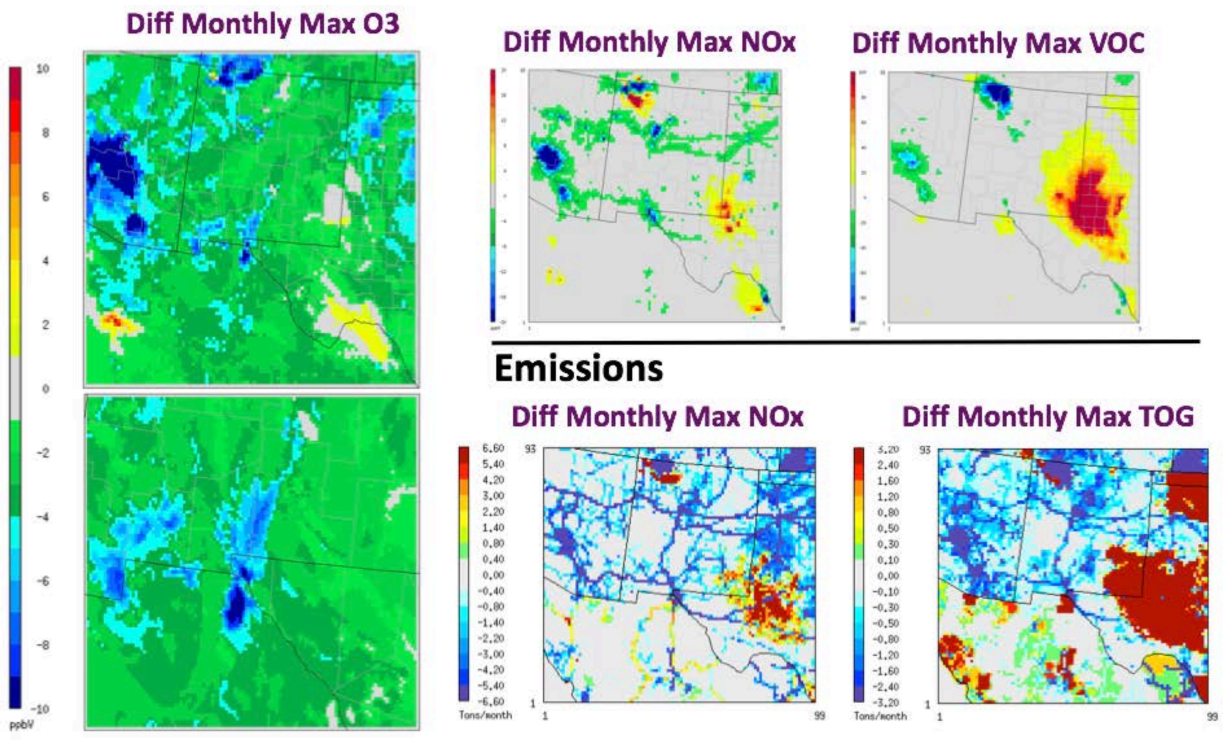


Figure 3-27. July 2011 differences (2025-2011) in CAMx monthly maximum O_3, NOx, VOC and corresponding emissions differences.

3.9.2 Significant Findings

CAMx predicted future year ozone reductions on most days of the summer season in Doña Ana County. The ozone reductions are consistent with significant reductions in ozone precursor emissions (NOx and VOC) in the area around Doña Ana County, particularly from the on-road mobile sector.

3.9.3 Milestones and Deliverables

- Power Point Presentation on future year air quality modeling (Completed 5/31/2016)

3.10 Task 10: Modeled Attainment Test

3.10.1 Task Summary

The objective of this task was to conduct a model attainment test using the U.S. EPA Model Attainment Test Software (MATS)[8] to estimate future design values (DVFs), relative response factors (RRFs), and unmonitored area analysis (UAA) for the SNMOS 12 and 4-km modeling domains. We used MATS version 2.6.1. to estimate DVFs and RRFs with the EPA default MATS configuration. In addition to the EPA defaults, we tested two different MATS configuration options to quantify how they impacted the attainment test results. Based on analysis conducted in Task 6, we also conducted an alternative MATS analysis that used the top 10 modeled 8-hour ozone days for days in which CAMx had a normalized mean bias < 10%. We

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[8] https://www3.epa.gov/scram001/modelingapps_mats.htm

created plots of all the MATS simulations and prepared a Power Point presentation of the results.

Under this task we compared ten years of design values at the Doña Ana County monitors and recent projections from the EPA to the SNMOS 2025 design values. Figure 3-28 compares the official ozone design values at each of the Doña Ana County monitors from 2006 to 2015. This plot illustrates that 2011 was the lowest reported year for several of the sites. The plot also compares the 2011 DVCs, EPA modeling 2017 DVFs, and SNMOS 2025 DVFs for the Doña Ana County monitors. While the 2025 DVFs appear consistent with the EPA 2017 modeling, it is important to note that as the SNMOS projections were made from 2011, they may be biased low because they are based off of an historically low concentration base year.

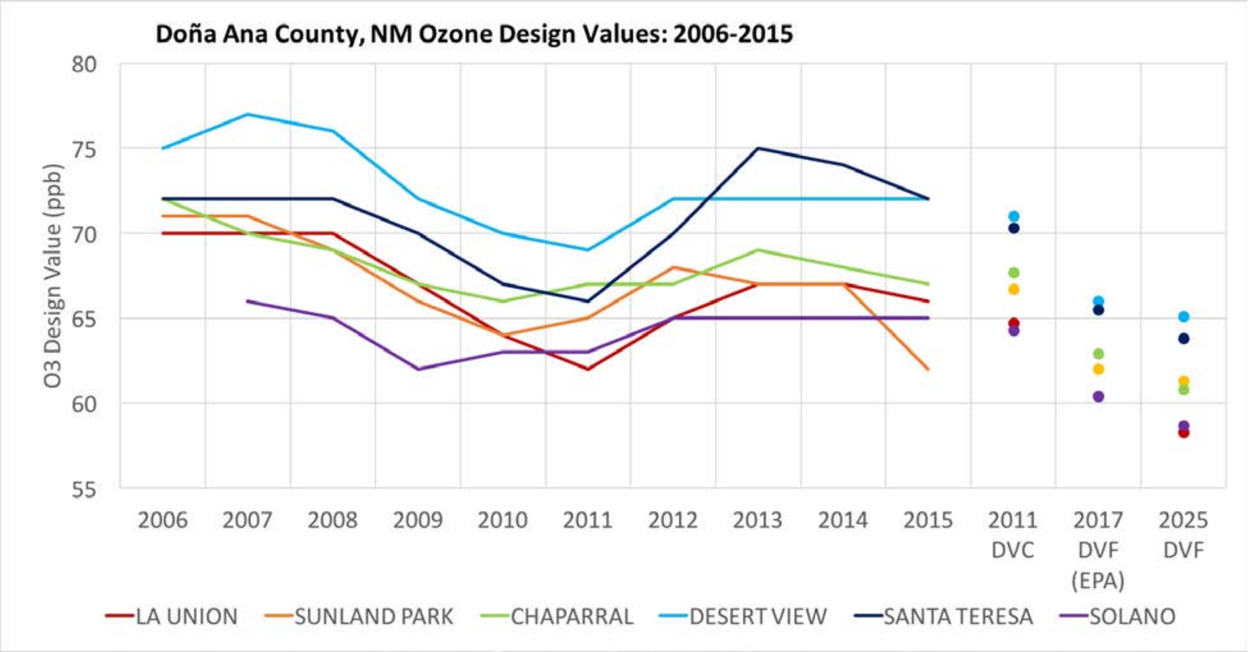


Figure 3-28. Annual ozone design values and a comparison of DVFs for EPA 2017 and SNMOS 2025 modeling.

Using the EPA default MATS configuration, we demonstrated that all of the monitors in the SNMOS 12-km domain, including all of the sites in Doña Ana County, are projected to be in attainment of the 2015 NAAQS for 8-hour ozone (70 ppb) in 2025 (Figure 3-29).

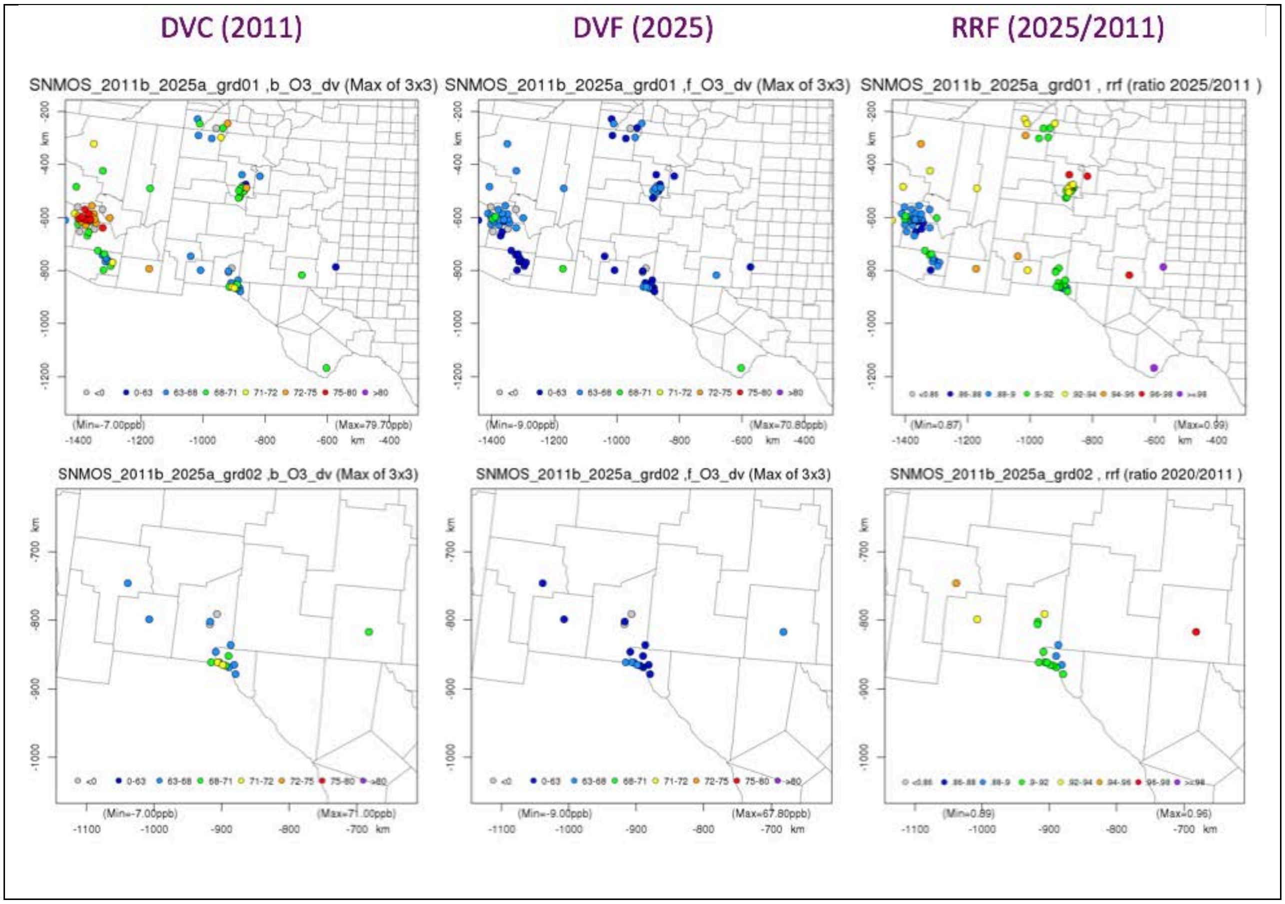


Figure 3-29. SNMOS 12-km (top) 4-km (bottom) domain MATS results.

In order to evaluate the sensitivity of the calculated DVFs to the MATS configuration and to biases in the CAMx ozone model, we conducted the following MATS sensitivity experiments:

- Spatial Matrix Experiment: test the impact of the size of the spatial matrix surrounding each monitor. MATS finds the maximum concentration from a matrix of modeled grid cells surrounding a monitor in the RRF calculation. We changed the EPA default from a 3x3 matrix to a 7x7 matrix.

- Temporal Averaging Experiment: test the impact of using fewer averaging days. Current EPA guidance uses the top 10 modeled daily maximum 8-hour average ozone in the RRF calculation. We tested the impact of using the top 5 modeled days.

- Model Performance Filter Experiment: test the impact of using only model days where the bias < 10%. We filtered the base year CAMx results to select the top 10 modeled days from only those days in which the Normalized Mean Bias was <= 10%. As this experiment required a separate MATS run for each monitor, we only used it for the Doña Ana County monitors in the 4-km modeling domain.

All of the experiments that we tested had little impact on the future year attainment status for the Doña Ana County monitors; they all continued to project attainment of the NAAQS. While the ozone bias filtering changed the DVF predictions by up to a few percent and resulted in a mix of higher and lower DVFs at the Doña Ana County monitors relative to the EPA default MATS configuration, none of the DVFs were greater than 65 ppb (Table 3-9).

Table 3-9. Low model bias MATS configuration 4-km domain results

Site ID	DVC	DVF (Base)	DVF (Bias < 10%)	RRF (Base)	RRF (Bias < 10%)	Site Name
350130008	64.7	58.3	60.2	0.9026	0.9306	LA UNION
350130017	66.7	61.3	60.9	0.9195	0.9136	SUNLAND PARK
350130020	67.7	60.8	62.9	0.8985	0.9293	CHAPARRAL
350130021	71	65.1	64.5	0.9183	0.9092	DESERT VIEW
350130022	70.3	63.8	64.3	0.9086	0.9158	SANTA TERESA
350130023	64.3	58.7	59.5	0.9136	0.9263	750 N.SOLANO DRIVE

The unmonitored area analysis that we conducted showed that all but a few cells in the 4-km domain will be in attainment in 2025 (Figure 3-30). The nonattainment cells in northern Grant County resulted from poor model performance related to a wildfire plume.

