

UTAH

State Implementation Plan

**Control Measures for Area and Point Sources, Fine
Particulate Matter,
Serious Area PM_{2.5} SIP for the Salt Lake City, UT
Nonattainment Area**

Section IX. Part A.31

Adopted by the Utah Air Quality Board
January 2, 2019

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Acronyms

BACT	Best Available Control Technology
CAA	Clean Air Act
CFR	Code of Federal Regulations
CAMx	Comprehensive Air Quality Model with Extensions
CTG	Control Techniques Guideline Documents
DAQ	Utah Division of Air Quality (also UDAQ)
EPA	Environmental Protection Agency
FRM	Federal Reference Method
MACT	Maximum Available Control Technology
MATS	Model Attainment Test Software
MPO	Metropolitan Planning Organization
MVEB	Motor Vehicle Emissions Budget
$\mu\text{g}/\text{m}^3$	Micrograms Per Cubic Meter
Micron	One Millionth of a Meter
NAAQS	National Ambient Air Quality Standards
NESHAP	National Emissions Standards for Hazardous Air Pollutants
NH_3	Ammonia
NO_x	Nitrogen Oxides
NSPS	New Source Performance Standard
NSR	New Source Review
PM	Particulate Matter
PM_{10}	Particulate Matter Smaller Than 10 Microns in Diameter
$\text{PM}_{2.5}$	Particulate Matter Smaller Than 2.5 Microns in Diameter
RACM	Reasonably Available Control Measures
RACT	Reasonably Available Control Technology
RFP	Reasonable Further Progress
SIP	State Implementation Plan
SMAT	Software for Model Attainment Test
SMOKE	Sparse Matrix Operator Kernel Emissions
SO_2	Sulfur Dioxide
SO_x	Sulfur Oxides
TSD	Technical Support Document
VOC	Volatile Organic Compounds
UAC	Utah Administrative Code
UWFPS	Utah Wintertime Fine Particulate Study
WRF	Weather Research and Forecasting

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Chapter 1 – INTRODUCTION AND BACKGROUND

1.1 Fine Particulate Matter

According to EPA's website, particulate matter, or PM, is a complex mixture of extremely small particles and liquid droplets. Particulate matter is made up of a number of components, including acids (such as nitrates and sulfates), organic chemicals, metals, and soil or dust particles.

The size of particles is directly linked to their potential for causing health problems. EPA is concerned about particles that are 10 micrometers in diameter or smaller because those are the particles that generally pass through the throat and nose and enter the lungs. Once inhaled, these particles can affect the heart and lungs and cause serious health effects. Other negative effects are reduced visibility and accelerated deterioration of buildings.

EPA groups particle pollution into two categories:

- "Inhalable coarse particles," such as those found near roadways and dusty industries, are larger than 2.5 micrometers and smaller than 10 micrometers in diameter. Utah has previously addressed inhalable coarse particles as part of its PM₁₀ SIPs for Salt Lake and Utah Counties, but this fraction is not measured as PM_{2.5} and will not be a subject for this nonattainment SIP.
- "Fine particles," such as those found in smoke and haze, are 2.5 micrometers in diameter and smaller and thus denoted as PM_{2.5}. These particles can be directly emitted from sources such as forest fires, or they can form when gases emitted from power plants, industries and automobiles react in the air.

PM concentration is reported in micrograms per cubic meter or $\mu\text{g}/\text{m}^3$. The particulate is collected on a filter and weighed. This weight is combined with the known amount of air that passed through the filter to determine the concentration in the air.

1.2 Health and Welfare Impacts of PM_{2.5}

Numerous scientific studies have linked particle pollution exposure to a variety of problems, including:

- increased respiratory symptoms, such as irritation of the airways, coughing, or difficulty breathing, for example;
- decreased lung function;
- aggravated asthma;

- development of chronic bronchitis;
- irregular heartbeat;
- nonfatal heart attacks; and
- pre-mature death in people with heart or lung disease.

People with heart or lung diseases, children and older adults are the most likely to be affected by particle pollution exposure. However, even healthy people may experience temporary symptoms from exposure to elevated levels of particle pollution.

1.3 Fine Particulate Matter in Utah

Excluding wind-blown desert dust events, wild land fires, and holiday related fireworks, elevated $PM_{2.5}$ in Utah occurs during the winter season when certain meteorological conditions create stagnant cold pools of air.

During a winter-time cold pool episode, dispersion is very poor due to the very stable air mass and $PM_{2.5}$ emissions become trapped in the valley. Furthermore, emissions of $PM_{2.5}$ precursors react quickly to create secondary PM and overall concentrations of primary and secondary $PM_{2.5}$ become elevated.

Cold pool episodes persist until meteorological conditions change to once again allow for good mixing. Episodes may last from a few days to tens of days.

The meteorological conditions that lead to the formation of cold pools in Utah's nonattainment areas are: synoptic scale ridging, subsidence, light winds, snow cover (often), and cool-to-cold surface temperatures. These conditions occur during winter months, generally mid-November through early March.

The scenario described above leads to exceedances and violations of the 2006, 24-hour health standard for $PM_{2.5}$. In other parts of the year concentrations are generally low, and even with the high peaks incurred during winter, average concentrations are well within the 2013, annual health standard for $PM_{2.5}$.

1.4 2006 NAAQS for $PM_{2.5}$

In September of 2006, EPA revised the (1997) National Ambient Air Quality Standards (NAAQS) for $PM_{2.5}$. While the annual standard remained unchanged at $15 \mu\text{g}/\text{m}^3$, the 24-hr standard was lowered from $65 \mu\text{g}/\text{m}^3$ to $35 \mu\text{g}/\text{m}^3$.

DAQ has monitored $PM_{2.5}$ since 2000, and found that all areas within the state were in compliance with the 1997 standards. However, using the new 2006 standard as the benchmark, all or parts of five counties were found to be out of compliance with the 24-hr standard. In 2013, EPA lowered the annual average to $12 \mu\text{g}/\text{m}^3$. Monitoring data shows no instances of noncompliance with this revised standard.

1.5 PM_{2.5} Nonattainment Areas in Utah

There are three distinct nonattainment areas for the 2006, 24-hour PM_{2.5} standard. These are the Salt Lake City, UT, and Provo, UT nonattainment areas, which together encompass what is referred to as the Wasatch Front. A third nonattainment area is more or less geographically defined by the Cache Valley which straddles the border between Utah and Idaho (the Logan, UT – ID nonattainment area.) Figure 1.1 below shows the geographic extent of these areas. None of these three areas has violated the annual NAAQS for PM_{2.5}. Without exception, the exceedances leading to 24-hr NAAQS violations are associated with relatively short-term meteorological occurrences.

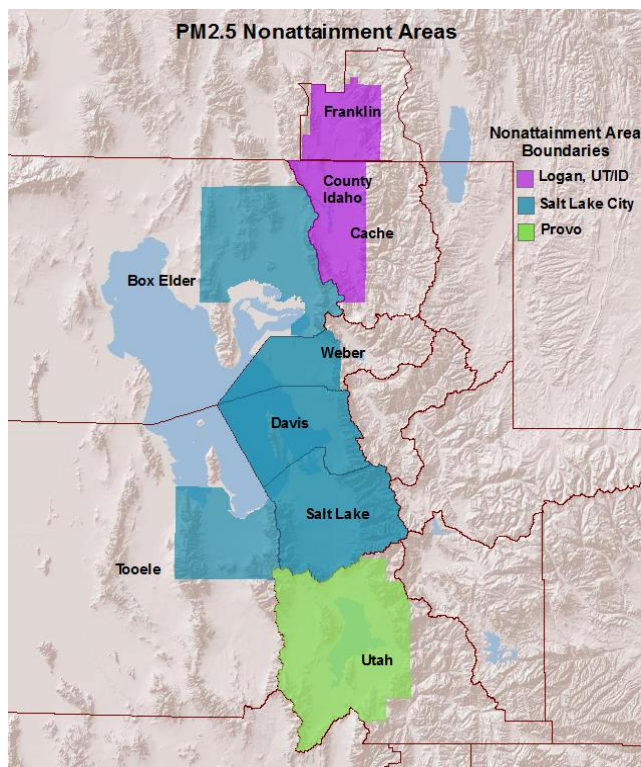


Figure 1.1, Nonattainment Areas for the 2006, PM_{2.5} 24-hr. NAAQS

Each of these three areas was effectively designated as nonattainment on Dec. 14, 2009 by the EPA (74 FR 58688) based on weights of evidence belonging to the following nine factors:

- pollutant emissions
- air quality data
- population density and degree of urbanization

- traffic and commuting patterns
- growth
- meteorology
- geography and topography
- jurisdictional boundaries
- level of control of emissions sources

EPA also used analytical tools and data such as pollution roses, fine particulate composition monitoring data, back trajectory analyses, and the contributing emission score (CES) to evaluate these areas.

1.6 Reclassification to Serious

The EPA originally designated the Salt Lake City nonattainment area under the general provisions of CAA title I, part D, subpart 1 (“subpart 1”), under which attainment plans must provide for the attainment of a specific NAAQS (in this case, the 2006 PM_{2.5} standards) as expeditiously as practicable, but no later than five years from the date the areas were designated nonattainment (December 14, 2014).

On December 11, 2013, Utah submitted a SIP that contained multiple area source rules intended to reduce emissions in the area. Subsequently, on January 4, 2013, the U.S. Court of Appeals for the District of Columbia Circuit held that the EPA should have implemented the 2006 24-hour PM_{2.5} standard based on both the general nonattainment area requirements in subpart 1 and the PM-specific requirements of CAA title I, part D, subpart 4 (“subpart 4”). Under subpart 4, PM nonattainment areas are initially classified as Moderate, and Moderate area attainment plans must address the requirements of subpart 4 as well as subpart 1. Additionally, CAA subpart 4 establishes a different SIP submittal due date and attainment year. For a Moderate PM_{2.5} nonattainment area, the attainment SIP is due no later than 18 months after designation and the attainment year is as expeditiously as practicable after designation but no later than the end of the sixth calendar year after designation (December 31, 2015).

On June 2, 2014 (79 FR 31566), the EPA finalized the Identification of Nonattainment Classification and Deadlines for Submission of State Implementation Plan (SIP) Provisions for the 1997 Fine Particulate (PM_{2.5}) NAAQS and 2006 PM_{2.5} NAAQS (“the Classification and Deadlines Rule”). This rule classified the areas that were designated in 2009 as nonattainment to Moderate, and set the attainment SIP submittal due date for those areas at December 31, 2014. This rule did not affect the Moderate area attainment date of December 31, 2015.

After the court’s decision, the Utah Department of Air Quality (UDAQ) withdrew all prior Salt Lake City, UT PM_{2.5} SIP submissions and submitted a new SIP to address both the general requirements of subpart 1 and the PM-specific requirements of subpart 4 for Moderate areas¹. The modeled attainment demonstration underlying the new Moderate Area SIP made its assessment concerning attainment by the applicable attainment date (December 31, 2015), and concluded that it would be impracticable to do so.

¹ The Moderate Area SIP for the Salt Lake City, UT PM_{2.5} nonattainment area was adopted by the Utah Air Quality Board on December 3, 2014 and submitted to the EPA on December 22, 2014. The narrative appears in the SIP at Section IX.A.21 and the Emission Limits and Operating Practices which apply to specific stationary sources located in the nonattainment area are listed in Section IX. Part H. 11 and 12.

After reaching the statutory attainment date, the EPA is compelled to determine whether the area has or has not achieved compliance with the standard by evaluating the prior three years of quality assured data. That determination was published on May 10, 2017 (89 FR 21711) and concluded that the Salt Lake City nonattainment area did not reach attainment of the 2006 24-hour standard by its attainment date, and would therefore be effectively re-classified from a Moderate PM_{2.5} nonattainment area to a Serious PM_{2.5} nonattainment area as of June 9, 2017. Under subpart 4 of the CAA, Serious PM nonattainment areas require, in addition to the provisions submitted to meet the Moderate area planning requirements, the submittal of a SIP revision that: 1) provides for attainment of the applicable NAAQS no later than the end of the 10th calendar year after the area's designation as nonattainment (December 31, 2019), and 2) includes provisions to assure that the Best Available Control Measures for the control of PM_{2.5} shall be implemented no later than four years after the date the area is re-classified as a Serious Area.

On August 24, 2016, the EPA finalized the Fine Particulate Matter National Ambient Air Quality Standards: State Implementation Plan Requirements ("PM_{2.5} Implementation Rule"), 81 FR 58010, which addressed the January 4, 2013 court ruling. The final implementation rule provides the EPA's interpretation of the requirements applicable to PM_{2.5} nonattainment areas and explains how air agencies can meet the statutory SIP requirements that apply under subparts 1 and 4 to areas designated nonattainment for any PM_{2.5} NAAQS. These statutory requirements are further addressed in Chapter 2.