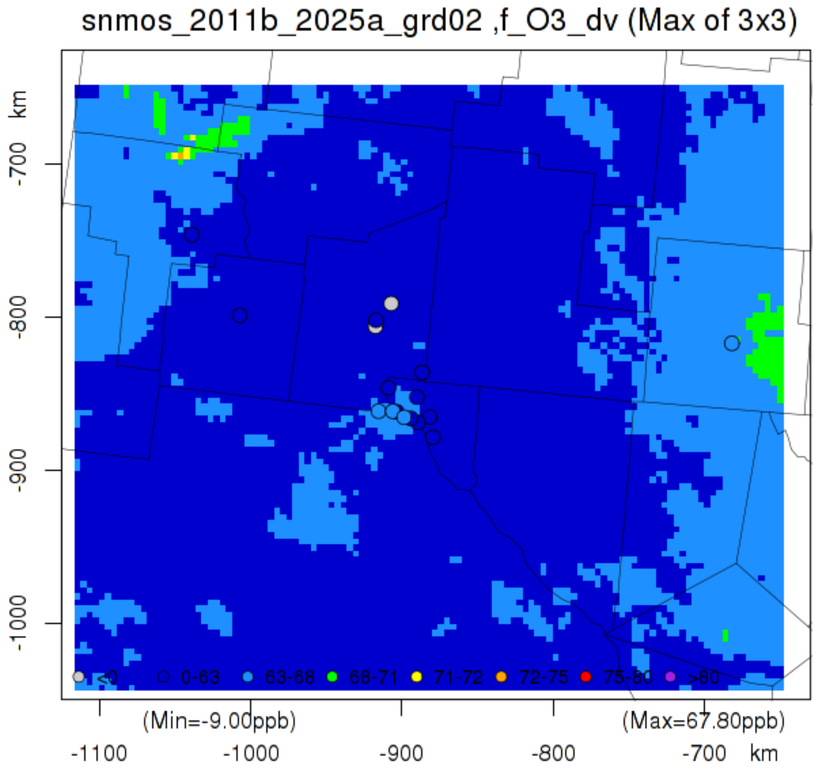


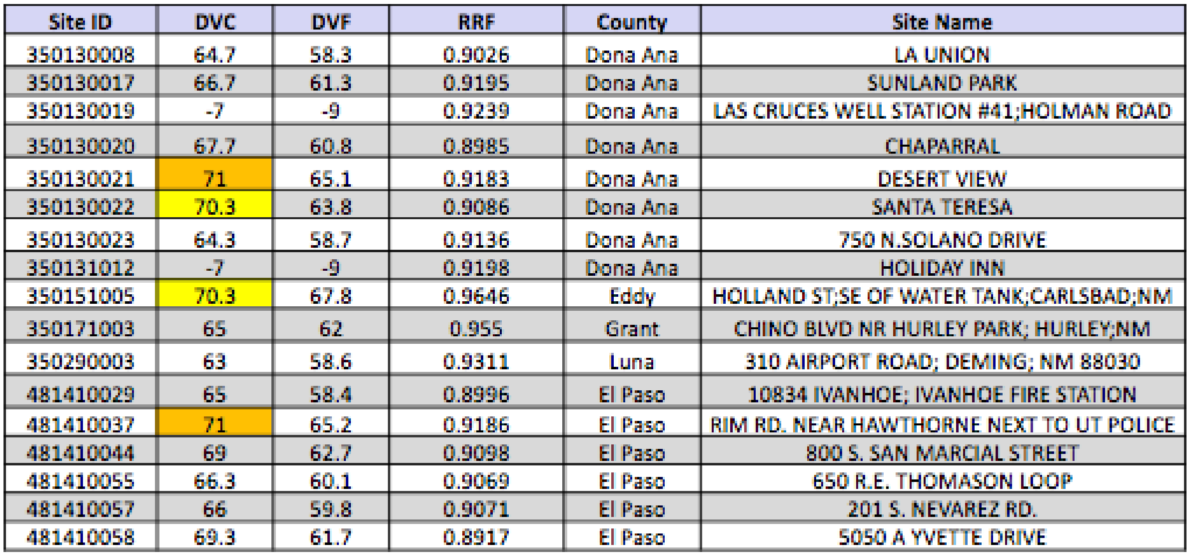
Figure 3-30. MATS unmonitored area analysis for 2025.

Additional details about the future year ozone projections using MATS is available in the final Power Point presentation for this task (UNC-IE and Ramboll Environ, 2016b).

3.10.2 Significant Findings

All of the Doña Ana County monitors are projected to be in attainment of the 2015 ozone NAAQS in 2025 (Table 3-10). We ran a series of experiments that showed despite fairly large changes to the EPA default MATS configuration, the projections of the future year attainment status did not significantly change.

Table 3-10. SNMOS 4-km CAMx modeling DVFs and RRFs



Site ID	DVC	DVF	RRF	County	Site Name
350130008	64.7	58.3	0.9026	Dona Ana	LA UNION
350130017	66.7	61.3	0.9195	Dona Ana	SUNLAND PARK
350130019	-7	-9	0.9239	Dona Ana	LAS CRUCES WELL STATION #41;HOLMAN ROAD
350130020	67.7	60.8	0.8985	Dona Ana	CHAPARRAL
350130021	71	65.1	0.9183	Dona Ana	DESERT VIEW
350130022	70.3	63.8	0.9086	Dona Ana	SANTA TERESA
350130023	64.3	58.7	0.9136	Dona Ana	750 N.SOLANO DRIVE
350131012	-7	-9	0.9198	Dona Ana	HOLIDAY INN
350151005	70.3	67.8	0.9646	Eddy	HOLLAND ST;SE OF WATER TANK;CARLSBAD;NM
350171003	65	62	0.955	Grant	CHINO BLVD NR HURLEY PARK; HURLEY;NM
350290003	63	58.6	0.9311	Luna	310 AIRPORT ROAD; DEMING; NM 88030
481410029	65	58.4	0.8996	El Paso	10834 IVANHOE; IVANHOE FIRE STATION
481410037	71	65.2	0.9186	El Paso	RIM RD. NEAR HAWTHORNE NEXT TO UT POLICE
481410044	69	62.7	0.9098	El Paso	800 S. SAN MARCIAL STREET
481410055	66.3	60.1	0.9069	El Paso	650 R.E. THOMASON LOOP
481410057	66	59.8	0.9071	El Paso	201 S. NEVAREZ RD.
481410058	69.3	61.7	0.8917	El Paso	5050 A YVETTE DRIVE

3.10.3 Milestones and Deliverables

- Power Point Presentation on future year ozone projections (5/31/2016)

3.11 Task 11: Future Year Emissions Sensitivity/Control Modeling

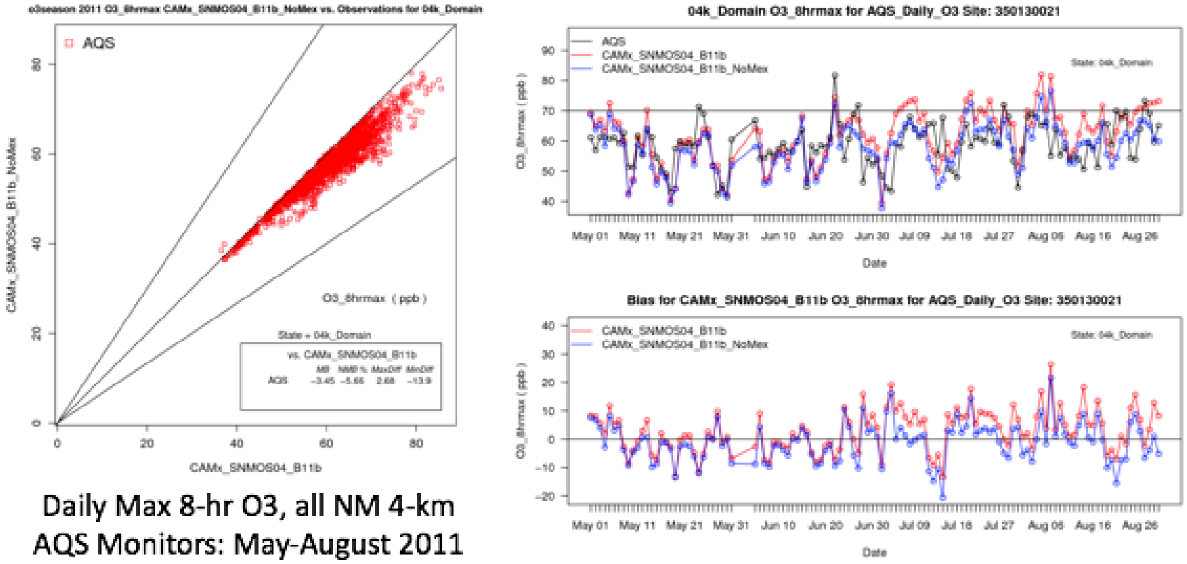
3.11.1 Task Summary

The objective of this task was to conduct CAMx sensitivity modeling to evaluate the impacts of emissions reductions on attainment of the ozone NAAQS. We ran two CAMx sensitivity simulations to quantify the impacts of emissions from anthropogenic sources in Mexico and from U.S. on-road mobile sources on ozone concentrations at monitors in Doña Ana County. We used MATS to estimate the changes in the design values and RRFs resulting from the sensitivity simulations. We created model evaluation plots comparing the base CAMx and sensitivity results and bubble plots of the results from the MATS simulations. We summarized this task and presented some of the key figures in a Power Point presentation.

We prepared the emissions and ran CAMx for two sensitivity simulations to test the impacts of key emissions sources on ozone concentrations in Doña Ana County. With the exception of the emissions changes in the designed sensitivity, all of the other CAMx inputs and configuration remained the same as the base CAMx simulation. We ran the sensitivities for the full SNMOS modeling period (April 15 – August 31, 2011) and for both the 12-km and 4-km modeling domains.

In the first sensitivity simulation we evaluated the impact of Mexico emissions sources on 2011 air quality by removing (“zero out”) all of the anthropogenic emissions in Mexico (SNMOS simulation ID: NoMex). The concept of this simulation was to estimate the ozone levels in Doña Ana County minus the influence of sources in Mexico. In the second sensitivity simulation we evaluated the sensitivity of 2025 projected U.S. air quality to the magnitude of the future year on-road mobile emissions estimates. We doubled the 2025 U.S. on-road mobile emissions (SNMOS simulation ID: 2xUSOR) to determine the sensitivity of the future year design values to this emissions source category. The concept of this simulation was to consider if a less conservative on-road mobile source projection scenario would still lead to ozone NAAQS attainment for the Doña Ana County monitors.

The NoMex simulation estimated that 2011 MDA8 ozone reduced by an average of 5.1 ppb (range -3.7 to -6.3 ppb) for the modeling period across all Doña Ana County monitors (Figure 3-31). The same figure shows a time series of observed (black) and modeled MDA8 at the Desert View monitor. The time series also shows the systematic ozone reductions in the NoMex simulation (blue) relative to the base 2011 CAMx simulation (red). The MATS results in Table 3-11 show that all of the monitors in the 4-km modeling domain reach NAAQS attainment in 2011 in the NoMex simulation. The design value at the Desert View monitor (2011 design value: 71 ppb) decreased by 6.2 ppb to 64.8 ppb. The results of the NoMex simulation provide evidence that in 2011 the monitors in Doña Ana County would have been in attainment of the ozone NAAQS but for the influence of anthropogenic emissions in Mexico.



Daily Max 8-hr O3, all NM 4-km AQS Monitors: May-August 2011 **NoMex vs Base11b**

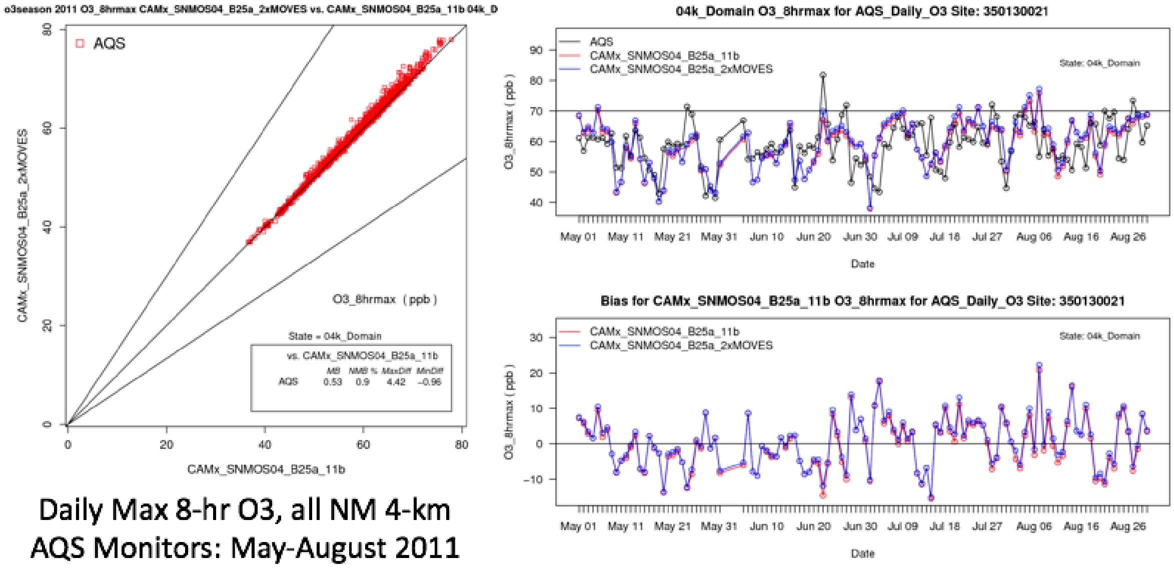
Desert View AQS Monitor Daily Max 8-hr O3: Obs, Base11b, NoMex

Figure 3-31. SNMOS 4-km domain 2011 zero out Mexico CAMx performance summary.

Table 3-11. SNMOS 4-km domain 2011 zero out Mexico MATS results

Site ID	DVC (2011)	DV No Mex (2011)	DV Diff	Site Name
350130008	64.7	59.6	-5.1	LA UNION
350130017	66.7	60.4	-6.3	SUNLAND PARK
350130020	67.7	63.3	-4.4	CHAPARRAL
350130021	71	64.8	-6.2	DESERT VIEW
350130022	70.3	65.2	-5.1	SANTA TERESA
350130023	64.3	60.6	-3.7	750 N.SOLANO DRIVE

The 2xUSOR simulation estimated that 2025 MDA8 ozone would increase by an average of 1.5 ppb (range: +1.3 to +1.6 ppb) for the modeling period across all Doña Ana County monitors. Despite doubling the 2025 emissions from on-road mobile sources (which contributed 70% of the anthropogenic NOx emissions in Doña Ana County), the projected air quality impacts were small. Table 3-12 shows that the DVFs for the Doña Ana County monitors were projected to increase by an average of 1.47 ppb and none of the monitors were predicted to be close to nonattainment of the 2015 ozone NAAQS (maximum 65.1 ppb at Desert View). The results of the 2xUSOR simulation demonstrate that a less conservative 2025 future year emissions scenario for U.S. on-road mobile sources than is currently estimated by MOVES will still lead to attainment of the 2015 ozone NAAQS for all monitors in Doña Ana County.

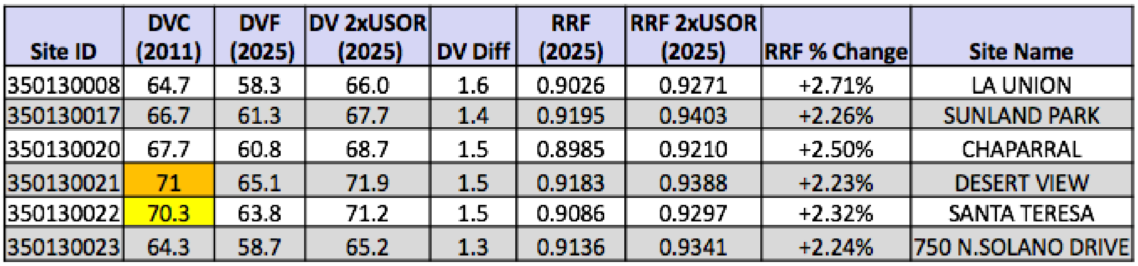


Daily Max 8-hr O3, all NM 4-km AQS Monitors: May-August 2011 **2xUSOR vs Base25a_11b**

Desert View AQS Monitor Daily Max 8-hr O3: Obs, Base25a_11b, 2xUSOR

Figure 3-32. SNMOS 4-km domain 2025 double U.S. on-road emissions CAMx performance summary.

Table 3-12. SNMOS 4-km domain 2025 double U.S. on-road emissions MATS results



Site ID	DVC (2011)	DVF (2025)	DV 2xUSOR (2025)	DV Diff	RRF (2025)	RRF 2xUSOR (2025)	RRF % Change	Site Name
350130008	64.7	58.3	66.0	1.6	0.9026	0.9271	+2.71%	LA UNION
350130017	66.7	61.3	67.7	1.4	0.9195	0.9403	+2.26%	SUNLAND PARK
350130020	67.7	60.8	68.7	1.5	0.8985	0.9210	+2.50%	CHAPARRAL
350130021	71	65.1	71.9	1.5	0.9183	0.9388	+2.23%	DESERT VIEW
350130022	70.3	63.8	71.2	1.5	0.9086	0.9297	+2.32%	SANTA TERESA
350130023	64.3	58.7	65.2	1.3	0.9136	0.9341	+2.24%	750 N.SOLANO DRIVE

Additional details about the future year ozone projections using MATS are available in the final Power Point presentation for this task (UNC-IE and Ramboll Environ, 2016c).

3.11.2 Significant Findings

The results of the NoMex simulation provide evidence that in 2011 the monitors in Doña Ana County would have been in attainment of the ozone NAAQS but for the contribution of emissions from anthropogenic sources in Mexico. Despite doubling the 2025 emissions projections for U.S. on-road mobile sources, all of the monitors in Doña Ana County are projected to be well in attainment of the ozone NAAQS.

3.11.3 Milestones and Deliverables

- Power Point Presentation on future year air quality modeling (Completed 8/15/2016)

3.12 Task 12: Future Year Source Apportionment Modeling

3.12.1 Task Summary

The purpose of Task 12 was to conduct CAMx source apportionment simulations to better understand the source regions and source categories that contribute to elevated ozone concentrations in Doña Ana County and vicinity. These simulations will help set the ground work for the development of a potential State Implementation Plan (SIP) to demonstrate attainment of the ozone NAAQS. CAMx source apportionment modeling will be used to provide a complete accounting of the contributions of all sources delineated by the defined Source Groups that contribute to ozone concentrations at the Doña Ana monitoring sites and throughout the 12/4 km modeling domain.

Ozone is formed in the atmosphere by reactions of NOx and VOC in the presence of sunlight. Once formed, ozone persists and can be transported by prevailing winds. The Ozone Source Apportionment Tool (OSAT) in CAMx uses tracers to keep track of ozone production and transport (Yarwood et al., 1996; Ramboll Environ, 2015). The OSAT algorithm performs source attribution of ozone within a CAMx simulation, i.e., it provides a quantitative accounting of where ozone originated for any and all locations in the CAMx simulation. Within photochemical models like CAMx, ozone can originate from the initial conditions, the boundary conditions and emissions of ozone precursors (NOx and VOC). The OSAT method allows the emission inventory to be disaggregated to geographic regions and/or source categories for purposes of source apportionment. This allows an assessment of the role of transported ozone and precursors in contributing to ozone episodes in Doña Ana County. The methodology is designed so that all ozone and precursor concentrations are attributed among the selected source groupings at all times. Thus, for all receptor locations and times, ozone (or ozone precursor concentrations) predicted by CAMx is attributed among the source groupings.

Source Groups are typically defined as the intersection between source regions (e.g., states) and source categories (e.g., on-road mobile sources). For the CAMx 12/4 source apportionment simulation defined four Source Regions and seven Source Categories as follows (Figure 3-33):

Source Regions (4):

- New Mexico
- Texas
- Mexico
- Arizona and remainder of other states in the 12-km domain

Source Categories (8):

- Natural (biogenics and lighting NOx)
- On-Road Mobile
- Non-Road Mobile
- Oil and Gas (point and non-point)
- Electrical Generating Unit (EGU) Point
- Non-EGU Point
- Open Land Fires (wildfire, prescribed, and agricultural burning)
- Remainder Anthropogenic.

Initial concentrations (IC) and boundary condition (BC) are always included as Source Groups, so that there were a total of 30 Source Groups (30 = 4 x 7 + 2) for the source apportionment modeling. The BCs represent the contribution from transport from outside of the 12/4 km SNMOS domain. This includes transport from sources in the remainder of U.S. outside the 12/4 km domain, international transport, and the natural global ozone background including stratospheric ozone intrusions. The boundary conditions as defined for the SNMOS includes contributions from additional sources of emissions relative to the North American background (NAB)[9] or the U.S. background (USB)[10].

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[9] North American Background Ozone (NAB) is defined by the U.S. EPA to be as the ozone levels that would exist in the absence of continental North American (i.e., Canadian, U.S., and Mexican) anthropogenic emissions

[10] U.S. background (USB) ozone is defined by the U.S. EPA to be any ozone formed from sources or processes other than U.S. manmade emissions of NOx, VOC, methane and CO. USB ozone does not include intrastate or interstate transport of manmade ozone or ozone precursors.

Figure 3-33. 12/4 km domain source regions used in source apportionment modeling.

We performed the source apportionment simulation using both the 2011 and 2025 emissions in order to:

- Obtain the contributions of Mexico to 2011 ozone design values and demonstrate that, without anthropogenic emissions from Mexico, Doña Ana County would have attained the ozone NAAQS;
- Calculate 2025 ozone projections removing the contributions of fires that have high uncertainties as well as year-to-year variations.
- Determine changes in contributions between 2011 and 2025 to explain the reductions in Doña Ana County design values and provide a rough estimate of ozone levels if the emission reductions are not as large as projected.
  - For example, the reductions in ozone due to on-road mobile sources were examined to determine what the 2025 ozone design values would be if we obtained a lower level of emission reductions.
- Provide an accounting of ozone contributions in 2025 that can be used to identify those sources that contribute the most to ozone levels in Doña Ana County.

We ran the CAMx model on the SNMOS 12/4 km grids using ozone source apportionment for April–August 2011 and 2025. CAMx was configured as in the SNMOS 2011 Base Case modeling (Table 3-7). 2011 calendar dates were used for the 2025 run. The modeling setup was identical to that used in the Task 11 Sensitivity Modeling except for the use of the use of the CAMx source apportionment tools and the unperturbed Base Case emission inventory for 2025. The 2025 Base Case emission inventory is described in Section 3.8.

We used EPA's MATS together with the CAMx OSAT results for 2011 and 2025 to calculate design values for 2025 and carry out the following analyses:

- Determine the source regions and source categories that contribute to elevated ozone concentrations in Doña Ana County and vicinity
- Obtain the contributions of Mexico emissions to 2011 ozone design values (DVs)
- Calculate 2025 ozone DVs without the contributions of fire emissions

We followed current EPA guidance on the use of MATS. The DVF calculation used the maximum concentration from a matrix 3 x 3 matrix (9 cells) of modeled grid cells surrounding each monitor. In the RRF calculation for each monitor in the 4-km grid, we used the top 10 modeled days (10 days with the highest modeled MDA8 ozone). We used a 70 ppb threshold and set the minimum number of days at or above the threshold to one day.

To calculate the contribution of each source group to each monitor's ozone design value, we first ran MATS with the full CAMx output for the base year ($CAMx\_total_{2011}$) and the future year ($CAMx\_total_{2025}$) and calculated the future year design value (DVF_{2025}) for each monitor using following EPA Guidance:

$$DVF_{2025} = \frac{CAMx\_total_{2025}}{CAMx\_total_{2011}} \times DVC_{2011}$$

where DVC_{2011} is the base year design value based on observed ozone. Next, we subtracted the ozone contribution from the ith source group (for example, New Mexico on-road mobile emissions) ($SrcGrpContrib^{i}_{2025}$) from the full model output ($CAMx\_total_{2025}$) and reran MATS without contribution from the ith source group.

$$DVF^{i}_{2025} = \frac{CAMx\_total_{2025} - SrcGrpContrib^{i}_{2025}}{CAMx\_total_{2011}} \times DVC_{2011}$$

The incremental contribution to the 2025 DVF from the ith source group is

$$\Delta DVF^{i}_{2025} = DVF_{2025} - DVF^{i}_{2025}.$$

We define the DVF for the year 2011 to be:

$$DVF^{i}_{2011} = \frac{CAMx\_total_{2011} - SrcGrpContrib^{i}_{2011}}{CAMx\_total_{2011}} \times DVC_{2011}$$

so that the contribution to the 2011 current year design value from source group i is

$$\Delta DVC_{2011}^{i} = DVC_{2011} - DVF_{2011}^{i}.$$

3.12.1.1 OSAT Results

In this section, we present results of the OSAT analysis. We begin with detailed source apportionment results for the Desert View monitor. Results for this monitor were similar to those for the other Doña Ana monitors, so we focus on Desert View only for the sake of brevity and because it is the only Doña Ana County monitor with a DVC_{2011} that exceeds the 2015 NAAQS of 70 ppb. Results for the other Doña Ana County monitors may be found in the Task 12 Summary PowerPoint presentation.

We used the source apportionment results to assess the importance of transport in determining ozone design values at Doña Ana monitors. We reviewed the effect of boundary conditions and transport from within the 12-km domain, but outside New Mexico. The results for the Desert View monitor are shown in Figure 3-34 and Figure 3-35. The DVC_{2011} for Desert View is 71.0 ppb and the DVF_{2025} is 65.1 ppb. The contribution from each of the 12/4 km domain source regions for both years is shown in the stacked bar charts.

The BC contribution includes the effects of sources within the U.S. (e.g., Los Angeles and Phoenix) as well as sources outside the US (Asia, regions of Mexico outside the 12/4 km grid) and the stratospheric contribution. The contribution to the Desert View DVC_{2011} and DVF_{2025} from the12-km BC contribution is far larger than those of regions within the 12-km domain and decreases from 54 ppb in 2011 to 50 ppb in 2025. The total contribution from transport is indicated by the red brackets in Figure 3-34 and includes the BC contribution as well as contributions from Mexico, Texas and the Other 12 km region that includes parts of Colorado, Oklahoma, Kansas, Utah and Arizona. In 2011, transport contributed 68.6 ppb to the Desert View design value of 71.0 ppb, while New Mexico emissions sources contributed 2.4 ppb. In 2025, transport contributed 63.5 ppb to the design value of 65.1 ppb and New Mexico sources contributed 1.6 ppb.

The New Mexico contribution to the Desert View DVC_{2011} and DVF_{2025} is smaller than the Texas and Mexico contributions in both 2011 and 2025. In 2011, New Mexico emissions sources contributed 2.4 ppb to the Desert View design value while Texas contributed 6.9 ppb and Mexico contributed 7.6 ppb. In 2025, New Mexico emissions sources contributed 1.6 ppb to the Desert View design value while Texas contributed 5.0 ppb and Mexico contributed 7.8 ppb.

The reduction in the Desert View DVF_{2025} is driven by the decrease in BCs from 54 ppb to 50 ppb and in reductions contributions from New Mexico (2.4 ppb to 1.6 ppb), Texas (6.9 ppb to 5.0 ppb). The contribution from Mexico, on the other hand, increases slightly from 7.6 ppb to 7.8 ppb.

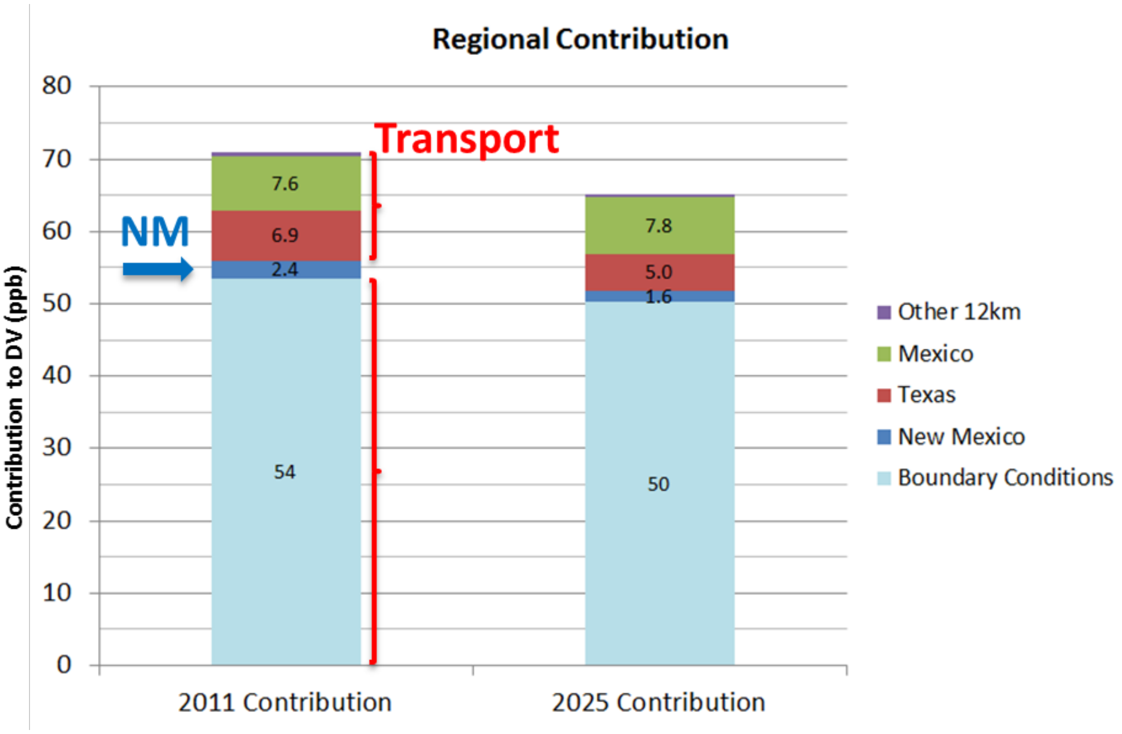


Figure 3-34. Contribution from source regions shown in Figure 3-33 and 12-km grid boundary conditions to 2011 and 2025 design values at the Desert View monitor. The contribution from New Mexico is shown in darker blue and the contribution from all sources outside New Mexico ("Transport") is indicated by the red bracket.

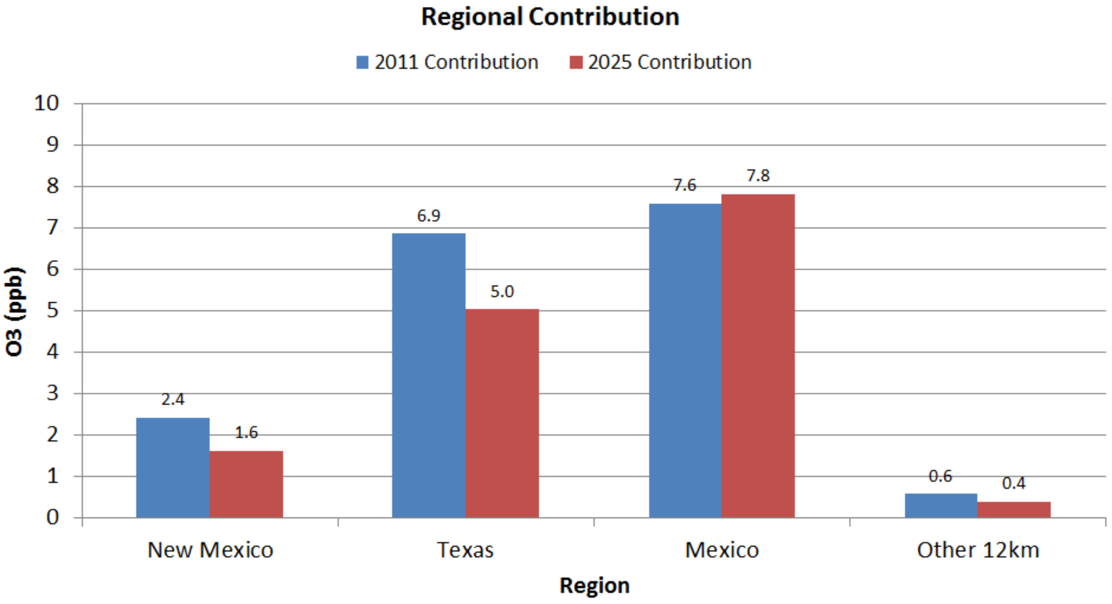


Figure 3-35. Contribution from source regions shown in Figure 3-33 to 2011 and 2025 design values at the Desert View monitor.

Figure 3-36 shows the contributions to the Desert View design values from the different emissions source categories. The largest contributions to the Desert View DVC_{2011} are from on-road mobile sources, natural sources, EGUs and non-road mobiles emissions. By 2025, the contribution of on-road mobile emissions decreases, but on-road mobile still contributes the most of any emissions source category to the Desert View design value. Natural emissions are the next largest contributor in 2025, followed by EGU and non-EGU point sources.

Figure 3-37 shows the top five contributing source groups to the DVC_{2011} at Desert View ranked by the value of their 2011 contribution alongside their 2025 contribution. The largest contributions to the Desert View DVC_{2011} are from Texas and Mexico on-road emissions and Mexico EGU and natural emissions. The largest 2025 contributions are from Mexico EGU and non-EGU point sources and on-road emissions from Texas and Mexico. Reductions in Texas, New Mexico and Mexico on-road contributions are responsible for much of the ozone decrease in the Desert View design value from 2011 to 2025.