1.7 PM_{2.5} Precursors

The majority of ambient PM_{2.5} collected during a typical cold-pool episode of elevated concentration is secondary particulate matter, born of gaseous precursor emissions. PM_{2.5} precursors include sulfur dioxide (SO₂), oxides of nitrogen (NO_x), volatile organic compounds (VOC), and ammonia (NH₃).

Clean Air Act Section 189(e) requires that the control requirements applicable in plans for major stationary sources of PM₁₀ shall also apply to major stationary sources of PM₁₀ precursors, except where the Administrator determines that such sources do not contribute significantly to PM₁₀ levels which exceed the standard in the area.

The new PM_{2.5} Implementation Rule interprets this requirement as it applies to PM_{2.5}. As part of this rule, a state may elect to submit one or more demonstrations to assert that reducing the emission level of a particular precursor will not result in a significant benefit to the area in terms of PM_{2.5} concentrations. Generally speaking, if a state elects to do so and the EPA subsequently approves the demonstration, the state would not be required to include emission controls for that precursor in its SIP control strategy.

Utah has not included any such demonstration with this Serious Area SIP submittal. As such, the requirement to ensure the implementation of best available control measures applies to emissions of PM_{2.5} and to each of the four PM_{2.5} precursors listed above. As such, each of these PM_{2.5} precursors is also defined as a PM_{2.5} plan precursor within the Salt Lake City, UT PM_{2.5} nonattainment area.

Chapter 2 – REQUIREMENTS FOR 2006, PM_{2.5} PLAN REVISIONS

2.1 Requirements for Nonattainment SIPs

Section 110 of the Clean Air Act lists the requirements for implementation plans. Many of these requirements speak to the administration of an air program in general. Section 172 of the Act contains the plan requirements for nonattainment areas in general.

The Clean Air Act also contains provisions, at Subpart 4 of Part D, that apply specifically to PM₁₀ nonattainment areas. On January 4, 2013, D.C. Circuit Court of Appeals found that these provisions should also apply to PM_{2.5} nonattainment areas.

Under Subpart 4, nonattainment areas for particulate matter may carry the classification of either moderate or serious. Addressed therein are the attainment dates and planning provisions for both moderate and serious areas. Of note is that the planning requirements for serious areas are *in addition to* those required for moderate areas.

EPA's new PM_{2.5} Implementation Rule interprets the requirements of Subpart 4 as they apply to PM_{2.5}. In particular, this rulemaking (81 FR 58010) recodifies Subpart Z of 40 CFR Part 51 ("Provisions for Implementation of PM_{2.5} National Ambient Air Quality Standards") which had been revoked as part of the January 4, 2013 Court ruling. Subpart Z details what is required of plan revisions addressing both moderate and serious PM_{2.5} nonattainment areas.

Utah has already addressed the moderate area planning requirements in the SIP it adopted on December 3, 2014. This SIP will now address the serious area requirements as articulated in Subpart Z.

This Serious Area implementation plan was developed to meet the requirements specified in the law, rule, and appropriate guidance documents identified above. Some of the more notable requirements that pertain to this SIP include:

- A demonstration, including air quality modeling, that the plan provides for attainment of the applicable NAAQS no later than the end of the 10th calendar year after the area's designation as nonattainment (December 31, 2019)
- A comprehensive base-year inventory of actual emissions as well as a projected inventory of emissions in the attainment year
- Provisions for the implementation of Best Available Control Measures including Technologies (BACM / BACT) no later than 4 years after the date the area is re-classified as a Serious Area
- Enforceable emission limits as well as schedules for compliance
- Transportation Conformity, including motor vehicle emission budgets
- Quantitative Milestones that demonstrate Reasonable Further Progress (RFP) toward attainment of the National Ambient Air Quality Standards by the applicable attainment date
- Contingency measures to be undertaken if the area fails to make reasonable further progress or attain the NAAQS by the applicable attainment date

Additional information is provided in the technical support document (TSD).

Chapter 3 – Ambient Air Quality Data

3.1 Measuring Fine Particle Pollution in the Atmosphere

Utah has monitored PM_{2.5} in its airsheds since 2000, following the promulgation of the 1997, PM_{2.5} NAAQS which was set at 65 µg/m³ for a 24-hour averaging period. PM_{2.5} concentrations, especially during Utah's wintertime cold pool episodes, tend to be regionally homogenous within a specific airshed. This means that just a few monitors can adequately determine compliance with the NAAQS for these airsheds. UDAQ's monitors are appropriately located to assess concentration, trends, and changes in PM_{2.5} concentrations. During Utah's wintertime temperature inversions, every day sampling and real time monitoring are needed public notification and for subsequent air quality modeling.

3.2 Utah's Air Monitoring Network

The Air Monitoring Section maintains an ambient air monitoring network in Utah that collects both air quality and meteorological data. Figure 3.1 shows the location of sites along the Wasatch Front and in the Cache Valley that collect PM_{2.5} data.

Data collected at three of the sites along the Wasatch Front is analyzed to determine the various species of PM_{2.5} that collectively make up the total mass. Particulate matter collected on the speciation filters is analyzed for organic and inorganic carbon and a list of 48 elements. PM_{2.5} speciation data is particularly useful in helping to identify sources of particulate matter.

The ambient air quality monitoring network along Utah's Wasatch Front and in the Cache Valley is routinely audited by the EPA, and meets the agency's requirements for air monitoring networks.

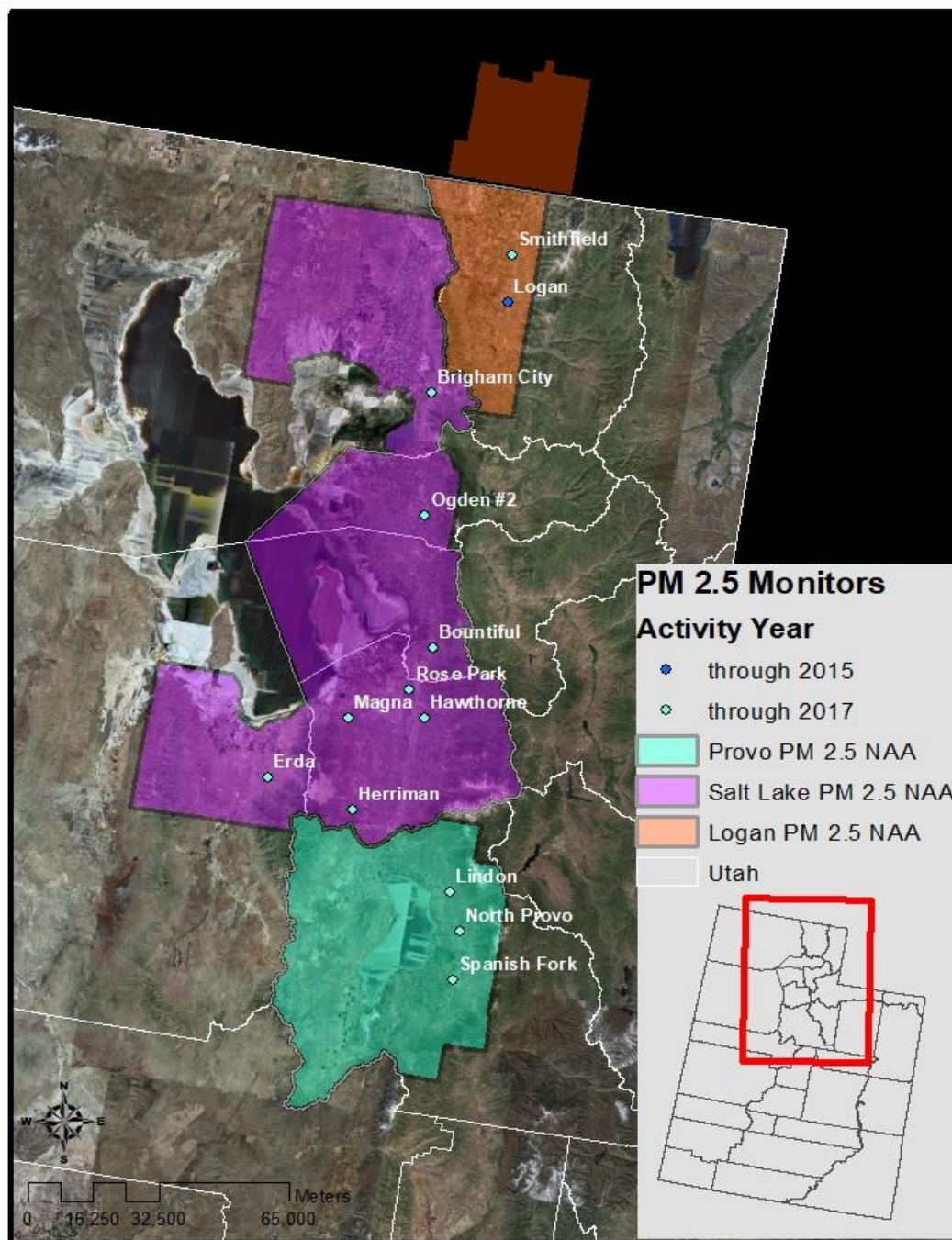


Figure 3.1, Utah's PM_{2.5} Air Monitoring Network

3.3 Data Handling

PM_{2.5} collected on filter media must be weighed and calibrated in order that a concentration may be determined for a 24-hour period. Once determined, the data is entered into a database maintained by the EPA (called AQS). In order to be used for regulatory purposes, data determined from filters must include verification that it was handled in accordance with certain quality assurance specifications; among these are appropriate ranges of temperature and relative humidity (RH) within which the processing must take place. A routine audit of Utah's air quality data collected from 2013 - 2015 identified numerous instances for which the temperature and RH parameters were either not recorded at all or were recorded outside of their specified range. It appeared, therefore, that this data could not be used for regulatory purposes. Particularly important was data collected in 2015, one of the years used to construct a monitored design value for this SIP.

The form of the PM_{2.5} NAAQS takes into consideration the percentage of data captured throughout each calendar quarter. There is a general expectation that at least 75% of the data scheduled for collection will actually be captured. The degree of data capture affects what value will be entered into the AQS database for comparison with the NAAQS. If data capture is poor, a higher more conservative value will be selected for use, particularly with respect to the 24-hour value denoted as the 98th percentile.

Further investigation into the suspect temperature and RH values identified the problem as a software error that affected the recording of the values measured by the filter robot rather than the values themselves. Data handling procedures allow for the substitution of temperature and RH data from other sources, and by substituting the temperature and RH data from instruments situated in the room within which the filter robot operates, UDAQ has been able to recover most of the suspect filter data from 2015. The entire problem had been rectified by 2016.

The number of filters recovered from the 2015 data record sits at four or five hundred. Priority was given to those filters that most directly affected this SIP. Still, there are more filters that UDAQ would like to recover, and this work will continue for some time after this SIP has been completed. This means that there will continue to be some discrepancies between the PM_{2.5} values reported herein and the values one may access in the AQS database. In order that a filter becomes fully recovered, EPA must remove a (null) code associated with each filter record. Another reason the PM_{2.5} values reported in this SIP may not match the values appearing in AQS concerns data flagged by UDAQ resulting from an exceptional event. Until EPA affixes a second flag indicating that it has concurred with UDAQ's assertion, the data will be considered useful for regulatory purposes. This will be discussed further in Chapter 6.

3.4 Annual PM_{2.5} – Mean Concentrations

The procedure for evaluating PM_{2.5} data with respect to the NAAQS is specified in Appendix N to 40 CFR Part 50. Generally speaking, the annual PM_{2.5} standard is met when a three-year average of annual mean values is less than or equal to 12.0 µg/m³. Each annual mean is itself an average of four quarterly averages.

Table 3.1, below shows the mean values for 2015, 2016, and 2017. These are the years surrounding 2016, the year for which the baseline modeling inventory was prepared. It also shows the 3-year average of those values, as a comparison against the NAAQS for each of Utah's monitoring locations. All locations are in compliance with the annual NAAQS.

Location	County	Annual Mean Values (µg/m ³)			3-Yr Average (µg/m ³)
		2015	2016	2017	
Logan	Cache	7.3			7.3
Smithfield	Cache	5.5	7.6	7.9	7.0
Brigham City	Box Elder	5.6	7.4	8.5	7.1
Ogden 2	Weber	9.7	9	7.3	8.6
Bountiful	Davis	6.5	8	9	7.8
Magna	Salt Lake	7.1	7.1	7.3	7.1
Hawthorne	Salt Lake	7.4	7.9	8.2	7.8
Rose Park	Salt Lake	8.7	9.4	7.8	8.6
Herriman 3	Salt Lake		4.6	5.7	5.1
Erda	Tooele		6.3	6.5	6.4
North Provo	Utah	7	8.2	5	6.7
Lindon	Utah	7.4	8.8	8.4	8.2
Spanish Fork	Utah	6.5	7.4	7.3	7.0

Table 3.1, PM_{2.5} Annual Mean Concentrations

3.5 24-hour PM_{2.5} – Averages of 98th Percentiles and Monitored Design Values

The procedure for evaluating PM_{2.5} data with respect to the NAAQS is specified in Appendix N to 40 CFR Part 50. Generally speaking, the 24-hr. PM_{2.5} standard is met when a 3-year average of 98th percentile values is less than or equal to 35 µg/m³. Each year's 98th percentile is the daily value beneath which 98% of all daily values would fall.

Table 3.2, below shows the 98th percentile values for 2015, 2016, and 2017. These are the years surrounding 2016, the year for which the baseline modeling inventory was prepared. It also shows the 3-year average of those values, as a comparison against the NAAQS for each of Utah's monitoring locations. It can be seen from the data that the 24-hr. NAAQS is violated at the Rose Park monitoring location. This SIP has been structured to specifically address the 24-hr. standard.

It is important to note that the data in **Tables 3.1 and 3.2** excludes several values from 2017, at certain stations, that were flagged by UDAQ as having been affected by wildland fire or fireworks. UDAQ expects that EPA will eventually concur with UDAQ's flags, thereby excluding them from regulatory use. Two such values were measured at Rose Park, and would therefore affect the 98th percentile value for that year. No exceptional events were flagged at the Hawthorne site. EPA has indicated to UDAQ that it is appropriate to exclude these values from the design values calculated in this SIP.

Location	County	98th Percentile Values (µg/m3)			3-Yr Average (µg/m3)
		2015	2016	2017	
Logan	Cache	29.0			29.0
Smithfield	Cache	28.9	34.0	36.0	32.9
Brigham City	Box Elder	26.7	34.8	34.4	31.9
Ogden 2	Weber	32.9	39.0	25.3	32.4
Bountiful	Davis	29.2	24.7	35.2	29.7
Magna	Salt Lake	22.9	30.7	30.1	27.9
Hawthorne	Salt Lake	28.8	38.4	35.7	34.3
Rose Park	Salt Lake	33.3	43.2	32.4	36.3
Herriman 3	Salt Lake		24.9	28.2	26.5
Erda	Tooele		25.1	20.5	22.8
North Provo	Utah	25.0	36.6	21.9	27.8
Lindon	Utah	27.3	36.3	27.6	30.4
Spanish Fork	Utah	28.1	29.2	27.6	28.3

Table 3.2, 24-hour PM_{2.5} Monitored Design Values

As mentioned in the foregoing paragraph, this SIP is structured to address the 24-hr. PM_{2.5} NAAQS. EPA's modeling guidance² prescribes a modeled attainment test that includes a monitored baseline design value for each monitoring location. It notes that the design values should be consistent with the form of the applicable NAAQS. The 24-hour PM_{2.5} NAAQS is based on a 3-year average of 98th percentile values. The modeling guidance suggests several possible methodologies to calculate baseline design values, including a 3-year average that coincides with the years used to designate the area to nonattainment as well as a 3-year average that straddles the baseline inventory year. In this case, the area was designated as nonattainment in 2006, too long ago for those years to still be considered representative. However, the three years used to construct the design values (2015 – 2017) straddle the baseline inventory year (2016) and include 2015, one of the years used to reclassify the area from moderate to serious.

3.6 Composition of Fine Particle Pollution – Speciated Monitoring Data

DAQ operates three PM_{2.5} speciation sites. The Hawthorne site in Salt Lake County is one of 52 Chemical Speciation Network sites (CSN) operated nationwide on an every-third-day sampling

² Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, PM_{2.5}, and Regional Haze (EPA -454B-07-002, April 2007)

schedule. Sites at Bountiful/Viewmont in Davis County and Lindon in Utah County are State and Local Air Monitoring Stations (SLAMS) PM_{2.5} speciation sites that operate on an every-sixth-day sampling schedule.

Filters are prepared by the EPA contract laboratory and shipped to Utah for sampling. Samples are collected for particulate mass, elemental analysis, identification of major cations and anions, and concentrations of elemental and organic carbon as well as crustal material present in PM_{2.5}. Carbon sampling and analysis changed in 2007 to match the Interagency Monitoring of Protected Visual Environments (IMPROVE) method using a modified IMPROVE sampler at all sites.

The PM_{2.5} is collected on three types of filters: Teflon, nylon, and quartz. Teflon filters are used to characterize the elemental content of PM_{2.5}. Nylon filters are used to quantify the amount of major inorganic ions, and quartz filters are used to quantify the organic and elemental carbon content in the ambient PM_{2.5}.

Data from the speciation network show the importance of volatile secondary particulates, particularly ammonium nitrate, during the colder months. A significant number of these particles are lost in FRM PM_{2.5} sampling.

During the winter periods between 2009 and 2011, UDAQ conducted special winter speciation studies aimed at better characterization of PM_{2.5} during the high pollution episodes. These studies were accomplished by shifting the sampling of the Chemical Speciation Network monitors to 1-in-2-day schedule during the months of January and February. Speciation monitoring during the winter high-pollution episodes produced similar results in PM_{2.5} composition each year.

The results of the speciation studies led to the conclusion that the exceedances of the PM_{2.5} NAAQS are a result of the increased portion of the secondary PM_{2.5}, mainly ammonium nitrate, that was chemically formed in the air and not primary PM_{2.5} emitted directly into the troposphere.

Figure 3.2 below shows the contribution of the identified compounds from the speciation sampler both during a winter temperature inversion period and during a well-mixed winter period.

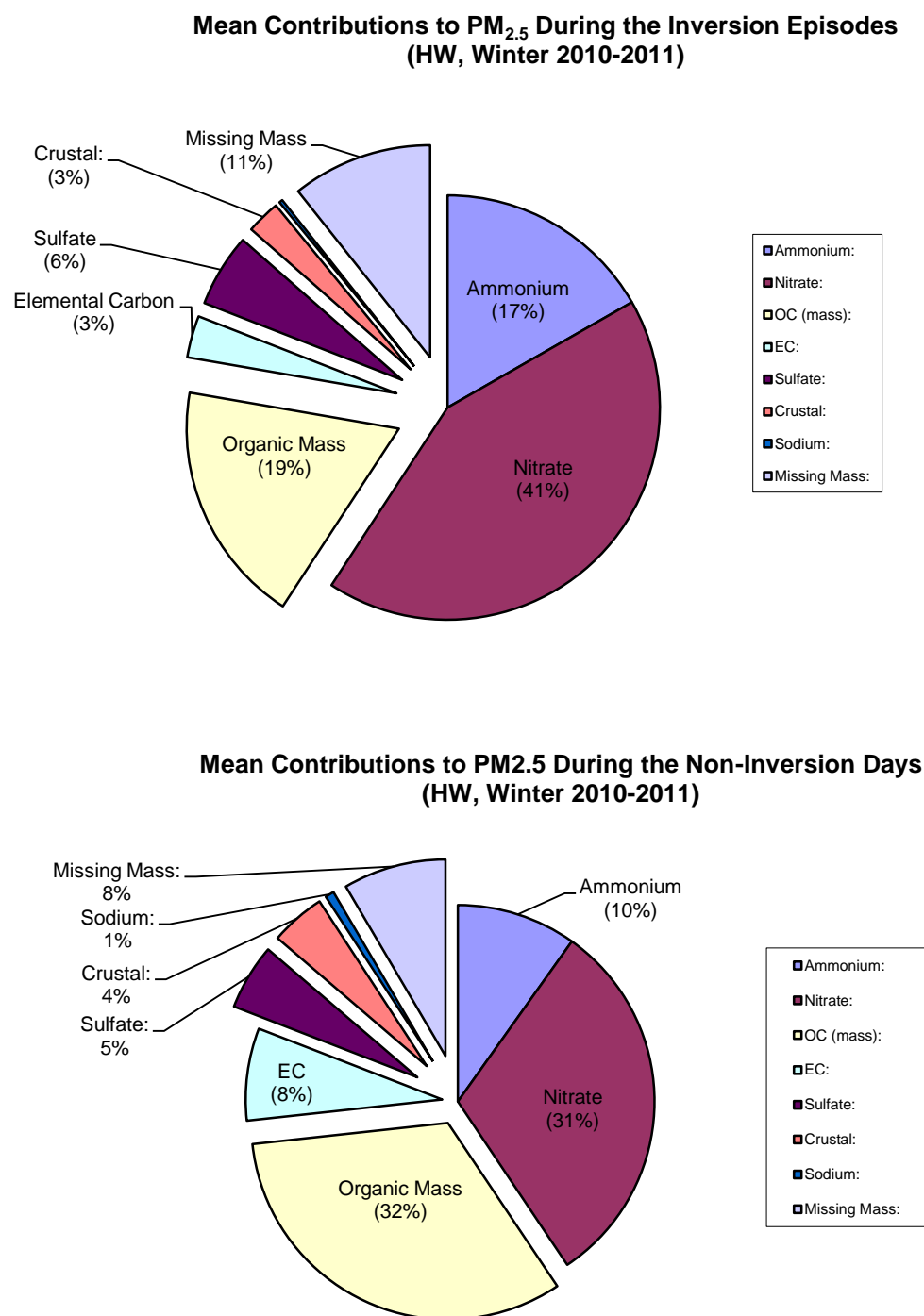


Figure 3.2, Composite Wintertime PM_{2.5} Speciation Profiles

3.7 Utah Winter Fine Particulate Study (UWFPS)

The Utah Winter Fine Particulate Study aimed to address the scientific uncertainties surrounding winter $PM_{2.5}$ pollution. The study took place during the winter of 2017, during which NOAA's specially equipped light aircraft known as the Twin Otter flew over the Cache, Salt Lake, and Utah valleys to survey the chemical conditions responsible for the formation of $PM_{2.5}$. This study was a collaborative project between scientists from the Division of Air Quality, the National Oceanic and Atmospheric Administration (NOAA) Earth System Research Laboratory (ESRL) and the Cooperative Institute for Research in Environmental Sciences (CIRES), University of Colorado Boulder, the Environmental Protection Agency (EPA), United States Department of Agriculture (USDA), University of Utah, University of Washington, University of Toronto, University of Minnesota, Utah State University, and Brigham Young University. The survey looked to investigate the chemistry, transport, and spatial and vertical distribution of species relevant to particulate formation.

Seven multi-day pollution episodes with elevated $PM_{2.5}$ were observed during 2016 – 2017 winter. Two dominating episodes with multiple NAAQS exceedances occurred during the UWFPS period, providing an opportunity to study the chemical and meteorological conditions during and outside pollution episodes in different environments and examine the temporal, spatial, and vertical variability of chemical conditions. Consistent with prior studies ammonium nitrate was found to dominate the $PM_{2.5}$ mass. One of the main questions with respect to ammonium nitrate is the attribution of the limiting reagents in each of the three valleys. The study found that Cache Valley is nitrate limited, while Salt Lake and Utah Valleys are predominately nitrate limited, but also may have periods where they are ammonium limited. Salt Lake Valley is the least nitrate limited and often is ammonium limited later in a persistent cold air pool episode.

Additionally, during the study high time resolution ammonia measurements were taken aboard the Twin Otter in Cache Valley, and some limited continuous ammonia measurements were taken along the Wasatch Front. Passive ammonia measurements were also collected in all three valleys in Utah. Ammonia concentrations were generally found to be much higher in the Cache valley compared to the Wasatch Front, and ammonia levels in the Salt Lake Valley were on average lower than in Utah Valley. This high level of spatial variability is in disagreement with the current inventory which shows comparable inventories for Cache, Utah, and Salt Lake Counties, indicating a potential misrepresentation of ammonia sources in the inventory. These same spatial discrepancies were not seen for the nitrogen oxide emissions inventory³. While limited, VOCs and halogens measurements were also collected during this study. These measurements highlighted the important role of VOCs and halogens in wintertime $PM_{2.5}$ formation and provided information on their potential sources. VOCs and halogens, particularly nitryl chloride ($ClNO_2$), act as radical sources important for the photochemical production of $PM_{2.5}$.

The chemical pathway where $ClNO_2$ is formed through the heterogeneous uptake of N_2O_5 on chloride-containing particles is also particularly active in the Salt Lake Valley. HCl also plays an important role in $PM_{2.5}$ formation. In the presence of excess ammonia, HCl will partition to

³Baasandorj, M., Brown, S., Hoch, S., Crosman, E., Long, R., Silva, P., . . . Eatough, D. (2018). 2017 Utah Winter Fine Particulate Study Final Report. Retrieved from <https://documents.deq.utah.gov/air-quality/planning/technical-analysis/research/northern-utah-airpollution/utah-winter-fine-particulate-study/DAQ-2018-004037.pdf>

aerosol particles forming ammonium chloride, with ammonium chloride accounting for up to 15% of $PM_{2.5}$ mass during high wintertime $PM_{2.5}$ pollution episodes⁴. While the UWFPS has shed light on many questions surrounding $PM_{2.5}$ formation, continued research and further analysis of the collected data is needed to reach more definitive findings regarding sources and processes leading to winter fine particulate matter in northern Utah and elsewhere.