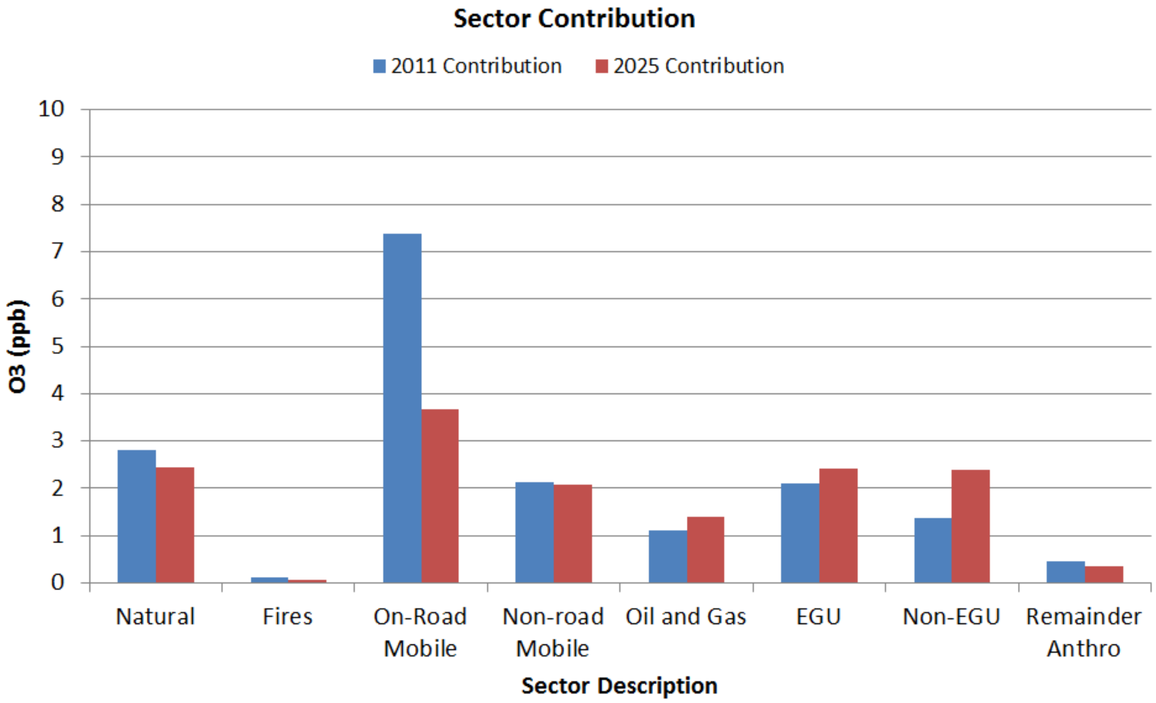


Figure 3-36. Contribution from emissions source categories to 2011 and 2025 design values at the Desert View monitor.

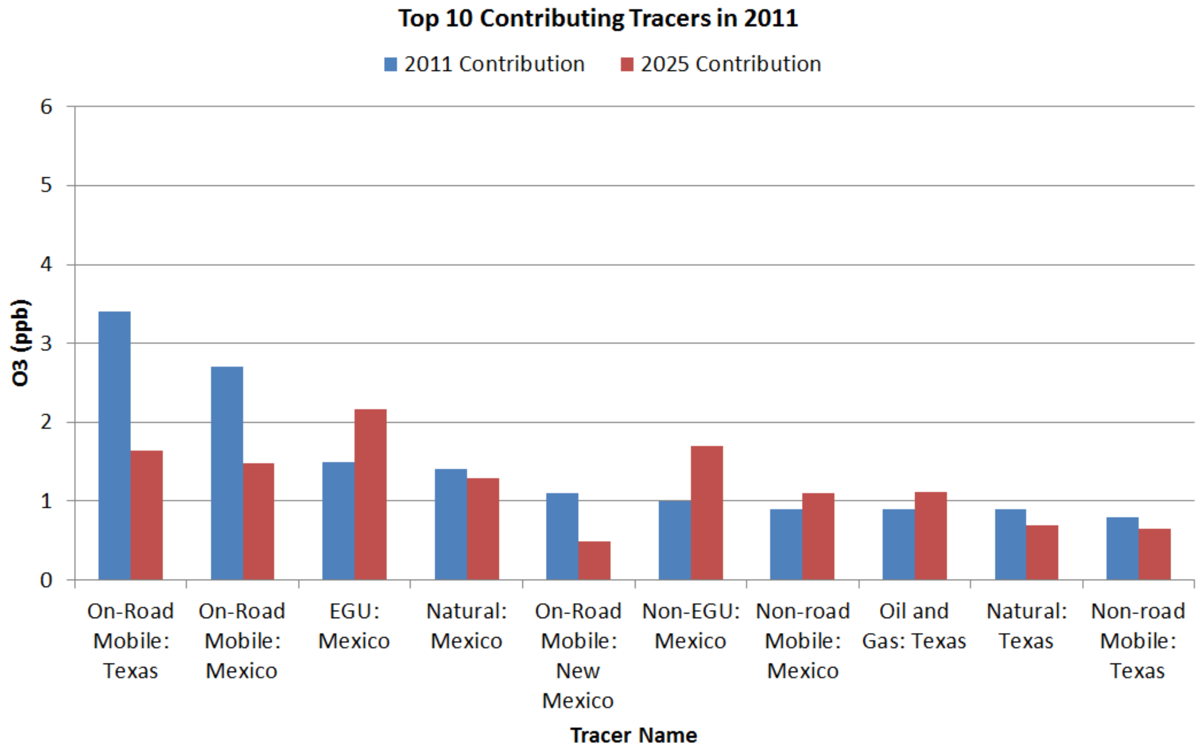


Figure 3-37. Contributions to the 2011 (blue) and 2025 (red) design values for the top ten contributing source groups in 2011 for the Desert View monitor. Source groups are ranked from left to right based on their contribution to the 2011 design values.

As noted above, results for the other Doña Ana County monitors are similar to those of Desert View and are available in the Task 12 PowerPoint. Next, we identify source groups that had the largest impact on Doña Ana County monitors. Figure 3-38 shows the frequency (as a count) with which each source group appears in the list of top five contributing source groups for the Doña Ana County monitors. We selected the top five source groups because contributions to design values tended to drop below 1 ppb for source groups outside the top five, so that focusing on the top five isolates the most important source groups. There were six Doña Ana County monitors active during this modeling episode (Figure 3-39), so that when the count for a source group is six (such as for natural emissions in Mexico in 2025) that source group was in the top five contributing source groups for all Doña Ana County monitors in that year.

Figure 3-37 shows that on-road, natural (Mexico) and EGU (Mexico) emissions appeared most frequently in the list of top five contributors to Doña Ana County monitor design values. All six Doña Ana County monitors had Texas on-road mobile sources appearing in the list of top five contributors in 2011. While New Mexico on-road mobile sources appeared in the list of the top five sources for five Doña Ana County monitors in 2011, reductions in on-road mobile emissions by 2025 meant that on-road mobile emissions from New Mexico appeared in the list of top five contributors for only one monitor (Solano) in 2025. Oil and gas emissions growth in the

Permian Basin is the cause of the increased frequency of appearance of Texas oil and gas sources in the list of top five contributors in 2025.

Mexico is the most frequently appearing source region, with emissions from Mexican natural sources, on-road mobile and EGU point sources appearing the most frequently in 2011 and Mexican natural emissions, on-road mobile sources and EGU and non-EGU point sources appearing most frequently in 2025. Next, we focus on the contribution from Mexico.

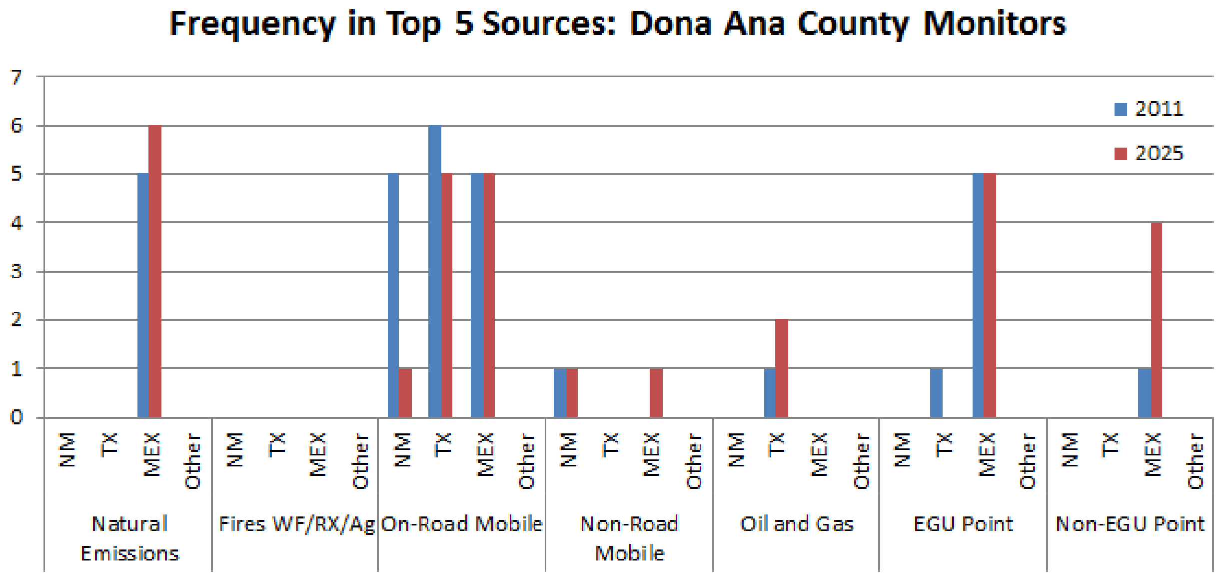


Figure 3-38. Frequency with which each source group appeared in the list of top five contributing source groups for the Doña Ana County monitors in 2011 and 2025.

Figure 3-40 shows the contributions to monitors within the 4-km domain due to emissions from Mexico along with a map of the monitors within and nearby Doña Ana County. The full map of monitors within the 4-km domain is shown in Figure 3-39. Contributions from Mexico emissions to 2011 and 2025 design values range from ~2-6 ppb at Doña Ana monitors and are similar in magnitude in 2011 and 2025. Monitors in New Mexico that are located near the U.S.-Mexico border (Desert View, Sunland Park) and El Paso monitors have larger contributions from Mexico emissions than monitors located further from the border (Carlsbad, Hurley). The contribution from Mexico emissions is significant and in 2011 is sufficiently large to affect the attainment status of the monitors. (See additional discussion below). The contribution from Mexico does not change substantially from 2011 to 2025; the contribution increases for some monitors (Sunland Park, El Paso UTEP) and decreases for other monitors (Santa Teresa, Ascarate Park).

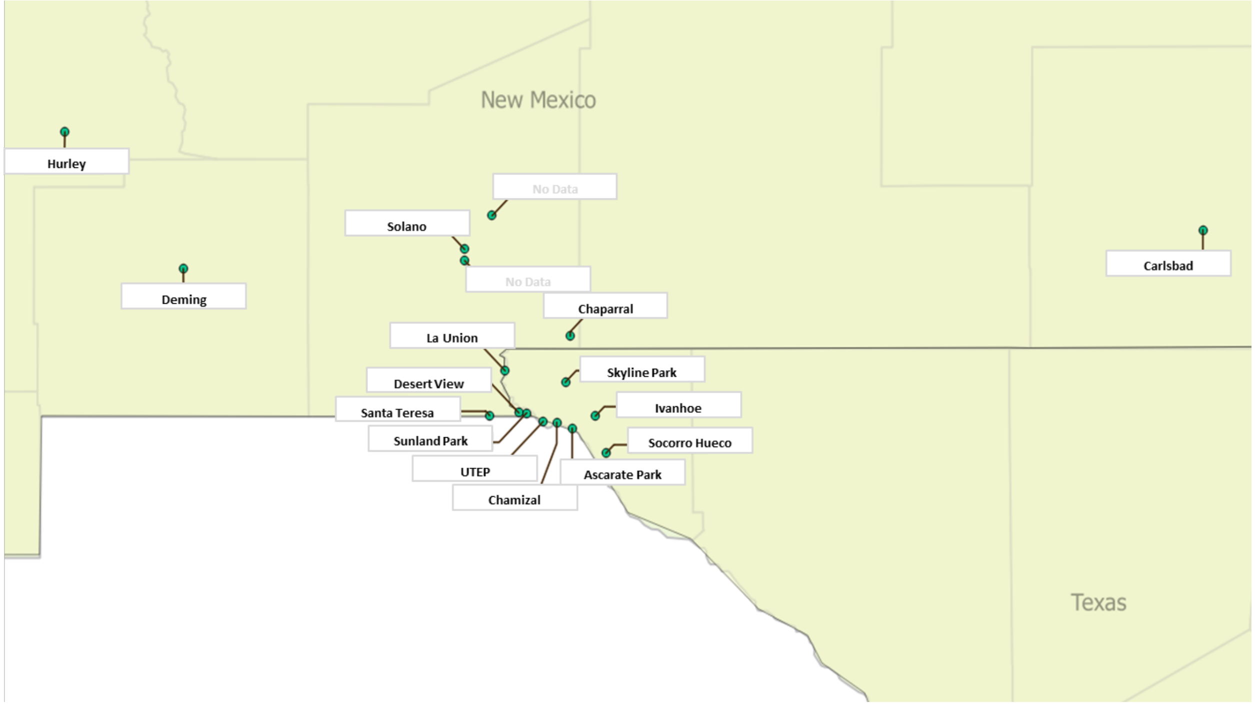


Figure 3-39. Map of ozone monitors within the SNMOS 4-km domain. Sites that were not active during the 2011 SNMOS modeling episode are indicated by "No Data".

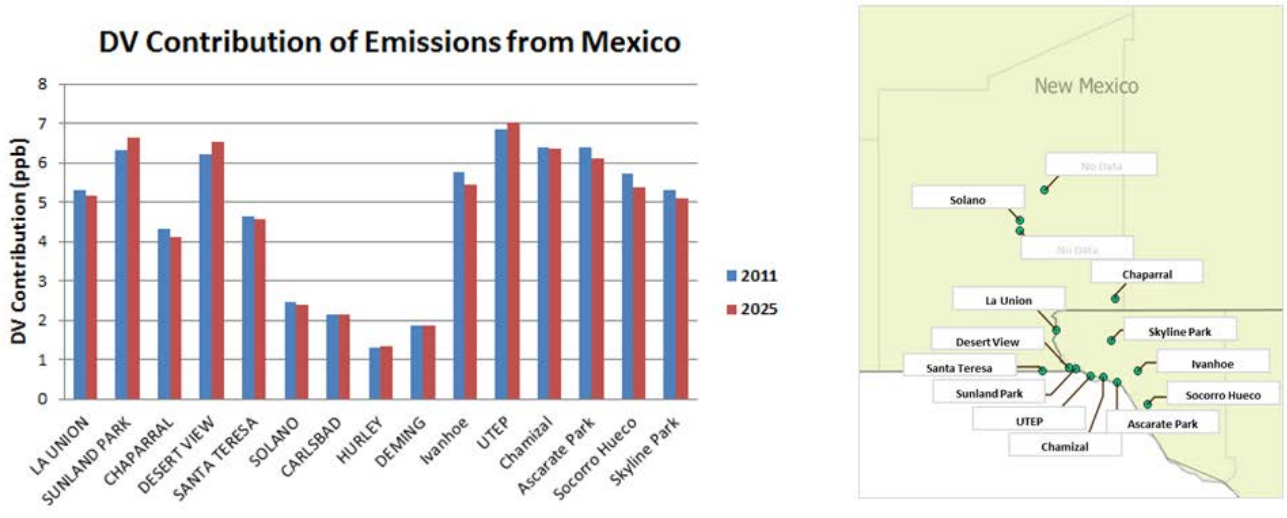


Figure 3-40. Left: contribution of Mexico anthropogenic emissions to 2011 and 2025 DVs for monitors in the 4-km grid. Right: map of ozone monitors within and nearby Doña Ana County.