⁴Kelly, K.E., R. Kotchenruther, R. Kuprov, and G.D. Silcox, Receptor model source attributions for Utah's Salt Lake City airshed and the impacts of wintertime secondary ammonium nitrate and ammonium chloride aerosol. *Journal of the Air & Waste Management Association*, 2013. 63(5): p. 575-590.

Chapter 4 – EMISSION INVENTORY DATA

4.1 Introduction

The emissions inventory is one means used by the state to assess the level of pollutants and precursors released into the air from various sources. The methods by which emissions inventories are collected and calculated are constantly improving in response to better analysis and more comprehensive rules. The inventories underlying this SIP were compiled using the best information available.

The sources of emissions that were inventoried may be discussed as belonging to four general categories: industrial point sources; on-road mobile sources; off-road mobile sources; and area sources which represent a collection of smaller, more numerous point sources, residential activities such as home heating, and in some cases biogenic emissions.

This SIP is concerned with PM_{2.5}, both primary in its origin and secondary, referring to its formation removed in time and space from the point of origin for certain precursor gasses. Hence, the pollutants of concern for inventory development purposes included PM_{2.5}, SO₂, NO_x, VOC, and NH₃.

On-road mobile sources are inventoried using EPA's MOVES2014a model, in conjunction with information generated by travel demand models such as vehicle speeds and miles traveled. The inventory information is calculated in units of tons per day, adjusted for winter conditions.

Emissions from the other three categories are calculated in terms of tons per year.

Prior to use in the air quality model, the emissions are pre-processed to account for the seasonality of Utah's difficulty with secondary PM_{2.5} formation during winter months. These temporal adjustments also account for daily and weekly activity patterns that affect the generation of these emissions.

EPA's PM_{2.5} Implementation Rule requires that the emission values shall be either: annual total emissions, average-season-day, or both, as appropriate for the relevant PM_{2.5} NAAQS.

Utah's long-running difficulties with fine PM may be characterized as a short-term (24-hour NAAQS) problem belonging to the winter months when meteorological conditions are conducive to the both the trapping of air in the valleys due to temperature inversions and to the secondary formation of PM_{2.5}. SIP analyses inventories have historically been adjusted to reflect this seasonality.

"Average-season-day emissions" are defined, in 40 CFR 51.1000, as the sum of all emissions during the applicable season divided by the number of days in that season.

Again, Utah's inventory is compiled using a variety of different averaging periods. The inventory is then gridded into the air model, using a pre-processor called SMOKE, along with an hourly temporal component for each 24 hour period. Emissions may then be extracted from SMOKE and reported in consistent time averaged units of "tons-per-day".

Each projection of the emissions inventory will be modeled with meteorology reflecting the actual episode used to validate the air quality model. This episode, spanning 11 days, was incurred from Friday, December 31 through Monday, January 10, 2011.

Thus, Utah's SIP will report, in its narrative, average-season-day emissions, with the definition of season spanning the 2011 episode. Original EI calculations will be included as part of the Technical Support Document (TSD).

There are various time horizons that are significant to the development of this SIP. It is first necessary to look at actual emissions incurred during past episodes of elevated PM_{2.5} concentrations in order to develop the air quality model. The episodes studied as part of the SIP occurred in 2011, 2013, and 2016. It is then necessary to look several years into the future when developing emission control strategies. The significant time horizon for this plan relates to the statutory attainment date, December 31, 2019. A projected inventory is prepared for 2019 and then compared with a baseline inventory that is contemporaneous with the monitored design values discussed in Section 3.4. In this case the baseline is represented by the year 2016. In addition, it will be necessary to evaluate progress towards attainment by looking at specific milestone years. In this case there are two significant mileposts; 2017 and 2020. Inventories must be prepared to evaluate all of these time horizons.

4.2 The 2014 Emissions Inventory

The forgoing paragraph identified numerous points in time for which an understanding of emissions to the air is important to plan development. The basis for each of these assessments was the 2014 tri-annual inventory. This inventory represented, at the time it was selected for use, the most recent comprehensive inventory compiled by UDAQ. In addition to the large major point sources that are required to report emissions every year, the tri-annual inventories consider emissions from many more, smaller point sources. These inventories are collected in accordance with state and federal rules that ensure proper methods and comprehensive quality assurance.

Thus, to develop other inventories for each of the years discussed above, the 2014 inventory was either back-cast and adjusted for certain episodic conditions, or forecast to represent more typical conditions.

4.3 Geographic Area: Nonattainment Areas and Modeling Domain

As said at the outset, an emissions inventory provides a means to assess the level of pollutants and precursors released into the air from various sources. This in turn allows for an overall assessment of a particular airshed.

The modeling analysis used to support this SIP considers a regional domain that encompasses three distinct airsheds belonging to three distinct PM_{2.5} nonattainment areas; The Cache Valley (the Logan UT/ID nonattainment area), the central Wasatch Front (Salt Lake City, UT nonattainment area), and the southern Wasatch Front (Provo, UT nonattainment area).

Within each nonattainment area greater attention will be given to the accuracy of the inventories. For example, point sources will be included at a threshold of 70 tons per year inside these areas, while outside the threshold will be 100 tpy. On-road mobile source emissions will make use of travel demand models in the nonattainment areas to make projections of Vehicle Miles Traveled. This is not possible in the outlying areas.

The actual modeling domain will encompass a much greater geographical area to ensure that all pollutants, including short-range transported pollutants, are included in the modeling process. This additional area encompasses the remaining 22 counties in Utah and some additional areas in Nevada, Arizona, New Mexico, Colorado, Wyoming, and Idaho. See **Figure 6.1 in Chapter 6**.

In some ways, these outlying areas will be inventoried at a lesser level of detail than the non-attainment areas. UDAQ will compile information directly for all areas of the state. By source category, this includes Point Sources, Area Sources, and Mobile Sources (both on-road and off). By contrast, UDAQ will import National Emissions Inventory (NEI) data from the EPA's website to fill in the outlying areas in other states.

The inventories developed for each of these three areas illustrate many similarities but also a few notable differences. All three areas are more or less dominated by a combination of on-road mobile and area sources. However, emissions from large point sources are non-existent in the Cache Valley. These emissions are mostly situated along the Wasatch Front, and primarily exhibited in the Salt Lake City nonattainment area. Conversely, most of the agricultural emissions are located in the Cache Valley.

Table 4.1 is specific to the Salt Lake City, UT nonattainment area, and shows actual emissions for the baseline year (2016), as well as projected emissions for the attainment year (2019), and each of two “milestone years” (2017 and 2020). All projections incorporate assumptions concerning growth in population and vehicle miles traveled. They also include the effects of emissions control strategies that are either already promulgated or will be required as part of the SIP. Emissions modeled for the remainder of the modeling domain are contained in the Technical Support Document.

Emissions [tons/day]	Sector	PM2.5	NOx	VOC	NH3	SO2
2016 Base Year	Area Sources	6.13	13.63	45.96	14.22	0.17
	Mobile Sources	4.98	55.38	31.84	1.29	0.41
	NonRoad Sources	1.01	16.41	8.70	0.02	0.32
	Point Sources	3.26	18.18	5.25	0.44	4.70
	Total	15.38	103.61	91.74	15.97	5.60
2017 Milestone Year	Area Sources	6.19	13.57	46.02	14.21	0.22
	Mobile Sources	5.02	52.53	30.87	1.30	0.43
	NonRoad Sources	0.96	15.77	8.47	0.02	0.33
	Point Sources	3.58	18.32	6.13	0.44	4.61
	Total	15.75	100.18	91.48	15.97	5.59
2019 Attainment Year	Area Sources	6.23	11.84	44.34	14.21	0.22
	Mobile Sources	4.78	44.02	27.26	1.25	0.43
	NonRoad Sources	0.88	15.18	9.01	0.02	0.35
	Point Sources	4.25	23.86	6.21	0.48	3.90
	Total	16.13	94.90	86.82	15.96	4.89
2020 Milestone Year	Area Sources	6.24	9.54	43.73	14.20	0.20
	Mobile Sources	4.68	40.38	25.42	1.23	0.42
	NonRoad Sources	0.82	14.08	8.10	0.02	0.36
	Point Sources	4.26	23.86	6.22	0.49	3.90
	Total	16.00	87.86	83.47	15.94	4.88

Table 4.1, Emissions Summaries for the Salt Lake City, UT PM_{2.5} Nonattainment Area; Baseline, Milestone and Attainment Years (SMOKE). Emissions are presented in tons per average-episode-day.

All estimates are calculated from the Sparse Matrix Operator Kernel Model (SMOKE) and presented in units of tons per average-episode-day. More detailed inventory information may be found in the Technical Support Document (TSD).

Table 4.2 is specific to the point sources located within the Salt Lake, UT nonattainment area, and shows actual emissions for the baseline year (2016), as well as projected emissions for the attainment year (2019), and each of two “milestone years” (2017 and 2020). All projections incorporate assumptions concerning growth and also include the effects of emissions control strategies that are either already promulgated or will be required as part of the SIP.

Site Name	2016 Emissions					2017 Emissions				
	PM _{2.5} (tons/yr)	SO _x (tons/yr)	NO _x (tons/yr)	VOC (tons/yr)	NH ₃ (tons/yr)	PM _{2.5} (tons/yr)	SO _x (tons/yr)	NO _x (tons/yr)	VOC (tons/yr)	NH ₃ (tons/yr)
*ACH Foam Technologies	0.05	0.00	0.67	75.82	0.00	0.05	0.00	0.67	75.82	0.00
ATK Launch Systems - Promontory	19.13	1.86	44.84	31.18	0.44	19.13	1.86	44.84	31.18	0.44
Big West Oil - Flying J Refinery	10.64	43.14	92.31	307.37	4.37	10.64	43.14	92.31	307.37	4.37
*Bimbo Bakeries USA Salt Lake City Plant	0.20	0.02	2.64	79.44	0.08	0.20	0.02	2.64	79.44	0.08
*Brigham Young University- Main Campus	3.35	117.92	151.21	5.07	0.54	3.35	117.92	151.21	5.07	0.54
Chevron Products Co - Salt Lake Refinery	33.99	23.62	260.87	304.98	8.90	33.99	23.62	260.87	304.98	8.90
Compass Minerals Ogden Inc. - Production Plant	80.50	9.81	134.50	72.82	3.61	80.50	9.81	134.50	72.82	3.61
*Geneva Nitrogen Inc.- Geneva Nitrogen Plant	28.28	0.00	109.14	0.02	2.70					
Hexcel Corporation- Salt Lake Operations	72.96	37.80	169.38	163.81	84.98	70.99	42.42	175.58	161.43	85.53
Hill Air Force Base - Main Base	8.45	4.01	151.42	126.36	1.45	26.10	34.14	283.95	306.86	1.45
Holly Corp- HRMC and HEP Woods Cross Operations	13.27	109.96	181.71	157.86	17.82	13.27	109.96	181.71	157.86	17.82
Kennecott Utah Copper LLC- Mine & Copperton Concentrator	274.05	1.99	4,199.63	213.70	1.75	274.05	1.99	4,199.63	213.70	1.75
Kennecott Utah Copper LLC- Power Plant Lab Tailings Impoundment	71.78	1,500.34	1,322.52	8.21	0.24	49.90	914.68	652.45	6.17	0.17
Kennecott Utah Copper LLC- Smelter & Refinery	421.19	704.35	160.21	10.37	5.62	421.19	704.35	160.21	10.37	5.62
Lhoist North America - Grantsville Plant	0.25	0.02	0.21	0.14	0.00	0.25	0.02	0.21	0.14	0.00
McWane Ductile - Utah	13.34	3.90	38.60	29.55	0.50	13.34	3.90	38.60	29.55	0.50
Nucor Steel- Nucor Steel	37.47	135.01	156.77	31.72	1.92	33.27	85.63	200.09	36.46	2.11
PacificCorp Energy- Gadsby Power Plant	16.86	1.52	117.39	9.57	13.15	16.86	1.52	117.39	9.57	13.15
PacificCorp Energy- Lake Side Power Plant	58.39	10.58	246.67	38.59	152.04	58.39	10.58	246.67	38.59	152.04
Procter and Gamble-Paper Manufacturing Plant	38.94	0.30	27.23	18.58	0.17	150.15	1.45	124.86	162.37	0.17
*Snowbird Development Corporation	3.52	1.48	93.33	12.11	0.64	3.52	1.48	93.33	12.11	0.64
Tesoro Refining & Marketing Company LLC	89.35	544.38	360.09	249.28	3.77	89.35	544.38	360.09	249.28	3.77
University of Utah- University of Utah facilities	15.28	0.80	73.25	10.49	3.38	15.23	0.80	73.04	10.46	3.37
Utah Municipal Power Agency - West Valley Power Plant	3.94	0.36	8.55	1.25	0.00	3.94	0.36	8.55	1.25	0.00
Vulcraft - Division of Nucor Corporation- Steel Products Manufacturing	9.68	0.50	6.68	44.91	0.04	9.87	0.53	7.10	48.29	0.04
*Wasatch Integrated Waste Mgt District- County Landfill & Energy Recovery Facility (DCERF)	9.79	17.16	236.44	23.18	0.00					
Total =	1,334.65	3,270.83	8,346.25	2,026.36	308.12	1,397.53	2,654.57	7,610.50	2,331.13	306.09
Site Name	2019 Emissions					2020 Emissions				
	PM _{2.5} (tons/yr)	SO _x (tons/yr)	NO _x (tons/yr)	VOC (tons/yr)	NH ₃ (tons/yr)	PM _{2.5} (tons/yr)	SO _x (tons/yr)	NO _x (tons/yr)	VOC (tons/yr)	NH ₃ (tons/yr)
*ACH Foam Technologies										
ATK Launch Systems - Promontory	19.13	1.86	44.84	31.18	0.44	19.13	1.86	44.84	31.18	0.44
Big West Oil - Flying J Refinery	10.64	43.14	92.32	291.97	4.37	10.64	43.14	92.32	291.97	4.37
*Bimbo Bakeries USA Salt Lake City Plant										
*Brigham Young University- Main Campus										
Chevron Products Co - Salt Lake Refinery	33.99	23.62	260.87	304.98	8.90	33.99	23.62	260.87	304.98	8.90
Compass Minerals Ogden Inc. - Production Plant	80.50	9.81	137.90	82.29	3.61	80.50	9.81	137.90	82.29	3.61
*Geneva Nitrogen Inc.- Geneva Nitrogen Plant										
Hexcel Corporation- Salt Lake Operations	77.09	50.15	188.81	171.86	92.65	78.15	50.31	186.51	174.97	93.82
Hill Air Force Base - Main Base	26.10	34.14	283.95	306.86	1.45	26.10	34.14	283.95	306.86	1.45
Holly Corp- HRMC and HEP Woods Cross Operations	13.27	109.96	181.71	157.86	17.82	13.27	109.96	181.71	157.86	17.82
Kennecott Utah Copper LLC- Mine & Copperton Concentrator	411.25	6.60	6,178.81	316.45	2.65	411.25	6.60	6,178.81	316.45	2.65
Kennecott Utah Copper LLC- Power Plant Lab Tailings Impoundment	165.61	1,344.13	1,039.39	33.80	1.56	165.61	1,344.13	1,039.39	33.80	1.56
Kennecott Utah Copper LLC- Smelter & Refinery	443.16	863.74	208.34	12.49	9.75	443.16	863.74	208.34	12.49	9.75
Lhoist North America - Grantsville Plant	0.25	0.02	0.21	0.14	0.00	0.25	0.02	0.21	0.14	0.00
McWane Ductile - Utah	13.34	3.90	38.60	29.55	0.50	13.34	3.90	38.60	29.55	0.50
Nucor Steel- Nucor Steel	33.87	93.59	214.04	39.50	2.32	33.87	93.59	214.04	39.50	2.32
PacificCorp Energy- Gadsby Power Plant	16.86	1.52	117.39	9.57	13.15	16.86	1.52	117.39	9.57	13.15
PacificCorp Energy- Lake Side Power Plant	58.39	10.58	246.67	38.59	152.04	58.39	10.58	246.67	38.59	152.04
Procter and Gamble-Paper Manufacturing Plant	150.15	1.45	124.86	162.37	0.17	150.15	1.45	124.86	162.37	0.17
*Snowbird Development Corporation										
Tesoro Refining & Marketing Company LLC	91.38	91.20	275.00	268.63	3.77	91.38	91.20	275.00	268.63	3.77
University of Utah- University of Utah facilities	15.64	0.87	60.36	10.92	3.45	17.46	0.89	61.66	11.15	3.52
Utah Municipal Power Agency - West Valley Power Plant	3.94	0.36	8.55	1.25	0.00	3.94	0.36	8.55	1.25	0.00
Vulcraft - Division of Nucor Corporation- Steel Products Manufacturing	13.94	0.77	10.56	69.86	0.07	13.94	0.77	10.56	69.86	0.07
*Wasatch Integrated Waste Mgt District- County Landfill & Energy Recovery Facility (DCERF)										
Total =	1,678.50	2,691.42	9,713.18	2,340.11	318.66	1,681.37	2,691.60	9,712.18	2,343.45	319.90

Table 4.2 Emissions from Point Sources

Chapter 5 – PROVISIONS TO ENSURE BEST AVAILABLE CONTROL MEASURES

5.1 Introduction

This chapter summarizes the requirement for a Serious Area plan revision to ensure the implementation of best available control measures (BACM) no later than four years after reclassification. Additional detail concerning the assessment of specific emission control measures is contained in the Technical Support Document.

BACM is defined as any technologically and economically feasible control measure that can be implemented in whole or in part within 4 years after the date of reclassification (to Serious) and that generally can achieve greater permanent and enforceable emissions reductions ... than can be achieved through the implementation of reasonable available control measures (RACM) on the same sources. BACM includes best available control technology (BACT).

The requirement to ensure BACM/BACT sits in addition to the requirements from the Moderate Area SIP, which included RACM/RACT. Utah addressed this requirement in its Moderate Area SIP⁵ (submitted December 22, 2014).

Unlike the RACM required as part of the Moderate Area SIP, BACM/BACT is regarded by EPA as “generally independent” of attainment. This interpretation maintains the policy expressed in the Addendum for PM₁₀ that BACM/BACT is to be determined without regard to the specific attainment demonstration for the area. Essentially, this means that if a control measure is determined to meet the definition of best available control measure or technology, it may not be disregarded simply because the demonstration of attainment might conclude that such measure would not be necessary to meet the NAAQS as expeditiously as practicable.

The BACM/BACT requirement for Serious PM_{2.5} nonattainment areas also applies to PM_{2.5} precursors, unless the state has submitted, and EPA has approved, a precursor analysis demonstrating that emissions from a particular precursor do not contribute significantly to PM_{2.5} levels that exceed the standard in the area. Utah has not included any such precursor demonstration with the Serious Area SIP for the Salt Lake City, UT nonattainment area. The list of PM_{2.5} precursors includes SO₂, NO_x, VOC and ammonia.

5.2 BACM Process

The Process for determining BACM/BACT for Serious PM_{2.5} Areas is articulated in 40 CFR 51.1010, and elaborated upon in the preamble to the rule. Essentially, this is a five step process where:

Step one is the development of a comprehensive inventory for the area, which aids in identifying the various source categories that contribute emissions to the airshed.

Step two is to identify potential control measures. The list of these potential measures should include options not previously considered as RACM/RACT for the area during the development of the Moderate Area SIP.

⁵ See SIP Section IX.A.21, Chapter 6 for a discussion of RACM/RACT in the Salt Lake City, UT PM_{2.5} nonattainment area.

In Step three, a determination is made for each of the potential control measures to see whether or not it would be technologically feasible to implement.

Step four is a determination of economic feasibility applied to each of the potential control measures that was determined to be technologically feasible. EPA did not establish a specific fixed \$/ton cost threshold for economic feasibility determinations, but indicated that states would need to consider emission reduction measures with higher costs per ton when assessing the economic feasibility of BACM/BACT controls as compared to the criteria applied in the RACM/RACT analysis for the same nonattainment area.

Step five is to determine the earliest date by which an economically feasible control measure can be implemented, in whole or in part.

5.3 Existing Control Measures

Ultimately, all control measures and technologies will have an effect on emission rates, and it is important to reflect these emission rates in the attainment demonstration.

Some of these control measures will be new and will have resulted from the exercise of ensuring that BACM/BACT will be implemented following reclassification of the area to Serious, but other control measures will already exist. Since about 1970 there have been regulations at both state and federal levels to mitigate air contaminants.

Utah's permitting rules require a review of new and modified major stationary sources in nonattainment areas, as is required by Section 173 of the Clean Air Act. Beyond that however, even minor sources and minor modifications to major sources planning to locate anywhere in the state are required to undergo a new source review analysis and receive an approval order to construct. Part of this review is an analysis to ensure the ongoing application of Best Available Control Technology (BACT).

Along the central Wasatch Front, major and minor⁶ stationary sources have been required to reduce emissions at several junctures to address nonattainment issues with SO₂, ozone, PM₁₀ and PM_{2.5}.

In reviewing the existing control measures to see if they meet BACM/BACT, states may not simply rely on prior BACT, LAER, and BART analyses for the purposes of showing that a source has also met BACT for the PM_{2.5} NAAQS. Rather, EPA expects that in step two of the determination process, the state would identify such measures as "existing measures" that should be further evaluated as potential BACM or BACT.

Existing controls also affect the emission rates from non-stationary source categories.

The federal motor vehicle control program has been one of the most significant control strategies affecting emissions that lead to PM_{2.5}. Tier 1 and 2 standards were implemented by 1997 and 2008 respectively. Similarly, the Heavy-Duty Engine and Vehicle Standards took effect in 2007 and were fully phased in by 2010. Air Quality benefits -- particularly those stemming from the Tier 2 and heavy-duty vehicle standards -- continue to be realized as older higher polluting vehicles are replaced by newer cleaner vehicles. This trend may be seen in the inventory projections for on-road mobile sources despite the growth in vehicles and vehicle miles traveled that are factored into the same projections. Tier 3 standards will continue the progress made

⁶ Within the context of this SIP, minor stationary sources are treated as "area sources". Such sources are typically regulated through promulgation of area source rules affecting various source categories.

since the late-1960s. Tier 3 became effective in 2017 and will be fully phased in by 2025 and will reduce emissions from a typical passenger vehicle by 70 to 80 percent.

To supplement the federal motor vehicle control program, Inspection / Maintenance (I/M) Programs were implemented in Salt Lake, Davis, and Weber Counties. These programs have been effective in identifying vehicles that no longer meet the emission specifications for their respective makes and models, and in ensuring that those vehicles are repaired in a timely manner.

Emissions from non-road mobile emission sources also benefit from several significant regulatory programs enacted at the federal level. This category of emitters includes airplanes, locomotives, hand-held engines, and larger portable engines such as generators and construction equipment. The effectiveness of these controls has been incorporated into the “NONROAD” model UDAQ uses to compile the inventory information for this source category. These measures affect not only the levels of current emissions, but some continue to affect emissions trends as well.

5.4 SIP Controls

Beyond the benefits attributable to the controls already in place, there are new controls identified by this SIP that provide additional benefit toward reaching attainment. A summary of the BACM/BACT review is presented here for each of the emission source sectors.

Stationary Point sources:

Best Available Control Technology – EPA has long interpreted BACM to include BACT, and in the same way that RACT is generally applied to stationary sources BACT is also regarded as a part of BACM that is typically applied to the review of stationary sources. This is not to say that BACT does not consider control measures other than technologies. The requirement for BACT at existing sources in the context of PM_{2.5} NAAQS implementation is separate and distinct from the BACT requirement for permitting new and modified sources under the Prevention of Significant Deterioration (PSD) program. However, BACT determinations for PM_{2.5} SIP purposes are to follow the same process and criteria that stem from the PSD program.

This SIP used the definition of “major stationary source” to compile a list of sources that would receive a source-specific BACT review. For a serious PM_{2.5} nonattainment area, this means any source that emits, or has the potential to emit, 70 ton per year or more of direct PM_{2.5} or any PM_{2.5} precursor. The 2014 tri-annual emissions inventory was used to assess the actual emissions. The rest of the stationary (point) sources were assumed to represent a portion of the overall “area source” inventory.

Sources meeting the criteria described above were individually evaluated to determine whether their operations would be consistent with BACT.

In conducting the analysis, UDAQ found that, as a whole, the large stationary sources were already operating with a high degree of emission control. It follows that the percentage of SIP related emissions reductions is not large relative to the overall quantity of emissions. As stated before, many of these sources were recently reviewed to ensure RACT as part of the Moderate Area SIP. Routine permitting in the Salt Lake City nonattainment area already includes BACT as an ongoing standard of review, and when developing the Moderate Area SIP, UDAQ generally identified a level of emission control that would be more consistent with best available controls than the reasonably available controls that were required.

For the Salt Lake City, UT nonattainment area, there are 26 stationary point sources that met or meet the threshold of 70 tons or more per year for PM_{2.5} or any precursor. The emissions from these sources that were modeled for 2016, 2017, 2019, and 2020 are shown below in Table 4.2. Note that these emissions also include any growth projections that were applied.

The BACT analysis for each of the listed sources may be found in the Technical Support Document.

The actual emission limits and operating procedures that reflect the implementation of BACM/BACT are listed in SIP Subsection IX. Part H. 11. & 12, which is made enforceable via incorporation into the Utah Air Quality Rules at R307-110-17.