The contribution to 4-km grid monitors from on-road mobile sources is shown in Figure 3-41. There are large (>7 ppb) 2011 contributions from on-road emissions to design values at Doña Ana and El Paso monitors. Decreases in U.S. and Mexico 2025 on-road mobile emissions relative to 2011 cause large decreases in the on-road mobile contribution in 2025 for all sites.

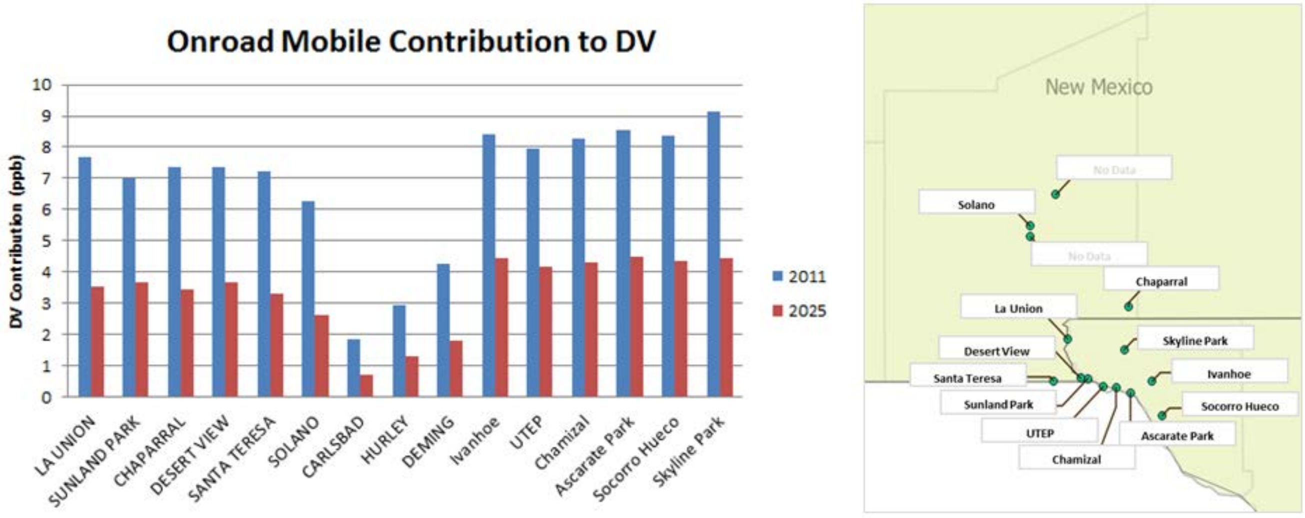


Figure 3-41. Left: contribution of on-road mobile emissions to 2011 and 2025 DVs for monitors in the 4-km grid. Right: map of ozone monitors within and nearby Doña Ana County.

Figure 3-42 shows the contribution of New Mexico anthropogenic emissions to design values of monitors in New Mexico. This represents the portion of the design values that are subject to local control. On-road mobile emissions make the largest anthropogenic contribution to design values at most New Mexico monitors. The Solano monitor has the largest contribution from on-road mobile sources. This monitor is located within the Las Cruces urban area and is also close to Interstate I-15. The contribution from on-road mobile sources decreases in 2025 for all New Mexico monitors, consistent with the decrease in New Mexico on-road mobile emissions in 2025 relative to 2011.

Non-road mobile and oil and gas sources make next largest contributions, followed by EGU point sources. Oil and gas sources make the largest contribution at the Carlsbad monitor, which is the monitor located closest to the Permian Basin (Figure 3-39). The magnitude of the oil and gas impact increases in 2025 consistent with projected growth in emissions in the Permian Basin in 2025 relative to 2011 (Section 3.2.1).

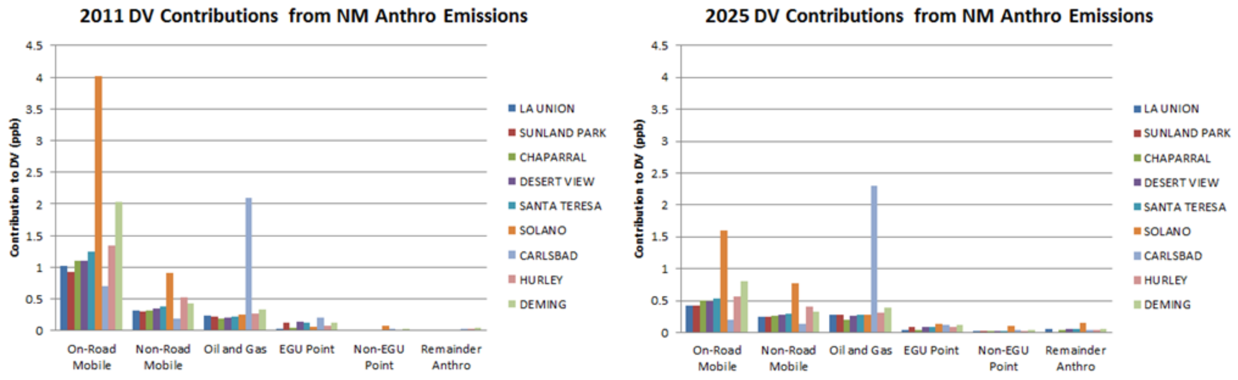


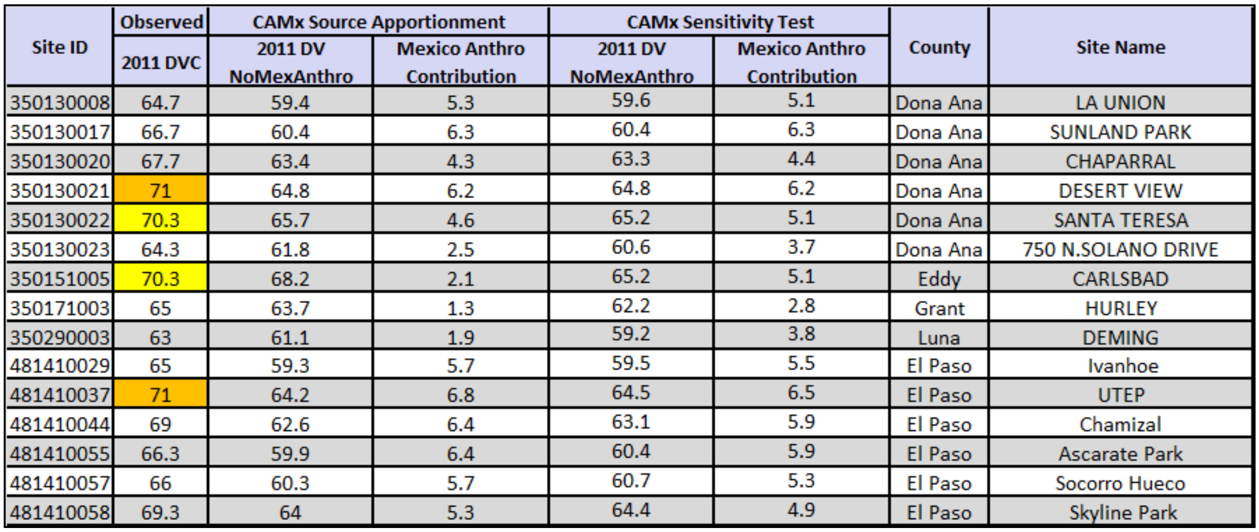
Figure 3-42. Contribution of New Mexico anthropogenic emissions to 2011 and 2025 design values for New Mexico monitors within the 4-km grid.

3.12.1.2 Contribution of Emissions from Mexico to Doña Ana County Ozone

We assessed the contribution of Mexico emissions to design values at Doña Ana monitors in 2011 and 2025 and compared the results with those of the Task 11 Sensitivity Test in which the ozone impacts of zeroing out Mexico anthropogenic emissions were quantified. This assessment is aimed at assessing whether a Section 179B "But For" test would be appropriate for Doña Ana monitors.

Section 179B of the Clean Air Act addresses impacts on U.S. air quality due to transport of pollution from outside the U.S. Section 179B provides relief from some requirements for areas that would be able to meet the NAAQS "but for" ozone impacts of emissions from another country. In preparing a Section 179B demonstration, an air agency must show that the area would attain the NAAQS but for the ozone contribution from outside the U.S. In Table 3-13, the contributions from Mexico anthropogenic emissions ("Mexico Anthro Contribution") to 2011 design values from the Task 12 source apportionment modeling as well as the Task 11 sensitivity modeling are shown. For the source apportionment results, the Mexico Anthro Contribution ranges between 1.3-6.8 ppb for monitors in the 4-km grid. Contributions to Dona Ana monitor design values from Mexico emissions range from ~2-6 ppb at Doña Ana monitors and are similar in 2011 and 2025. Subtracting the Mexico Anthro Contribution from the 2011 DVC yields the 2011 DV NoMexAnthro, the value of the 2011 DVC at the monitor when the contribution from Mexico anthropogenic emissions is removed. When the ozone contribution from Mexico anthropogenic emissions is subtracted, the Desert View 2011 DVC drops from 71 ppb, which exceeds the 70 ppb NAAQS, to 64.8 ppb, which attains the 70 ppb NAAQS. Table 3-13 indicates that but for the contribution of emissions from Mexico, the Desert View monitor would have attained the 70 ppb NAAQS in 2011. The same is true for the UTEP monitor in El Paso; the UTEP monitor's 2011 design value drops from 71 ppb to 64.2 ppb when the contribution from Mexican anthropogenic emissions is removed.Table 3-13 indicates that monitors closer to the U.S.-Mexico border have a larger Mexico contribution (e.g., El Paso monitors) than monitors which are more distant from the border (Carlsbad, Deming).

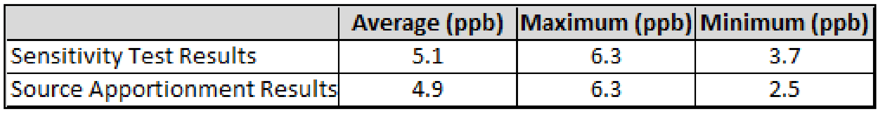
Table 3-13. Ozone contribution to 2011 DVs from Mexico anthropogenic emissions (Mexico Anthro Contribution) for all monitors in the 4-km grid. Results are shown for the sensitivity test (Task 11) and source apportionment (Task 12) analyses. Orange shading of the 2011 DVC indicates that the DVC exceeds the 2015 ozone NAAQS of 70 ppb. Yellow shading indicates 70 ppb < DVC < 71 ppb.



Site ID	Observed	CAMx Source Apportionment		CAMx Sensitivity Test		County	Site Name
	2011 DVC	2011 DV NoMexAnthro	Mexico Anthro Contribution	2011 DV NoMexAnthro	Mexico Anthro Contribution		
350130008	64.7	59.4	5.3	59.6	5.1	Dona Ana	LA UNION
350130017	66.7	60.4	6.3	60.4	6.3	Dona Ana	SUNLAND PARK
350130020	67.7	63.4	4.3	63.3	4.4	Dona Ana	CHAPARRAL
350130021	71	64.8	6.2	64.8	6.2	Dona Ana	DESERT VIEW
350130022	70.3	65.7	4.6	65.2	5.1	Dona Ana	SANTA TERESA
350130023	64.3	61.8	2.5	60.6	3.7	Dona Ana	750 N.SOLANO DRIVE
350151005	70.3	68.2	2.1	65.2	5.1	Eddy	CARLSBAD
350171003	65	63.7	1.3	62.2	2.8	Grant	HURLEY
350290003	63	61.1	1.9	59.2	3.8	Luna	DEMING
481410029	65	59.3	5.7	59.5	5.5	El Paso	Ivanhoe
481410037	71	64.2	6.8	64.5	6.5	El Paso	UTEP
481410044	69	62.6	6.4	63.1	5.9	El Paso	Chamizal
481410055	66.3	59.9	6.4	60.4	5.9	El Paso	Ascarate Park
481410057	66	60.3	5.7	60.7	5.3	El Paso	Socorro Hueco
481410058	69.3	64	5.3	64.4	4.9	El Paso	Skyline Park

We compared the sensitivity and source apportionment results to see whether they are consistent in their estimates of the importance of the ozone contribution from Mexico. The Mexico Anthro Contribution is similar in magnitude in the source apportionment and the sensitivity testing results (Table 3-14).

Table 3-14. Contribution of Mexico emissions to 2011 DVs for Doña Ana County monitors (4-km grid results): comparison of CAMx zero out sensitivity test (Task 11) and source apportionment (Task 12) results.



	Average (ppb)	Maximum (ppb)	Minimum (ppb)
Sensitivity Test Results	5.1	6.3	3.7
Source Apportionment Results	4.9	6.3	2.5

The source apportionment and sensitivity test results are consistent in showing that Mexico emissions had a significant impact on Doña Ana County design values in 2011 and that the Desert View monitor would have attained the 70 ppb NAAQS but for the contribution of anthropogenic emissions from Mexico. The source apportionment results and the sensitivity test show similar maximum and average impacts and the sensitivity test has a higher minimum impact.

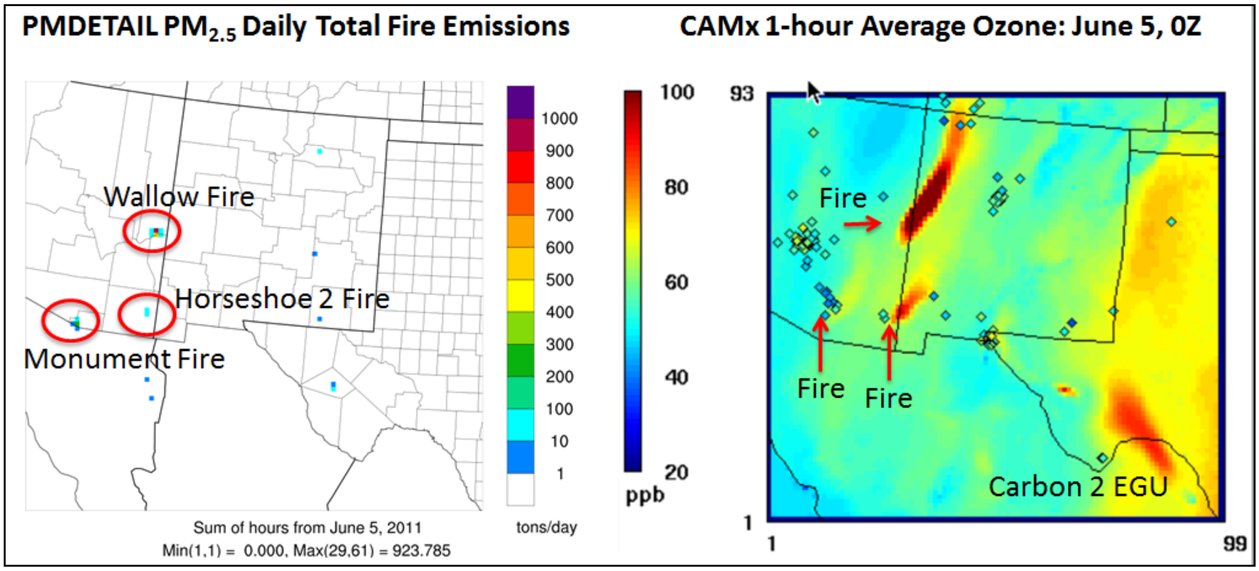
3.12.1.3 Contribution of Fire Emissions to Doña Ana County Ozone

In 2011, the southwestern U.S. had an active fire season, with a number of large fires occurring in the SNMOS 12-km domain. The CAMx modeling of 2011 showed intermittent large impacts from fire emissions. For example, on June 5, 2011, there were several large wildfires burning within the 12-km domain. In the left panel of Figure 3-43, there are areas of $PM_{2.5}$ emissions at the location of these fires, which were also apparent in satellite imagery for June 5 (Figure 3-13). The right hand panel of Figure 3-43 shows CAMx modeled 1-hour ozone for 0Z on June 5, and the plumes from the wildfire emissions in the left panel are apparent as regions of enhanced ozone. The Wallow Fire plume has modeled 1-hour ozone values exceeding 160 ppb, while ozone outside the plume ranges from ~50-70 ppb. The Wallow Fire plume passes over several ozone monitors in northern New Mexico and southern Colorado, but the monitors do not show enhanced ozone concentrations comparable to the modeled plume. The model overestimates ground level ozone impacts from the Wallow Fire plume as well as the other fires in the 12-km domain on June 5. This overestimate of fire plume ozone impacts was typical of SNMOS CAMx model performance.

The modeled ozone impacts of fires depend on accurate characterization of fire emissions and simulation of the transport, chemical transformation, and fate of emitted ozone precursors and the ozone that forms from them. Fire emissions contain uncertainties in both their magnitude and their chemical composition (e.g,. Wiedinmyer et al. 2011; Jaffe and Wigder, 2012). The chemical composition of the emissions plays a role in the photochemistry of the resulting fire plume and therefore the resulting ozone impact.

The chemistry of ozone production in fire plumes is an area of active research. Measurement campaigns in which aircraft made transects through fire plumes and measured ozone and other trace gases have produced a range of results regarding the magnitude of ozone production in fire plumes (e.g., Bertschi et al., 2004; Alvarado et al; 2010). Jaffe and Wigder (2012) note that there is not a clear relationship between the quantity of ozone precursor emissions released into the atmosphere and the ozone produced in the plume downwind of the fire. Wigder et al. (2013) hypothesize that plume rise and the altitude of subsequent plume transport can affect ozone production in the plume because temperatures are lower at higher altitudes. The interaction of fire plumes with anthropogenic emissions is not well understood. Singh et al. (2012) and Wigder et al. (2013) found enhanced ozone in fire plumes that mixed with air containing urban emissions. The presence of aerosols (smoke) in the fire plume can reduce the amount of sunlight available to initiate photochemistry, inhibiting ozone formation (e.g. Parrington et al., 2013).

Finally, in order to simulate the transport of ozone and precursors away from a fire, the meteorological model must successfully reproduce the true wind field and accurately represent vertical transport of emitted and secondary pollutants. Even if the photochemical accurately represents the amount of ozone and precursors in the fire plume, there will be bias in the modeled ground level ozone if transport and vertical mixing are not accurately simulated. In the SNMOS modeling, for example, it is possible that the modeled Wallow Fire plume affected the surface while in the real world, the fire plume passed over the monitor aloft without mixing down to the surface.



PMDETAIL $PM_{2.5}$ Daily Total Fire Emissions

CAMx 1-hour Average Ozone: June 5, 0Z

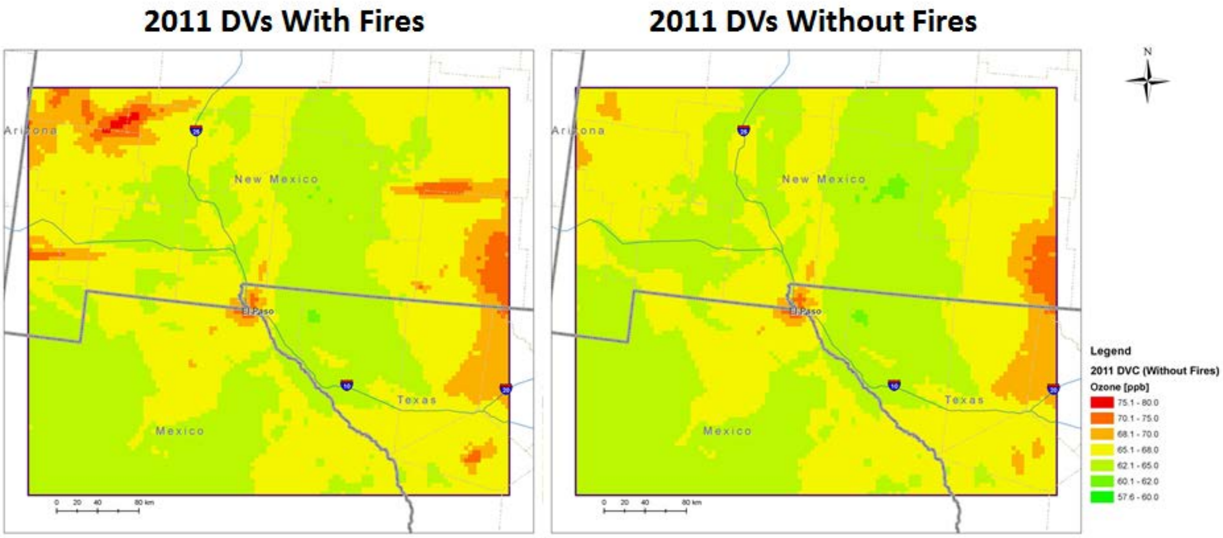
Figure 3-43. Fire emission ozone impacts on June 5, 2011. Left panel: PMDETAIL $PM_{2.5}$ emissions indicating the location of fires on June 5. Larger fires within the 12-km domain are circled in red. Right panel: CAMx 1-hour average modeled ozone for 0Z on June 5. Monitor locations are indicted by diamonds and the observed value for 0Z June 5 is indicated by the color within the diamond. The location of large fires and the ozone plume from the Carbon II Power Plant in Mexico are shown.

In the SNMOS source apportionment modeling, we treated fires separately from the rest of the natural emission inventory so their impacts could be tracked. We used source apportionment to quantify the effect of fire emissions on Doña Ana DVs in order to assess the uncertainty introduced into the design value analysis by the fire emissions modeling. Table 3-15 shows the future year 2025 design values (DVF) with and without the contribution from fire emissions for all monitors in the 4-km domain. The difference between these two DVFs is the impact of fire emissions on each monitor’s design value. The impact of fire emissions on the 4-km grid monitor 2025 DVFs was < |0.5| ppb for all monitors. This indicates that fire emissions did not have a substantial effect on the design value results for monitors in the 4-km grid.

Table 3-15. Impact of fire emissions on 4-km grid monitor 2025 design value results.

Site ID	State	County	2011 DVC (ppb)	2025 Design Values (ppb)		Fire Impact on 2025 DVF (ppb)	Site Name
				DVF (without fires)	DVF (with fires)		
350130008	New Mexico	Dona Ana	64.7	58.3	58.3	0.006	LA UNION
350130017	New Mexico	Dona Ana	66.7	61.4	61.3	-0.007	SUNLAND PARK
350130020	New Mexico	Dona Ana	67.7	61.3	60.8	-0.439	CHAPARRAL
350130021	New Mexico	Dona Ana	71.0	65.1	65.1	-0.007	DESERT VIEW
350130022	New Mexico	Dona Ana	70.3	63.8	63.8	-0.007	SANTA TERESA
350130023	New Mexico	Dona Ana	64.3	58.6	58.7	0.108	SOLANO
350151005	New Mexico	Eddy	70.3	67.6	67.9	0.295	CARLSBAD
350171003	New Mexico	Grant	65.0	62.0	62.0	0.013	HURLEY
350290003	New Mexico	Luna	63.0	58.6	58.6	-0.038	DEMING
481410029	Texas	El Paso	65.0	58.4	58.4	0.006	Ivanhoe
481410037	Texas	El Paso	71.0	65.3	65.2	-0.163	UTEP
481410044	Texas	El Paso	69.0	62.5	62.7	0.158	Chamizal
481410055	Texas	El Paso	66.3	60.1	60.1	0.007	Ascarate Park
481410057	Texas	El Paso	58.7	59.8	59.8	0.000	Socorro Hueco
481410058	Texas	El Paso	69.3	62.1	61.7	-0.380	Skyline Park

The MATS design value analysis presented in Table 3-15 applies only to the monitoring sites within the 4-km domain. To determine whether fire emissions influenced ozone design values away from the monitoring sites, we performed a MATS Unmonitored Area Analysis (UAA). The UAA was performed by interpolating DVCs from monitoring sites to each grid cell in the modeling domain using the Voronoi Neighbor Averaging interpolation technique. The modeled ozone gradients are taken into account in the interpolation in order to reflect modeled higher and lower ozone areas in the interpolated DVC field. An unmonitored area analysis was performed that interpolated the 2011 DVCs across the modeling domain and performed ozone projections using the modeling results within each grid cell only. Figure 3-44 shows the results of the UAA for 2011 with the impacts of fire emissions included (left panel) and excluded (right panel). The difference of these two fields is shown in Figure 3-45. Figure 3-45 shows that larger fire impacts on design values (> 5 ppb) occurred away from monitoring sites within the 4-km domain downwind of 2011 fires. For example, the plume from the Horseshoe 2 Fire (Figure 3-43) in eastern Arizona extends into southwestern New Mexico and the ozone impacts of a number of other fires are apparent within the 4-km grid. Impacts away from the monitors exceeded 5 ppb in some of these plumes. Given the high bias seen in the CAMx simulated ozone downwind of fires in the 2011 model performance evaluation, these impacts may be overestimated and must be considered highly uncertain. However, because of the location of the fires in 2011 and wind patterns that caused plumes to miss the monitors in the 4-km domain, this uncertainty does not affect the design value results at the monitors. Results for the future year 2025 modeling are shown in Figure 3-46 and Figure 3-47and are similar to those of 2011.



2011 DVs With Fires

2011 DVs Without Fires

Figure 3-44. Impact of fire emissions on 4-km grid design value results: 2011 MATS Unmonitored Area Analysis.

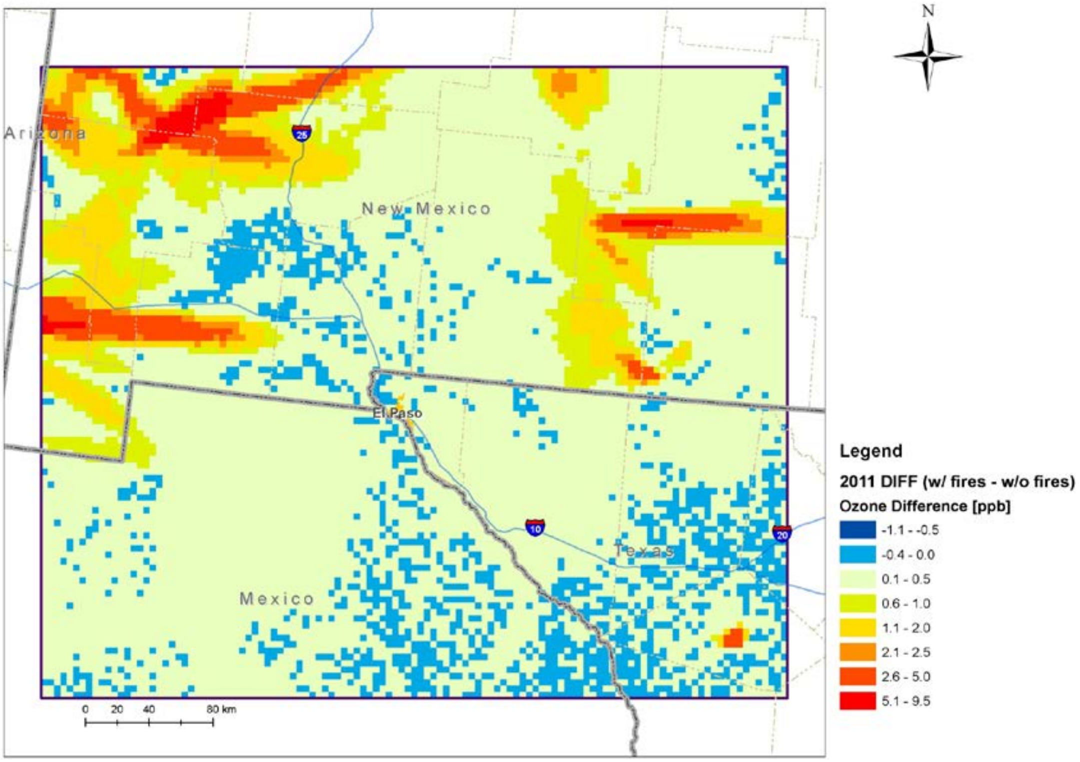


Figure 3-45. Impact of fire emissions on 4-km grid design value results: 2011 MATS Unmonitored Area Analysis: DVC(with fire contribution) - DVC(without fire contribution).

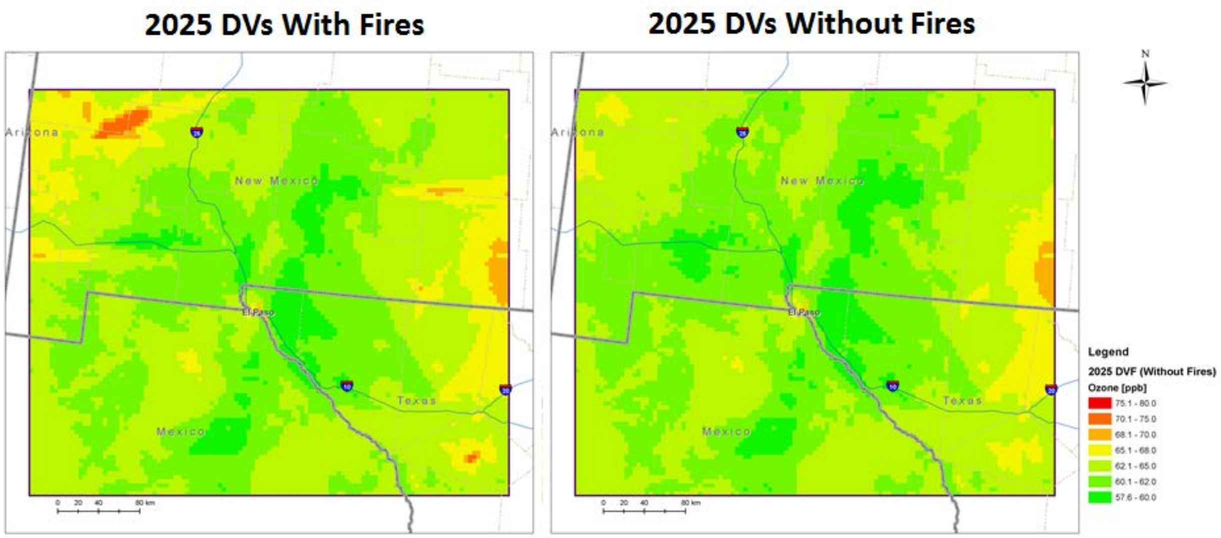


Figure 3-46. Impact of fire emissions on 4-km grid design value results: 2025 MATS Unmonitored Area Analysis.