New Source Review / Banked Emission Reduction Credits – Under Utah’s new source review rules in R307-403-8, banking of emission reduction credits (ERCs) is permitted to the fullest extent allowed by applicable Federal Law as identified in 40 CFR 51, Appendix S, among other documents. Under Appendix S, Section IV.C.5, a permitting authority may allow banked ERCs to be used under the preconstruction review program (R307-403) as long as the banked ERCs are identified and accounted for in the SIP control strategy. For the Moderate Area PM_{2.5} SIP, however, it was not possible to include banked ERCs in the attainment demonstration. The PM_{2.5} SIP adopted by the Air Quality Board on December 4, 2013 did not include banked PM_{2.5} or PM_{2.5} precursor ERCs in the attainment demonstration and therefore under R307-403-8 any ERCs that were banked prior to December 4, 2013 could no longer be used as emission offsets for PM_{2.5} nonattainment areas. The use of these existing banked ERCs to meet the requirements of existing SIPs for PM₁₀, SO₂ and ozone are not affected by the PM_{2.5} SIP and would be evaluated according to the provisions of those SIPs. In this Serious Area SIP, the handful of ERCs generated after December 4, 2013 for PM_{2.5} or PM_{2.5} precursors has been accounted for in the modeled attainment demonstration and are eligible to be used as emission offsets for PM_{2.5} or PM_{2.5} precursors. A listing of these ERCs has been included in the Technical Support Documentation.

Area sources:

Smaller stationary sources are too numerous to warrant individual attention, but they must also implement BACM/BACT.

The area source BACM analysis consisted of a thorough review of the entire seasonally adjusted area source inventory for anthropocentrically derived direct PM_{2.5} and precursor constituents. The analysis centered on whether best control measures are available for a given source category. A search through the literature identified EPA guidance documents and regulations including: Control Techniques Guidelines (CTG), Alternative Control Techniques (ACT), and New Source Performance Standards (NSPS). Other sources of information included the Ozone Transport Commission’s (OTC) model rules as well as rules from other serious nonattainment air districts addressing ozone and/or PM_{2.5}.

For the BACM review, each of UDAQ’s existing area source rules⁷ was re-evaluated with respect to these examples to ensure that all appropriate source categories have been addressed in rulemaking, and that the level of control required is consistent with BACM. For newly identified controls or enhancement of existing controls, an evaluation was made to determine technological and economic feasibility.

⁷ As part of the Moderate Area PM_{2.5} SIP, UDAQ introduced or augmented 25 area source rules to control emissions of PM_{2.5} or PM_{2.5} precursors.

The BACM review resulted in revisions to 13 different rules which affect surface coating (for a variety of different surfaces), graphic arts, and Aerospace Manufacture & Rework Facilities. At the same time however, a cleaning solvent VOC limit of 0.21 lb/gal found in some of these rules was found to be overly aggressive and had to be relaxed.

The overall BACT analysis for the area source rules may be found in the Technical Support Document.

The area source rules have been incorporated into the Utah Air Quality Rules at R307.

Table 5.1 shows the effectiveness of the area source rules within the Salt Lake City, UT nonattainment area by indicating the quantities of emissions eliminated from the inventory for each of the relevant years. Emission units are in lb/day.

SLC, UT PM2.5 Nonattainment Area	Emissions Reduced in Pounds Per Day (lb/day)									
	2016 Base Year					2017 Milestone Year				
	NOx	VOC	NH3	SO2	PM2.5	NOx	VOC	NH3	SO2	PM2.5
adhesive/sealants	0.00	869.91	0.00	0.00	0.00	0.00	1,176.59	0.00	0.00	0.00
aerospace										
aggregate operations	0.00	0.00	0.00	0.00	5.59	0.00	0.00	0.00	0.00	5.58
appliance										
autobody	0.00	344.17	0.00	0.00	0.00	0.00	698.06	0.00	0.00	0.00
coil/containers										
commercial cooking	0.00	51.31	0.00	0.00	0.00	0.00	52.01	0.00	0.00	0.00
consumer products	0.00	4,372.48	0.00	0.00	0.00	0.00	4,435.39	0.00	0.00	0.00
degreasing										
fabric/vinyl										
flat wood										
fugitive dust	0.00	0.00	0.00	0.00	1,442.43	0.00	0.00	0.00	0.00	1,455.69
graphic art										
Hydronic heater ban	5.80	188.20	4.80	5.80	178.60	5.60	187.40	4.60	5.60	178.40
Landfill	0.00	276.51	0.00	0.00	0.00	0.00	281.87	0.00	0.00	0.00
magnet wire										
metal furniture										
misc metal										
paint	0.00	6,089.71	0.00	0.00	0.00	0.00	6,177.26	0.00	0.00	0.00
paper/film/foil										
pilot light	3,383.76	197.98	0.00	21.60	15.48	4,511.65	263.95	0.00	28.79	20.62
plastic										
Residential wood burning ban	1,344.82	10,436.32	389.15	133.89	9,046.46	1,339.19	10,405.97	386.33	133.26	9,019.87
water heaters										
wood furniture manuf										
Total Area Source Emissions Reduced	4,734.4	22,826.6	393.9	161.3	10,688.6	5,856.4	23,678.5	390.9	167.7	10,680.2

SLC, UT PM2.5 Nonattainment Area		Emissions Reduced in Pounds Per Day (lb/day)									
Area Source Rule Name	2019 Attainment Year					2020 Milestone Year					
	NOx	VOC	NH3	SO2	PM2.5	NOx	VOC	NH3	SO2	PM2.5	
adhesive/sealants	0.00	1,513.14	0.00	0.00	0.00	0.00	1,533.71	0.00	0.00	0.00	
aerospace	0.00	28.73	0.00	0.00	0.00	0.00	43.13	0.00	0.00	0.00	
aggregate operations	0.00	0.00	0.00	0.00	5.57	0.00	0.00	0.00	0.00	5.56	
appliance	0.00	0.46	0.00	0.00	0.00	0.00	0.69	0.00	0.00	0.00	
autobody	0.00	1,435.97	0.00	0.00	0.00	0.00	1,817.76	0.00	0.00	0.00	
coil/containers	0.00	83.64	0.00	0.00	0.00	0.00	125.00	0.00	0.00	0.00	
commercial cooking	0.00	53.57	0.00	0.00	0.00	0.00	54.29	0.00	0.00	0.00	
consumer products	0.00	4,559.88	0.00	0.00	0.00	0.00	4,625.34	0.00	0.00	0.00	
degreasing	0.00	1,014.89	0.00	0.00	0.00	0.00	1,527.89	0.00	0.00	0.00	
fabric/vinyl	0.00	362.02	0.00	0.00	0.00	0.00	442.96	0.00	0.00	0.00	
flat wood	0.00	11.37	0.00	0.00	0.00	0.00	17.15	0.00	0.00	0.00	
fugitive dust	0.00	0.00	0.00	0.00	1,483.96	0.00	0.00	0.00	0.00	1,497.15	
graphic art	0.00	995.47	0.00	0.00	0.00	0.00	1,062.39	0.00	0.00	0.00	
Hydronic heater ban	5.80	186.60	4.80	5.80	177.00	5.80	186.00	4.80	5.80	176.60	
Landfill	0.00	293.81	0.00	0.00	0.00	0.00	299.37	0.00	0.00	0.00	
magnet wire	0.00	22.03	0.00	0.00	0.00	0.00	22.18	0.00	0.00	0.00	
metal furniture	0.00	167.13	0.00	0.00	0.00	0.00	249.51	0.00	0.00	0.00	
misc metal	0.00	273.76	0.00	0.00	0.00	0.00	411.43	0.00	0.00	0.00	
paint	0.00	6,344.07	0.00	0.00	0.00	0.00	6,441.84	0.00	0.00	0.00	
paper/film/foil	0.00	97.89	0.00	0.00	0.00	0.00	147.62	0.00	0.00	0.00	
pilot light	5,834.66	396.40	0.00	43.19	31.00	4,926.20	361.78	0.00	39.47	28.29	
plastic	0.00	189.32	0.00	0.00	0.00	0.00	222.41	0.00	0.00	0.00	
Residential wood burning ban	1,332.30	10,343.10	385.71	132.01	8,964.81	1,327.61	10,311.50	384.46	131.70	8,939.47	
water heaters	1,396.75	0.00	0.00	0.00	0.00	1,632.52	0.00	0.00	0.00	0.00	
wood furniture manuf	0.00	604.15	0.00	0.00	0.00	0.00	910.88	0.00	0.00	0.00	
Total Emissions Reduced: (lb/day)	8,569.5	28,977.4	390.5	181.0	10,662.3	7,892.1	30,814.8	389.3	177.0	10,647.1	

Table 5.1, Emissions Reductions from Area Source SIP Controls

On-road mobile sources:

Federal Regulations

Section 209(a) of the Clean Air Act (CAA) preempts states other than California from adopting or enforcing standards for on-highway vehicles. Nevertheless, emissions reduction credit for federal on-highway vehicle controls was accounted for because federal control effectiveness has been incorporated into the MOVES model which the Utah Division of Air Quality (UDAQ) uses to calculate on-road emissions. Additional information is provided in the Technical Support Document.

State Regulations

Inspection/Maintenance (I/M) programs are already in place for Salt Lake, Davis and Weber Counties. Utah Code Annotated 41-6a-1642 gives authority to each county to implement and manage an I/M program to attain and maintain any National Ambient Air Quality Standard (NAAQS). I/M programs were implemented in Salt Lake and Davis counties in 1984, and a program for Weber County was added in 1990. These programs have been effective in both identifying vehicles that no longer meet the emission specifications for their respective makes and models and ensuring that those vehicles are repaired in a timely manner.

Davis, Salt Lake and Weber Counties current I/M programs consist of decentralized, test-and-repair network for the testing of all model year 1968 and newer vehicles except for exempt vehicles registered in the applicable county. Vehicles less than two years old as of January 1 on any given year are exempt from an emissions inspection. Vehicles from two to five years old as of January 1 on any given year are inspected biennially. Vehicles six years old and older as of January 1 on any given year are inspected annually. Vehicles 1996 and newer are subject to an OBD II inspection. Vehicles 1995 and older are subject to a two-speed idle test. To ensure that

analyzers are the highest quality and to take advantage of improved technology, Davis, Salt Lake and Weber Counties recently updated the test analyzers used in their respective I/M programs.

Off-road mobile sources:

Section 209(e) of the Clean Air Act (CAA) preempts states other than California from adopting or enforcing emissions standards for terrestrial and marine non-road engines or vehicles.

Similarly, CAA section 233 preempts states from adopting or enforcing emissions standards from aircraft or aircraft engines. For this reason, the Utah Division of Air Quality (UDAQ) did not consider any SIP controls for non-road mobile sources beyond those already promulgated at the federal level. Nevertheless, emissions reduction credit for these federal controls was accounted for because their effectiveness has been incorporated into the NONROAD model which UDAQ uses to calculate non-road emissions. Additional information is provided in the Technical Support Document.

Chapter 6 – ATTAINMENT DEMONSTRATION

6.1 Air Quality Modeling

UDAQ used the Comprehensive Air Quality Model with Extensions (CAMx) version 6.30 for air quality modeling. CAMx v6.30 is a state-of-the-art air quality model that includes State of Utah funded enhancements for wintertime modeling. These enhancements include snow chemistry, topographical and surface albedo refinements. CAMx is an EPA approved model for use in SIP modeling. Its configuration for use in this SIP, with respect to model options and model adjustments, is discussed in the Technical Support Document.

Emissions Preparation

The emissions processing model used in conjunction with CAMx is the Sparse Matrix Operator Kernel Emissions Modeling System (SMOKE) version 3.6.5⁸. SMOKE prepares the annual emissions inventory for use in the air quality model. There are three aspects to the preparation of an annual emissions inventory for air quality modeling:

- Temporal: Convert emissions from annual to daily, weekly and hourly values.
- Spatial: Convert emissions from a county-wide average to gridded emissions.
- Speciation: Decompose PM_{2.5} and VOC emissions estimates into individual subspecies using the latest Carbon Bond 6 speciation profiles.

The process of breaking down emissions for the air quality model was done with sets of activity profiles and associated cross reference files. These are created for point or large industrial source emissions, smaller area sources, and mobile sources. Direct PM_{2.5} and PM_{2.5} precursor estimates were modified via temporal profiles to reflect wintertime conditions.

Activity profiles and their associated cross reference files from the EPA's 2011v6⁹ modeling platform were used. For stationary non-point and mobile sources, spatial surrogates from the EPA Clearinghouse for Inventories and Emissions Factors (CHIEF¹⁰) were used to distribute emissions in space across the modeling domain. Emissions from large industrial sources (i.e., point) were placed at the location of the source itself. Where reliable local information was available (e.g., population density, traffic demand modeling, residential heating), profiles and surrogates were modified or developed to reflect that information.

Photochemical Modeling Domains and Grid Resolution

The UDAQ CAMx 6.30 modeling framework consists of two spatial domains: a high-resolution 1.33 km domain nested inside of a coarser 4 km domain (see **Figure 6.1, below**). This configuration allows one to efficiently integrate regional effects with local impacts within the Salt Lake City nonattainment area. Vertical resolution in the model consists of 41 layers extending to the top of the atmosphere.