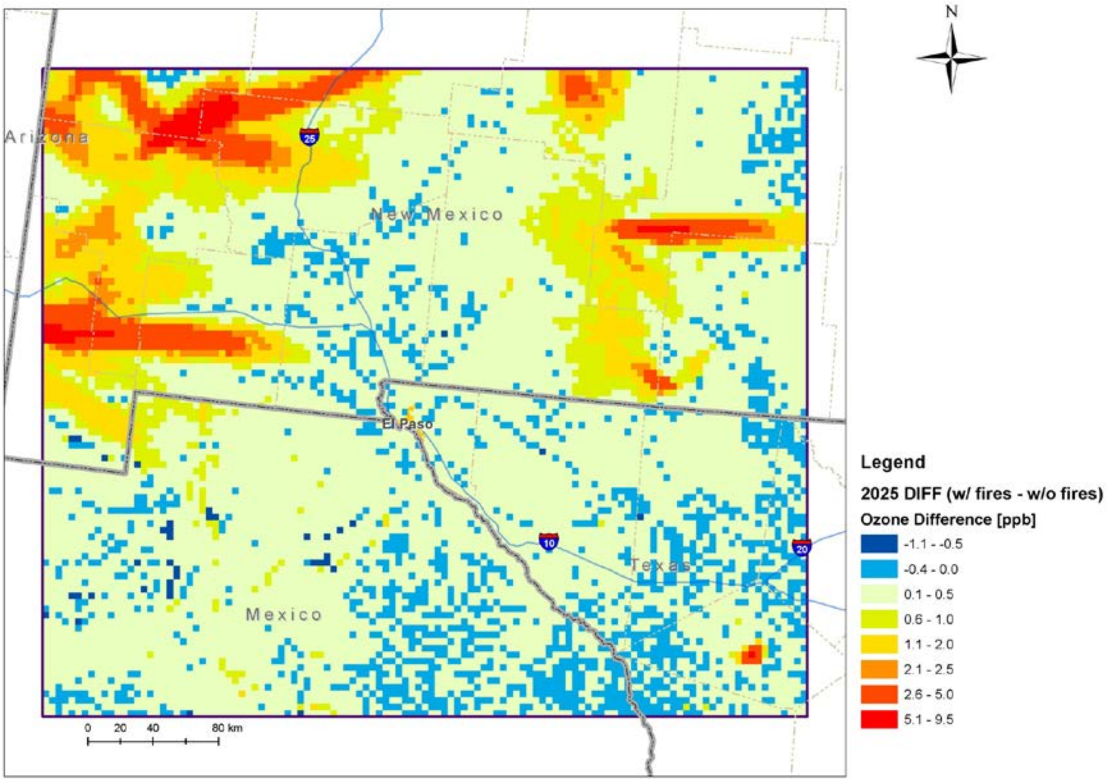


Figure 3-47. Impact of fire emissions on 4-km grid design value results: 2011 MATS Unmonitored Area Analysis: DVF(with fire contribution) - DVF(without fire contribution).

3.12.1.4 Source Apportionment Visualization Tools Overview

The SNMOS modeling results were loaded into a web-based Source Apportionment Visualization Tool (SA Vis Tool) on the Intermountain West Data Warehouse website (**http://views.cira.colostate.edu/tsdw/**). Documentation of the source apportionment results may be found in the SNMOS wiki on the IWDW website[11] (Figure 3-48).

The IWDW has been fully supported by multiple federal and state agencies, with assistance from WESTAR-WRAP, since its creation through the 3SAQS Pilot Study. The IWDW provides air quality data, photochemical grid modeling products, and analysis tools to support various air quality applications. Available datasets include emissions inventories, meteorological data, air quality modeling platforms, and monitoring data.

Figure 3-48. IWDW web page.

The SNMOS ozone design value source apportionment modeling analysis is available in an interactive Excel spreadsheet that can be accessed through a link in the SNMOS wiki page. To display the Source Group contributions to 2011 and 2025 MDA8 ozone concentrations, the user can access the SNMOS 2011 and 2025 SA Vis Tool through the SNMOS wiki. The SA Vis Tools generate pie charts of 2011 and 2025 ozone contributions by Source Region, Source Category or both (i.e., Source Groups) for monitoring sites within the SNMOS 4-km modeling domain. The SA Vis Tools can be used to display base (2011) and future (2025) year MDA8 SA results. The SA Vis Tools provide source apportionment results as well as information on CAMx model performance by monitor and by date.

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[11] http://vibe.cira.colostate.edu/wiki/wiki/9131/southern-new-mexico-ozone-study-snmos-2011-and-2025-ozone-source-apportionm

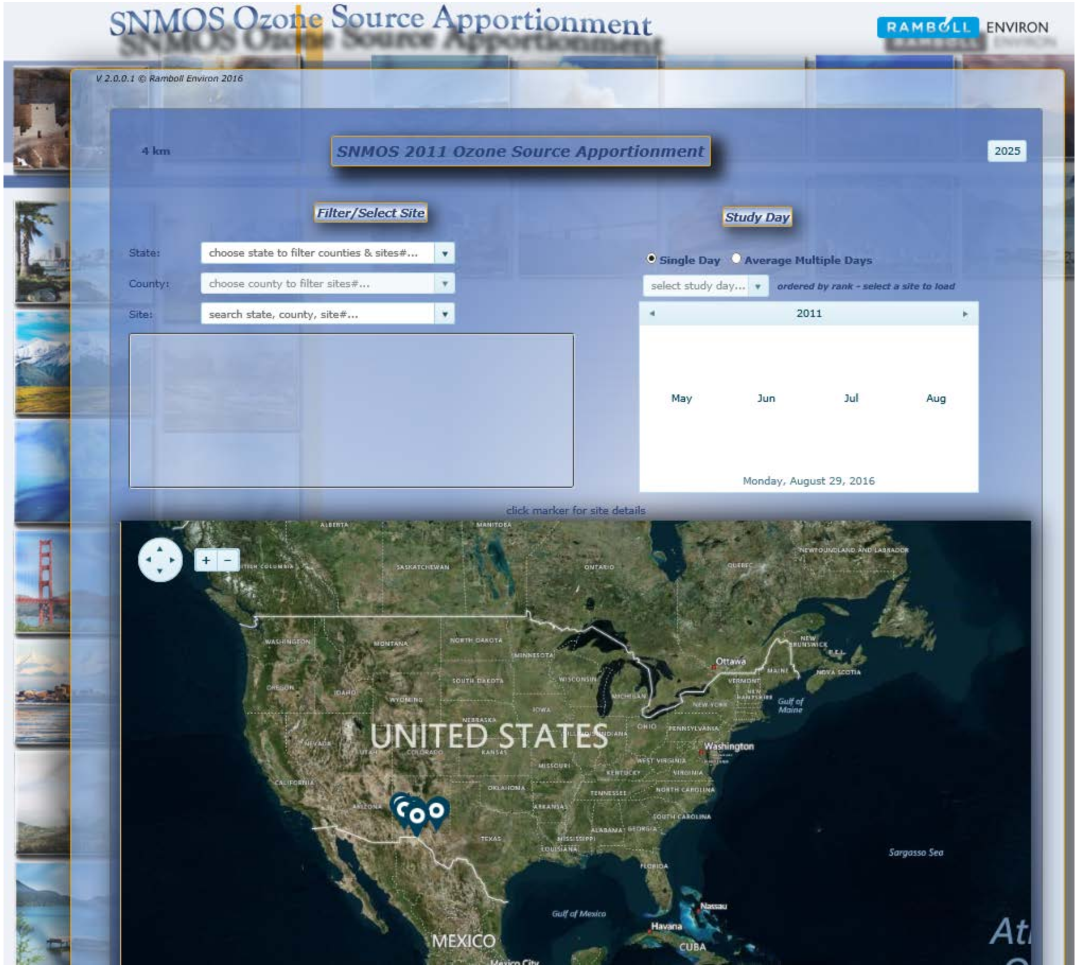

Figure 3-49. SNMOS SA Vis Tools website.

3.12.2 Significant Findings

Transport plays an important role in determining ozone levels in Doña Ana County. For Doña Ana County monitors, the 12-km grid boundary conditions were the largest contributor of ozone; this is a typical result for a regional modeling study. The contribution of New Mexico emissions to Doña Ana County monitor design values is smaller than the contributions of Texas and Mexico for all Doña Ana monitors except Solano, which has a large on-road mobile contribution from New Mexico on-road mobile emissions.

The source apportionment results indicate that the contribution of Mexico anthropogenic emissions to Doña Ana monitor 2011 design values ranges from 2.5 – 6.3 ppb with an average of 4.9 ppb. The source apportionment results confirm that all Doña Ana County ozone monitors, including Desert View, would have attained the 70 ppb ozone NAAQS in 2011 but for the ozone contribution due to anthropogenic emissions from Mexico.The source apportionment (Task 12) and Sensitivity Test (Task 11) model analyses are consistent in showing this result.

The emissions sources within the 12/4 km modeling domains that contributed the most ozone to Doña Ana County ozone monitors in 2011 were: (1) on-road mobile emissions from Texas, Mexico and New Mexico; (2) power plant emissions from Mexico; and (3) natural emissions from Mexico. In 2025, the emissions sources within the 12/4 km modeling domains that contributed the most ozone to Doña Ana County ozone monitors were: (1) on-road mobile emissions from Texas and Mexico; (2) power plant non-power plant point source emissions from Mexico; and (3) natural emissions from Mexico.

Of all New Mexico anthropogenic emissions sources, on-road mobile emissions make the largest contribution to design values at Doña Ana monitors. New Mexico anthropogenic emission sources that contributed the most ozone to New Mexico monitors in the SNMOS 4-km grid were: (1) on-road mobile; (2) offroad mobile; (3) oil and gas; and (4) power plants. Oil and gas emissions made the largest New Mexico anthropogenic contribution at the Carlsbad monitor due to its closer proximity to the Permian Basin. The impact of oil and gas sources increases in 2025 due to projected growth in Permian Basin emissions.

Fire emissions had a small (≤ |0.5| ppb) effect on 2011 and 2025 DVs at Doña Ana County monitors. These impacts are too small to affect the attainment status results for 2011 and 2025. The small magnitude of the impacts is due to location of monitors relative to 2011 fires and 2011 winds. Fire emissions had a larger effect on 2011 and 2025 DVs at grid cells elsewhere in the 4-km domain with the UAA showing design value impacts exceeding 5 ppb downwind of the fire locations.

3.12.3 Milestones and Deliverables

- Carry out SNMOS ozone source apportionment CAMx modeling of 2011 and 2025 (Completed July 18, 2016)
- PowerPoint presentation on ozone source apportionment modeling (Completed September 8, 2016)
- Wiki and SA Vis Tools Provide interactive spreadsheet source apportionment results on ozone DVs(Completed September 8, 2016)
- Provide SA Visualization Tool for 2011 and 2025 ozone contributions to MDA8 ozone at monitors (hosted on IWDW and available through wiki) (Completed September 8, 2016)

3.13 Task 13: Technical Support Document

3.13.1 Task Summary

A Technical Support Document that (TSD) that summarizes the SNMOS (this document) was prepared and submitted to the NMED.

3.13.2 Significant Findings

UNC-IE and Ramboll Environ prepared a draft TSD documenting Tasks 1-12 and submitted the draft TSD for review. The draft TSD will be updated to reflect comments received and a Response to Comments (RtC) document will be prepared and submitted along with the final AQTSD.

3.13.3 Milestones and Deliverables

- Draft Technical Support Document (TSD) (completed September 30, 2016)
- Final TSD (to completed by November 18, 2016)
- Response to Comments (RtC) document for NMED (to completed by November 18, 2016)
- Modeling data, RtC document, and final TSD posted on WAQS data warehouse (to completed by November 18, 2016)

4.0 SUMMARY OF FINDINGS AND RECOMMENDATIONS

In this section, we summarize the main findings of the SNMOS. We discuss the major sources of uncertainty noted during the study and provide recommendations for future work to reduce these uncertainties.

4.1 SNMOS Major Findings

- 2025 future year design value projections indicate that all Doña Ana County ozone monitors are expected to attain the 70 ppb ozone NAAQS in 2025.
    - The finding of attainment was not sensitive to the method used in the MATS design value projection procedure, the model’s bias in simulating ozone, or to the modeling of fire emissions
    - The finding of attainment was robust under a sensitivity test in which projected reductions in on-road mobile emissions by 2025 were smaller than EPA MOVES model estimates
- The projected decreases in Doña Ana County ozone design values between 2011 and 2025 are mainly driven by projected reductions in on-road mobile source emissions.
- All Doña Ana County ozone monitors would have attained the 70 ppb ozone NAAQS in 2011 but for the ozone contribution due to anthropogenic emissions from Mexico.
- Emissions sources within the 12/4 km modeling domains that contributed the most ozone to Doña Ana County ozone monitors in 2011 were: (1) on-road mobile emissions from Texas, Mexico and New Mexico; (2) power plant emissions from Mexico; and (3) natural emissions from Mexico.
- Emissions sources within the 12/4 km modeling domains that contributed the most ozone to Doña Ana County ozone monitors in 2025 were: (1) on-road mobile emissions from Texas and Mexico; (2) power plant non-power plant point source emissions from Mexico; and (3) natural emissions from Mexico.
- Ozone transport plays an important role in determining ozone levels in Doña Ana County. For Doña Ana County monitors, the 12-km grid boundary conditions were the largest contributor of ozone; this is a typical result for a regional modeling study. For all Doña Ana County monitors except Solano, the ozone contribution from Texas and Mexico was larger than that of New Mexico.
- New Mexico anthropogenic emission sources that contributed the most ozone to New Mexico monitors in the SNMOS 4-km grid were: (1) on-road mobile; (2) offroad mobile; (3) oil and gas; and (4) power plants.
- Oil and gas emissions are the largest New Mexico anthropogenic contribution at the Carlsbad monitor due to its closer proximity to the Permian Basin. The impact of oil and gas sources increases in 2025 due to projected growth in Permian Basin emissions.

4.2 Recommendations for Future Work

Based on our evaluation of model performance and the major uncertainties in the SNMOS, we make the following recommendations for future work.

4.2.1 WRF Meteorological Modeling

WRF meteorological model performance is a source of uncertainty in the SNMOS. While WRF performance was improved using the Multiscale (grid-aware) Kain-Fritsch cumulative cloud scheme, the model was still unable to consistently simulate precipitation, temperature and wind patterns related to the North American monsoon. This likely degraded the CAMx model's simulation of ozone in southern New Mexico.

Recommendation: Perform additional sensitivity testing to refine the WRF configuration with the aim of improving model performance in simulating temperatures, winds and precipitation improves during the months when the North American Monsoon is active.

4.2.2 Natural Emissions

Modeling of natural emissions (biogenics, fire and lightning) is an active area of scientific research, and the SNMOS emission inventories should be considered to have considerable uncertainty associated with them. In order to understand and possibly reduce this uncertainty, additional study of these emissions and their effect on Doña Ana County ozone should be undertaken.

In the MEGAN v2.1 biogenic inventory, there is a discontinuity in isoprene and monoterpene emissions at the U.S.-Mexico border with emissions larger in Mexico than in the U.S. for environments that appear from Google Earth imagery to have comparable vegetation cover.

Recommendation: Further investigation of differences in U.S. and Mexico MEGAN inputs should be undertaken to understand their origin and to ensure that the most accurate and consistent input data available are used as well as using the most up-to-date calculation methods to develop emissions on both sides of the border.

While modeling of fire emissions did not have a substantial effect on the design value analysis at Doña Ana County monitors, fires had impacts exceeding 5 ppb on design values for grid cells elsewhere in the modeling domain. In an episode in which fires are in different locations and wind patterns are different, fire emissions may have a large influence on Doña Ana County monitors and may introduce significant uncertainty, complicating air quality planning efforts.

Recommendation: Perform a detailed analysis of the fire emissions, their modeling, and the resulting CAMx air quality model simulation of the fire plume in order to better understand the reasons for CAMx overestimates of ozone at ground level monitoring sites during 2011.

LNOx emissions are intermittent, but can contribute to regional background ozone. In the SNMOS model performance evaluation, CAMx had a high bias during July and August and better performance earlier in the episode, before the onset of the monsoon, when intense convection and associated lightning occur across the region.

Recommendation: Investigate the effect of LNOx emissions on modeled ozone by zeroing out the SNMOS LNOx emissions and comparing the resulting ozone with the 2011 model base case. If there is a significant effect on model performance (such as a reduction in model high bias in July and August), efforts should be made to improve the treatment of LNOx emissions in the Southern New Mexico ozone modeling. We recommend a review of current parameterizations for specifying LNOx emissions to determine whether an alternate approach would be beneficial and whether satellite data can be used to constrain LNOx emissions over Southern New Mexico and the surrounding region, including Mexico.

4.2.3 Anthropogenic Emissions

The SNMOS used the best available anthropogenic emission inventories for the region. However, uncertainties in these inventories may affect the SNMOS modeling results as well as future air quality planning efforts for Doña Ana County.