⁸ <https://www.cmascenter.org/smoke/>

⁹ <https://www.epa.gov/air-emissions-modeling/2011-version-6-air-emissions-modeling-platforms>

¹⁰ <https://www.epa.gov/chief>

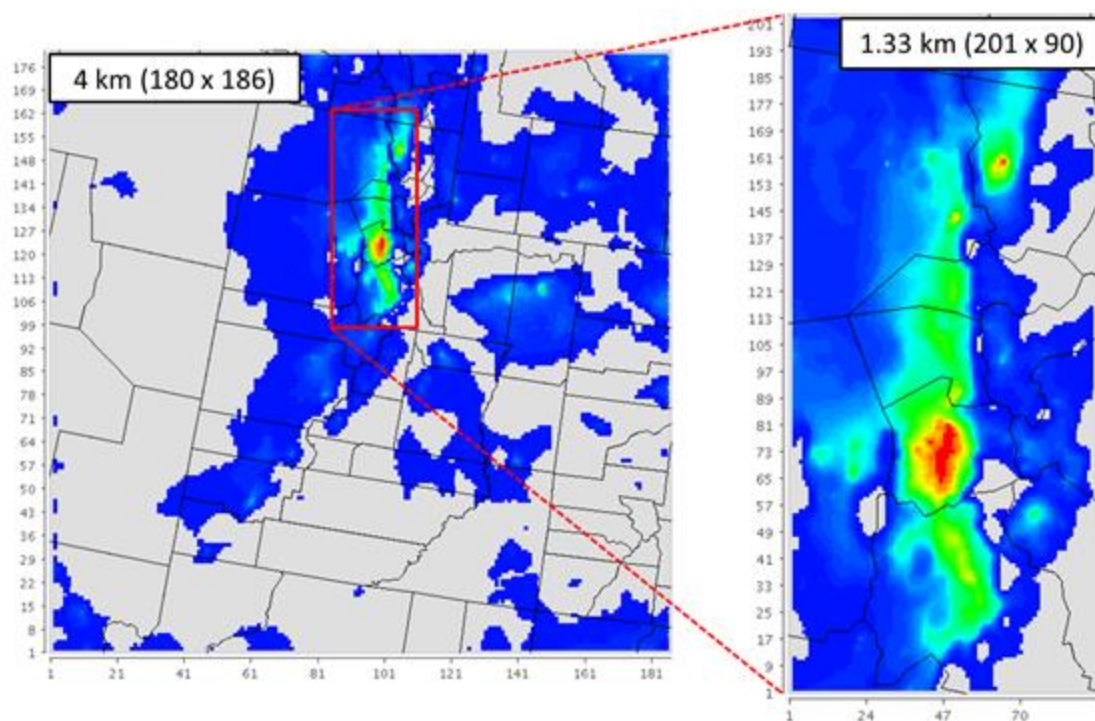


Figure 6.1: Two CAMx modeling domains in two-way nesting configuration.

The UDAQ 4 km coarse domain covers the entire state of Utah, a significant portion of Eastern Nevada (including Las Vegas), as well as smaller portions of Idaho, Wyoming, Colorado, and Arizona. The fine 1.33 km domain covers all of Utah's three PM_{2.5} nonattainment areas, including the Salt Lake City nonattainment area. Throughout this document, we will refer to the fine 1.33 km domain as the “modeling domain” when the coarse domain is not specified.

Meteorological Data

Meteorological modeling was carried out by the University of Utah with financial support from UDAQ.

Meteorological inputs were derived using the Weather Research and Forecasting¹¹ (WRF) Advanced Research WRF (WRF-ARW) Model to prepare meteorological datasets for our use with the photochemical model. WRF contains separate modules to compute different physical processes such as surface energy budgets and soil interactions, turbulence, cloud microphysics, and atmospheric radiation. Within WRF, the user has many options for selecting the different schemes for each type of physical process. There is also a WRF Preprocessing System (WPS) that generates the initial and boundary conditions used by WRF, based on topographic datasets, land use information, and larger-scale atmospheric and oceanic models.

Model performance of WRF was assessed against observations at sites maintained by the University. A summary of the performance evaluation results for WRF is included in the Technical Support Document:

WRF has reasonable ability to replicate the vertical temperature structure of the boundary layer (i.e., the temperature inversion), although it is difficult for WRF to reproduce the inversion when the inversion is shallow and strong (i.e., an 8 degree temperature increase over 100 vertical meters).

¹¹ <https://www.mmm.ucar.edu/weather-research-and-forecasting-model>

Episode Selection

Part of the modeling exercise involves a test to see whether the model can successfully replicate the PM_{2.5} mass and composition that was observed during some prior episode(s) of elevated PM_{2.5} concentration.

The selection of an appropriate episode, or episodes, for use in this exercise requires some forethought and should determine the meteorological episode that helps produce the best air quality modeling performance.

EPA's April 2007 "Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, PM_{2.5}, and Regional Haze" identifies some selection criteria that should be considered for SIP modeling, including:

- Select episodes that represent a variety of meteorological conditions that lead to elevated PM_{2.5}.
- Select episodes during which observed concentrations are close to the baseline design value.
- Select episodes that have extensive air quality data bases.
- Select enough episodes such that the model attainment test is based on multiple days at each monitor violating NAAQS.

After careful consideration, the following meteorological episodes were selected as candidates for Utah's SIP modeling:

- January 1-10, 2011
- December 7-19, 2013
- February 1-16, 2016

In addition to the criteria identified in the modeling guidance, each of these candidate episodes may be characterized as having the following atmospheric conditions:

- Nearly non-existent surface winds
- Light to moderate winds aloft (wind speeds at mountaintop < 10-15 m/s)
- Simple cloud structure in the lower troposphere (e.g., consisting of only one or no cloud layer)
- Singular 24-hour PM_{2.5} peaks suggesting the absence of weak intermittent storms during the episode

Previous work conducted by the University of Utah and Utah Division of Air Quality (DAQ) showed the four conditions listed above improve the likelihood for successfully simulating wintertime persistent cold air pools in the Weather Research and Forecasting (WRF) model¹².

¹² <https://www.mmm.ucar.edu/weather-research-and-forecasting-model>

A comprehensive discussion of the meteorology model performance for all three episodes may be found in the Technical Support Document, as well as at the link below.

<https://documents.deq.utah.gov/air-quality/planning/technical-analysis/research/model-improvements/3-wintertime-episodes/DAQ-2017-014342.pdf>

Model adjustments

In order to better simulate Utah's winter-time inversion episodes six different adjustments were made to CAMx input data:

1. Increased vertical diffusion rates (Kvpatch)
2. Lowered residential wood smoke emissions to reflect burn ban compliance during forecasted high PM_{2.5} days (burn ban)
3. Ozone deposition velocity set to zero and increased urban area surface albedo (snow chemistry)
4. Cloud water content reduced during certain days (cloud adjustment)
5. Ammonia injection to account for missing ammonia sources in UDAQ's inventory. This is defined as artificially adding non-inventoried ammonia emissions to the inventoried emissions that are input into CAMx.
6. Reduced the dry deposition rate of ammonia by setting ammonia Rscale to 1. Rscale is a parameter in CAMx that reflects surface resistance.

Depending on the episode, different adjustments were applied. All adjustments were applied to the January 2011 episode while select adjustments were applied to the other two episodes.

Kvpatch improved overall model performance by enhancing vertical mixing over urban areas. Snow chemistry modifications, which included reducing ozone deposition velocity and increasing surface albedo over urban areas, helped improve the model performance by better representing secondary ammonium nitrate formation during winter-time inversion episodes in Utah.

Ammonia injection values were based on measurements conducted during February 2016. These measurements were used to determine the ammonia injection values for the February 2016 episode. Similar injection values were then assumed for the January 2011 episode.

Cloud adjustments were only applied to the January 2011 episode, which was characterized by cloud cover on January 6-8 over the Salt Lake Valley. This cloud cover led to a high bias in sulfate due to the effect of ammonia on the gas-to-particle partitioning of sulfate in clouds. Application of the cloud adjustment scheme helped reduce this bias.

Rscale modification and burn ban adjustments were also only applied to the January 2011 episode. The burn ban adjustments reflect the compliance rate with the state's two-stage policy ban on wood-burning.

Episodic model performance

Shown below for each of three episodes are the CAMx performance results in total 24-hour PM_{2.5} concentrations.

January 1-10, 2011

For the January meteorological episode, CAMx performance in 24-hour $PM_{2.5}$ is generally good at Hawthorne (Salt Lake County) (**Fig. 6.2.1**). However, the earlier part of the modeled episode at Hawthorne is impacted by the absence of thin mid-level clouds that were present during January 3-5. The absence of clouds here had the effect of warming the surface and increasing the mixing height in the simulation. Kvpach depth was lowered during this period to account for this, while keeping modeled primary aerosol concentrations reasonable.

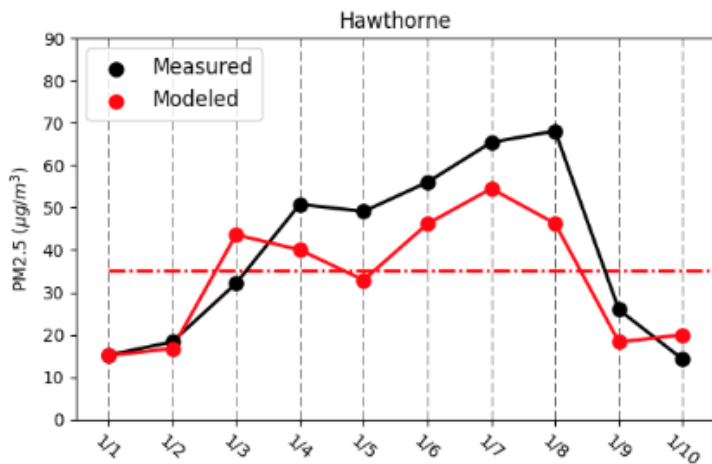


Figure 6.2.1: 24-hr $PM_{2.5}$ concentrations during January, 2011 episode. Observed (black) vs. modeled (red) for Hawthorne, Salt Lake County

Looking at **Fig. 6.2.2**, observed speciated $PM_{2.5}$ mass from the Hawthorne Chemical Speciation Network (CSN) monitor (January 7), there is good agreement in nitrate (NO_3) and ammonium (NH_4) with the CAMx modeling results. The agreement between modeled and observed NO_3 is a benefit from the ammonia injection. Simulated fine crustal matter (CM) and elemental carbon (EC) concentrations were a bit higher than observed. The overestimation of CM was likely the result of a high bias in the re-suspended road dust calculation tool (AP-42).

Measured vs. Modeled

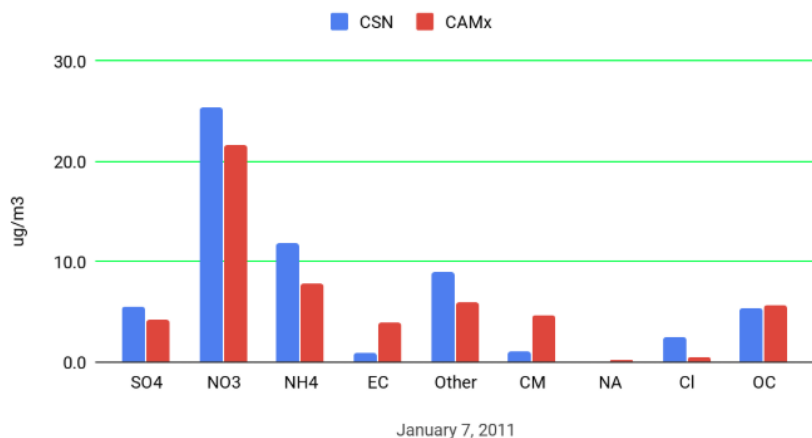


Figure 6.2.2: 24-hr speciated $PM_{2.5}$ mass ($\mu g/m^3$) for January 7, 2011. Blue (red) bars represent measured (modeled) mass for Hawthorne, Salt Lake County.

December 7-19, 2013

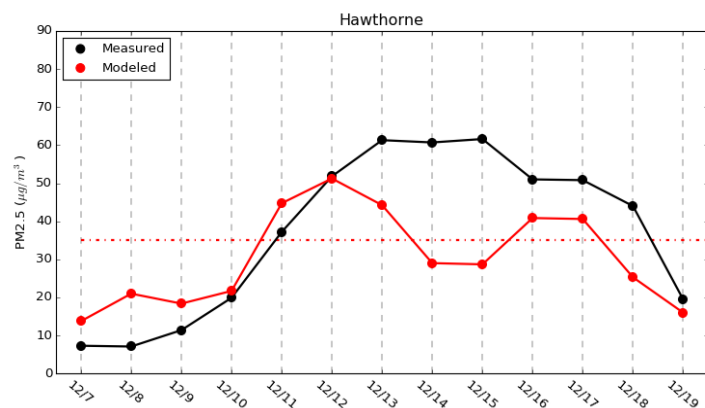


Figure 6.3.1: 24-hr PM_{2.5} concentrations during December, 2013 episode. Observed (black) vs. modeled (red) for Hawthorne, Salt Lake County.