Much of the reduction in Doña Ana County design values between 2011 and 2025 is driven by reductions in on-road mobile emissions. Therefore, the projection of attainment of the NAAQS by 2025 for Doña Ana monitors depends on the accuracy of these estimates of on-road mobile emissions. In the SNMOS, we used EPA's NEI on-road mobile emission estimates, which were calculated using the MOVES model. Given the importance of on-road mobile emissions for air quality planning in Doña Ana County, we recommend further evaluation of the inventory.

Recommendation: Review the MOVES inputs and model configuration for the emissions modeling in the 2011 NEI platform with the goal of evaluating the likelihood of the modeled reductions in regional on-road mobile emissions between 2011 and 2025.

Anthropogenic emissions from Mexico are a source of uncertainty in the SNMOS modeling. The data used in the SNMOS were determined to be the most complete and accurate available information, but are based on 2008 data.

Recommendation: We recommend that the NMED continue to work with air quality planning partners in Mexico to ensure that the most complete and recent available emissions data available for Mexico are integrated into modeling efforts for Southern New Mexico.

New Mexico and Texas Counties within the Permian Basin showed increases in oil and gas emissions between 2011 and 2025, and the increased emissions were reflected in the increased ozone contribution from oil and gas sources in 2025. Oil and gas emissions in these counties were among the few U.S. source groups to show an increase in projected emissions in 2025 relative to 2011. Permian Basin emissions are based on 2014 AEO activity projections. Because the oil and gas industry undergoes rapid changes in response to fluctuations in pricing and domestic and foreign production, we recommend that the Permian Basin projections be revisited before any future modeling effort is carried out.

Recommendation: Update activity projections for the Permian Basin in advance of future ozone modeling efforts.

5.0 REFERENCES

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NMED
EXHIBIT 8

KERWIN C. SINGLETON

EDUCATION

Bachelor of Science, Chemical Engineering 1982 University of Missouri - Columbia

EXPERIENCE

New Mexico Environment Department Santa Fe, New Mexico August 2004 - Present

Planning Section Chief – Air Quality Bureau June 2018 – Present

The Planning Section of the Air Quality Bureau includes the Control Strategies, Dispersion Modeling, Emissions Inventory, and Small Business Assistance Programs. The control strategies section is responsible for preparing state implementation plan, policies, and regulations for air quality. The dispersion modeling and emission inventory section ensures that all air dispersion modeling analyses submitted to our agency are accurate and complete, assists major sources with the submittal of annual emissions inventories, and performs a quality control check of submitted data prior to certification and submittal to the US EPA. The Small Business Assistance Program assists small businesses in meeting air quality regulatory requirements.

Manager, Control Strategies - Air Quality Bureau July 2008 – June 2018

As the Manager of Control Strategies, managed a staff of environmental analysts for the development of air quality plans and regulations for the State of New Mexico, including providing guidance and assistance to staff to ensure that plans and regulations are successfully adopted by the Environmental Improvement Board; providing technical, fiscal, performance and administrative analysis on draft bills during the legislative session; and representing the Department at stakeholder meetings on issues related to air quality plans and rule development.

Environmental Scientist & Specialist – Advanced August 2004 - July 2008

As a permit writer, processed all assigned air quality permit applications (New Source Review, Prevention of Significant Deterioration, and Title V) to final action before or by regulatory deadlines in accordance with approved Department policies and standards and performed special projects to achieve the enhancement of the Bureau’s goals.

Concept Technical Group Menomonee Falls, Wisconsin March 2003 - July 2004
Engineer

As a staff engineer, provided project-specific environmental support to the Johnson Controls Battery Group manufacturing sites and group headquarters, including preparation of air quality construction permit applications with detailed emissions calculations and supporting documentation; annual emission inventories; Toxic Release Inventory Form R reports; updating storm water management and contingency plans; and development of standardized environmental procedures.

RMT, Inc. Chicago, Illinois December 1994 - January 2003
Senior Project Manager/Operations Manager

As a Senior Project Manager, guided clients through the complexities of air pollution permitting, reporting and compliance in multiple states to minimize their regulatory burden and obtain permits according to schedule. As the Chicago Operations Manager, managed three staff engineers, identified and developing project opportunities for engineers to meet or exceed utilization goals, and provided training and workload leveling.

Johnson Controls Battery Group, Inc. Milwaukee, Wisconsin March 1992 - December 1994
Environmental Engineer

As an Environmental Engineer, maintained air quality compliance at thirteen lead-acid battery plants and successfully obtained air construction permits to support all new equipment installations and plant modifications.

NMED Exhibit 8

Olin Corp. – Brass Group/Winchester Operations East Alton, Illinois June 1989 - March 1992
Senior Environmental Engineer
As a Senior Environmental Engineer, prepared and submitted all air pollution permit applications and annual emissions reports for the casting plant, brass mill and Winchester ammunition operations. Duties also included the development and implementation of an obsolete chemical identification project to minimize future liabilities; the investigation and categorization of the use of hazardous solvents and implementation of non-hazardous alternatives that resulted in the elimination of several waste streams and a reduction of waste management costs; and providing comprehensive environmental permitting and compliance assistance for satellite operations in Missouri and Ohio.

Missouri Department of Natural Resources St. Louis, MO July 1984 - June 1989
Environmental Engineer I/II
As an Environmental Engineer, conducted inspections of hazardous waste generators and treatment/storage/disposal Facilities in the St. Louis region for compliance with state and federal regulations, and represented the Department at industrial association meetings and seminars.

NMED
EXHIBIT 9

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Resume

Summary of Qualifications

- Registered Professional Engineer, State of Louisiana (Mechanical)
- 31 years successful experience in small and medium business management
- Experience in HR management including recruitment, development and retention of personnel
- Exceptional skills in engineering, business management, customer service and problem solving
- Computer Skills: Solid knowledge of Window software applications, various special purpose software programs (HTML web site design, 3D CAD, desktop publishing, graphics design, video editing, etc.), as well as customization of proprietary software

Management Flexibility and Accomplishments:

- **Entrepreneurial Skills**: Conceptualized, created, and managed **CompServCo**, a successful software development, marketing, and fulfillment company that produced a product MacCAD that won a "Top 100 Macintosh Products" award. CompServCo also won fulfillment contracts (packaging design, packaging, and shipping) for several other engineering software products. These contracts also included co-marketing efforts such as multi-product display ads in national magazines, technical support, packaging and national trade shows.
- **Marketing**: After a few years, CompServCo won the exclusive North American distributorship of a proprietary 3-D CAD kitchen design software product, Planit. To fulfill this contract, CompServCo spun off another software distributing company, **Planit USA**. In return for a lucrative distributing contract, CompServCo though Planit USA, capitalized the marketing and database development of Planit in the USA, and brought this new product from being unknown in this vertical market to a market leader within a few years. Sold the company in 1997.
- **Contract Negotiations**: 11 years experience in upper management level contract negotiations with major manufacturing firms in the United States, Canada, and Europe (including: Masco, Woodmode, Aristocraft, Craftmaid, and Merillat).
- **Sales & Marketing**: Over 17 years experience in marketing, sales, and customer service. Responsible for conceptualizing and coordinating a national marketing campaigns for several software products, including personally creating display ads, internet advertising (web site & e-mail campaigns), national trade shows (booth design and marketing focus), and negotiating co-marketing efforts. As VP Sale & Marketing, I grew a commercial print shop to win American Printing Magazine's "Top 50 Fastest Growing Printing Companies" award. I also put systems in place to diversify the sales base and move the company to web-based publishing.
- **Software Development**: Managed software programmers developing various products for CompServCo: MacCAD (3-D graphic engineering templates), Riddler (teaching software that incorporated text-graphics-sounds in a gaming style user interface), My Family Tree (genealogy software that mapped and produced a family book with text and photos), Planit Cut List (produced a cut list of panel parts and sizes from a list of kitchen cabinets).
- **Engineering: Space Shuttle External Tank**: As a facilities design engineer for Martin Marietta, under contract to NASA, building the External Tank for the Space Shuttle I designed and managed construction of a dust collection system for Thermal Protection System (TPS) machining facility, re-designed a faulty lifting hook and insertion mechanism that inserted an

umbrella-like washing probe into the interior of the liquid hydrogen portion of the space shuttle external tank, designed and oversaw the TPS application on an emergency basis on the dome of the LOX (liquid oxygen) tank of the External Tank used in the first Space Shuttle flight.
- **Engineering & Manufacturing Management**: Starting as an engineer at Dixie Manufacturing, I co-designed pneumatic instrumentation that sensed emergency conditions at the oil wellhead and shut down all operations using pneumatics only (no electricity or sparks to ignite fuel). After being promoted to General Manager, I was responsible for all aspects of production and marketing of the company’s products. In my youth, I started a jewelry manufacturing business that successfully mass produced and marketed silver and gold jewelry before returning to school to obtain my engineering degree.
- **Environmental Regulatory Management**: Almost 12 years experience managing permitting programs (New Source Review, Technical Services Units) of the Air Quality Bureau, New Mexico Environment Department. I am now the Acting Permit Programs Manager for the Air Quality Bureau. In this capacity I am responsible for overseeing all aspects of the Air Permitting Programs for all applicable sources of air pollution in the State of New Mexico.

Work History

6/14 – Present	NMED, AQB Santa Fe, NM	Permit Programs Section Chief
6/01 – 6/14	NMED, AQB Santa Fe, NM	Minor Source/Tech Serv Manager
5/00 – 5/01	Pre-Paid Legal, Inc. Santa Fe, NM	Independent Associate Executive Director
6/97 – 5/00	TLC Printing & Copying, Inc Metairie, LA	VP Sales & Marketing
1/97 – 6/97	Sabbatical	USA, Europe, Asia
5/86 – 1/97	Planit USA Slidell, LA	Owner
7/84 – 1/97	CompServCo Slidell, LA	Owner
1/82 – 7/84	Dixie Manufacturing, Inc. Harvey, LA	General Manager
2/79 – 1/82	Martin Marietta Aerospace, Corp. Metairie, LA	Facilities Design Engineer
8/77 – 1/79	LSU at New Orleans New Orleans, LA	Student, engineering
2/74 – 7/77	Abraxas Jewelry Manufacturing New Orleans, LA	Owner

Education, Certifications:	Professional Engineer, Louisiana	Mechanical Engineering
	LSU, New Orleans	BS. Mechanical Engineering
	University of Texas at El Paso	BS. Math, Physics

Interests: Gardening, reading, jewelry making (certified gemologist), writing, sailing, and hiking.

NMED
EXHIBIT 10

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Angela R. W. Raso

Education

Purdue University, West Lafayette, IN **December 2018**
Doctor of Philosophy, Analytical chemistry
Dissertation: "Halogen Photochemistry and Emissions from the Arctic Snowpack"
Advisor Dr. Paul B. Shepson, Dr. Kerri A. Pratt (University of Michigan)

Whitman College, Walla Walla, WA **May 2012**
Bachelor of Arts, Chemistry. Mathematics minor.
Undergraduate Thesis: "Determining the Presence of Dense Non-Aqueous Phase Liquid (DNAPL) Pollutants in River Sediments"
Advisor Dr. Frank M. Dunnivant

Professional Experience

Dispersion Modeler, New Mexico Environment Department, Air Quality Bureau **September 2018 - Present**

- Evaluate facilities emissions for compliance with Ambient Air Quality Standards using dispersion models
- Assist with data analysis and evaluation related to emissions inventories
- Assist with special projects involving modeling and emissions inventories including; preparation for photochemical modeling, modeling for state implementation plans

Research Experience

Research Assistant, Purdue University **Fall 2012 – August 2018**

- Lead field work based research on gas phase oxidation processes in the Arctic to understand a complex environmental system
- Collaboratively design and perform atmospheric chemistry experiments in the Arctic including eddy covariance flux measurements
- Full process responsibility for analytical measurements in a remote Arctic environment
- Coordinate logistical needs to ensure successful Arctic fieldwork in Barrow, Alaska
- Manage instrumentation including a homebuilt chemical ionization mass spectrometer, and an ion chromatography / liquid chromatography system
- Mentor and train students to safely and effectively use instrumentation
- Conduct zero- and one- dimensional photochemical modeling to understand and contextualize the importance of measurements

Visiting Research Assistant, University of Michigan **Fall & Winter 2015**

- Collaboratively planned for a spring 2016 field study in Barrow, Alaska

User, Environmental Molecular Sciences Laboratory, **October 2015**
Pacific Northwest National Laboratory

- Acquired first ever measurements of iodide in Arctic snow using ion chromatography coupled with inductively coupled plasma mass spectrometry (IC-ICPMS)

Undergraduate Research Assistant, Whitman College **Fall 2010 –Spring 2012**

- Conducted research on dense non-aqueous phase liquids in mixed stream-bed media for detection at highly polluted sites using gas chromatography – electron capture detection

Teaching Experience

General Chemistry Adjunct, Santa Fe Community College **Spring & Fall 2019**

- Instructed General Chemistry Laboratories

Analytical Chemistry TA, Purdue Chemistry Department **Fall 2013**

- Instructed laboratory sessions for upper division chemistry students in a major required course

- Wrote and graded exam questions and graded written lab reports, giving important feedback to students

Fundamental General Chemistry TA, Purdue Chemistry Department **Spring 2013**

- Instructed laboratory and recitation for students with no previous chemistry courses to give a gentle introduction to important laboratory and scientific skills

General Chemistry for Engineers TA, Purdue Chemistry Department **Fall 2012**

- Instructed laboratory and recitation sessions to introduce freshman engineers and scientists to college level science courses.

Chemistry Tutor, Whitman Chemistry Department **2010 -2012**

- Demonstrated concepts and problem solving techniques for students from general, organic and analytical chemistry classes in an open "drop in" environment using a variety of teaching methods

Organic Chemistry Laboratory Assistant, Whitman Chemistry Department **Fall 2011**

- Supported students in an organic chemistry laboratory to ensure safe, time effective, and comprehensive completion of experiments

Quantitative Analysis Lab. Assistant, Whitman Chemistry Department **Fall 2011**

- Supported students in a data rich laboratory to introduce analytical methods to chemistry majors
- Corrected spreadsheet style lab reports to give important feedback to students

Tutor, Whitman College Academic Resource Center **2010-2012**

- Tutored general chemistry, organic chemistry, calculus I, calculus II and differential equations to support student understanding and grades

Publications and Presentations

- "Active Molecular Iodine Photochemistry in the Arctic" December 11, 2017. Oral Presentation, American Geophysical Union Meeting. New Orleans, La
- "Surface fluxes and recycling of molecular halogens above the snowpack" December 11, 2017. Poster, American Geophysical Union Meeting. New Orleans, La
- Raso, A. R. W., K. D. Custard, N. W. May, D. J. Tanner, M. K. Newburn, L. Walker, R. Moor, L. G. Huey, M. L. Alexander, P. B. Shepson, K. A. Pratt "Active Molecular Iodine Photochemistry in the Arctic" *Proceedings of the National Academy of Sciences 114(38) 10053-10058*
- Custard, K. D., A. R. W. Raso, K. A. Pratt, R. M. Staebler, and P. B. Shepson (2017) "Molecular halogen production in and flux measurements from tundra snow" *ACS earth and space chem. 1(3), 142-151*
- Raso, A.R.W., B. Elstrott, and F. M. Dunnivant, (2012) Envirolab: Simulations of Laboratory experiments in environmental chemistry [Computer Program]
- Available at http://people.whitman.edu/~dunnivfm/software.html
- "Mass transport and recycling of molecular halogens near the snowpack surface in Barrow (Utqiaġvik), Alaska" December 12, 2016. American Geophysical Union Fall Meeting. San Francisco, Ca.
- "The impact of Molecular iodine photochemistry in the Arctic" December 17, 2014. Poster, American Geophysical Union Fall Meeting. San Francisco, Ca.
- "Determining the presence of dense non-aqueous phase liquid (DNAPL) pollutants in river sediments" March 26, 2012. Poster, National Spring Meeting of the American Chemical Society. San Diego, Ca.