Fig. 6.3.1 indicates that, at Hawthorne, modeled PM_{2.5} was of a similar magnitude as observed. However, there was a bimodality in the modeled results not observed in measurements. While observations show peak PM_{2.5} concentrations during December 13-15, CAMx is producing a local minima.

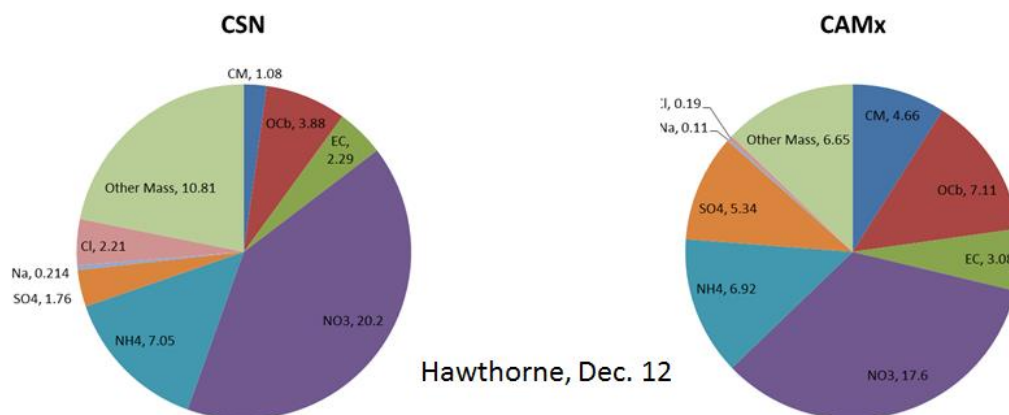


Figure 6.3.2: 24-hr speciated PM_{2.5} mass (µg/m³), December 12, 2013. Observed (left) vs. modeled (right). Hawthorne, Salt Lake County.

Speciated AQS data was available for only one day (December 12) at the onset of the multi-day peak PM_{2.5} period (December 12-16). NH₄ and NO₃ appear well simulated. As with the January, 2011 episode, the modeled crustal matter apportionment is much higher than the observed. Modeled SO₄ was roughly 3 times higher than observed (see **Fig. 6.3.2**).

Overall, the speciation for December 12 appears reasonable, but the use of the December, 2013 episode data may not be a good choice for attainment demonstration modeling. The anti-correlation between modeled and observed results during the peak PM_{2.5} shows that the December, 2013 CAMx performance is undesirable for SIP development.

February 1-16, 2016

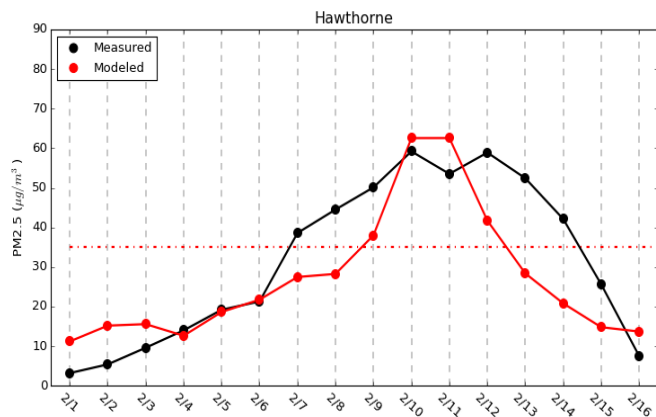


Figure 6.4.1: 24-hr PM_{2.5} concentrations during February, 2016 episode. Observed (black) vs. modeled (red) for Hawthorne, Salt Lake County.

Fig. 6.4.1 shows that CAMx was able to simulate the peak PM_{2.5} concentration levels seen in monitored observations at Hawthorne for February, 2016. At Hawthorne, modeled PM_{2.5} tapered off rapidly during the latter part of the February episode (February 12-16).

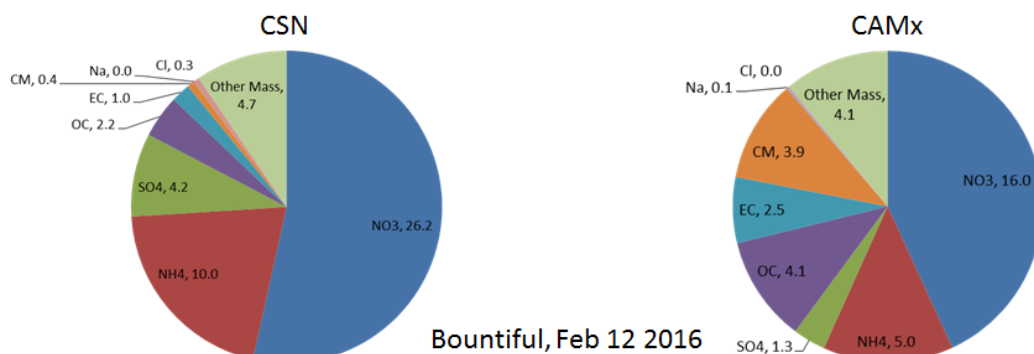


Figure 6.4.2: 24-hr speciated PM_{2.5} mass (µg/m³), February 12, 2016. Observed (top) vs. modeled (bottom). Bountiful, Davis County. Bountiful is used since Hawthorne measurements were unavailable.

It can be seen from **Fig. 6.4.2** that the February 12, NO₃ and NH₄ simulations were relatively poor compared to the other two episodes considered. Modeled organic carbon (OC) was twice as high measured and SO₄ was under-represented. The CAMx results don't quite reflect the high wintertime PM_{2.5} composition one would expect during this period.

Conclusion

Examining the PM_{2.5} model performance for all three episodes, it's clear that CAMx performed best when using the January, 2011 WRF output.

The WRF model was specifically calibrated to the meteorological conditions experienced during January, 2011; a period that coincided with the Persistent Cold Air Pool Study¹³ (PCAPS), an exhaustive field campaign focused exclusively on the Salt Lake Valley.

The scatter plots below (**Figure 6.5**) show simulated PM_{2.5} (CAMx) against the PM_{2.5}, measured at Utah's Hawthorne federal reference method (FRM) monitor. Linear regression fits are also

¹³ <http://www.pcaps.utah.edu/>

shown (dashed lines). The relatively tight dispersion in (FRM, CAMx) points along the diagonal black line ($x=y$) for January, 2011 implies that model bias is low and temporal correlation is high relative to when using WRF output for the other two episodes.

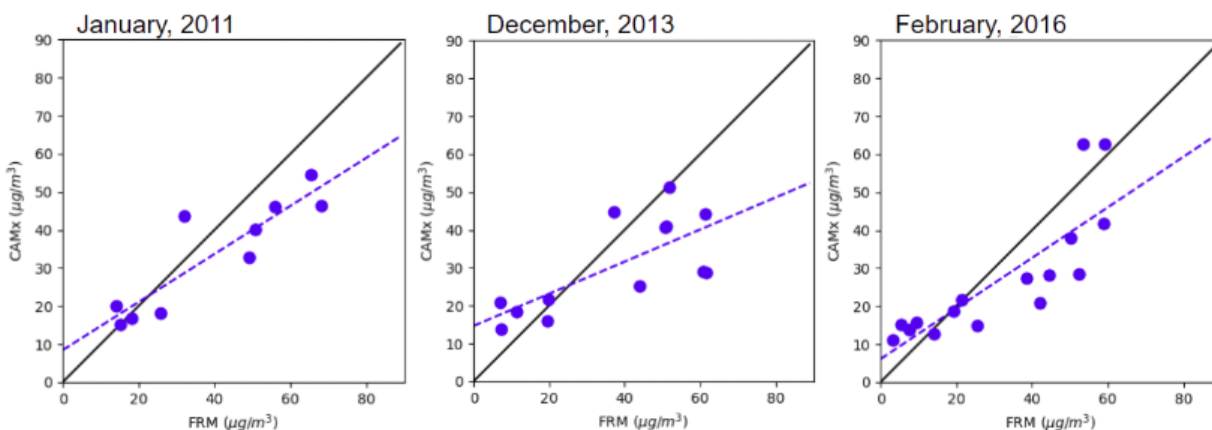


Figure 6.5: Modeled (vertical axis) versus measured (horizontal axis) 24-hour $PM_{2.5}$ for three meteorological episodes. Dots represent each individual day of the modeling episode. Linear regression fits are shown for each episode (dashed line).

The January, 2011 WRF data produced superior performance for all important metrics when compared with the other two episodes. Therefore, UDAQ selected the January, 2011 episode to conduct its modeled attainment demonstration work. A more thorough discussion is provided in the Technical Support Document.

Photochemical Model Performance Evaluation

Introduction

To assess how accurately the photochemical model predicts observed concentrations and to demonstrate that the model can reliably predict the change in pollution levels in response to changes in emissions, a model performance evaluation was conducted. This model performance evaluation also provides support for the model modifications that were implemented (ammonia injection, albedo, snow cover, ozone deposition velocity, cloud-water content and vertical diffusion modifications) to more accurately reproduce winter-time inversion episodes. A detailed explanation of these model modifications as well as a more thorough examination of the model performance is provided in the Technical Support Document.

Available ambient monitoring data was used for this photochemical model performance evaluation. Data included 24-hr total $PM_{2.5}$ and 24-hr chemically-speciated $PM_{2.5}$ measurements collected at UDAQ's Hawthorne monitoring station in the Salt Lake City non-attainment area. Ammonia measurements collected during special field studies carried out in winters of 2016 were also used for this performance evaluation. These ammonia measurements were used since measurements of ammonia were not available during 2011. The evaluation was based on the December 31 – January 10, 2011 episode, which will be used for the modeled attainment test. The 2011 emissions inventory was considered for this purpose. The evaluation was also focused on days with $PM_{2.5}$ concentration exceeding the 24-hr national ambient air quality standard ($> 35 \mu\text{g}/\text{m}^3$). December 31, which is a spin-up day, was excluded from this evaluation. A more detailed model performance evaluation that examines the model performance for ozone (O_3), nitrogen oxides ($NO_x=NO+NO_2$), carbon monoxide (CO) and volatile organic compounds

(VOCs) is provided in the Technical Support Document. More details on the model performance at various sites within the Salt Lake City non-attainment area are also included.

Daily PM_{2.5} Concentrations

Figure 6.6 shows 24-hr modeled and observed PM_{2.5} during January 1-10, 2011 at the Hawthorne monitoring station in the Salt Lake non-attainment area. Overall, the model accurately captures the temporal variation in PM_{2.5}. The gradual increase in PM_{2.5} concentration and its transition back to low levels are generally well reproduced by the model. It is noteworthy that the overestimation in PM_{2.5} on January 3 at Hawthorne is related to the meteorological model performance on this day. While thin mid-level clouds were observed on January 3-4, these clouds were not simulated in the meteorological model, leading to an increasingly stable low-level boundary layer, particularly at night (details provided in Utah's meteorological model performance final report¹⁴). This limited the mixing of pollutants on January 3 in the model, resulting in an over-prediction in PM_{2.5} levels. The underestimation in PM_{2.5} on January 5, 2011 is also related to the meteorological model performance on this day, where the meteorological model overestimated the wind shear near the mixing height, leading to increased vertical instability in the simulated temperature structure and therefore lower modeled PM_{2.5} concentrations.

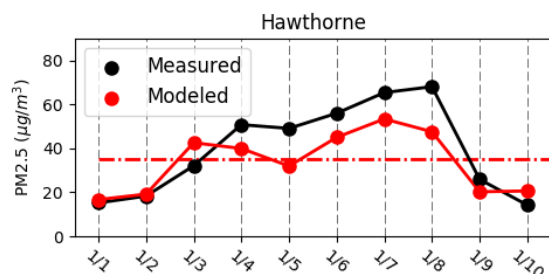


Figure 6.6: Ten-day time series of observed (black) and modeled (red) mean 24-hour PM_{2.5} concentrations (red) for January 1 - 10, 2011 (MDT) at Hawthorne, Salt Lake County. Dashed red line shows 24-hr PM_{2.5} NAAQS.

PM_{2.5} Chemical Speciation

To further investigate the model performance, UDAQ compared measured and modeled PM_{2.5} chemical species at the Hawthorne monitoring site, which is part of EPA's Chemical Speciation Network (CSN). **Figure 6.7** shows a comparison of the bulk chemical composition of measured and modeled PM_{2.5} at Hawthorne on January 7, 2011, which is the only PM_{2.5} exceedance day where measurement data is available. Chemical species, including nitrate (NO₃), sulfate (SO₄), ammonium (NH₄), organic carbon (OC), elemental carbon (EC), chloride (Cl), sodium (Na), crustal material (CM) and other species (other), were considered in this analysis.

The model performance for particulate nitrate (NO₃), which is the major PM_{2.5} component, was good, with both modeled and measured particulate nitrate accounting for similar contributions to PM_{2.5} filter mass (40 and 41% respectively) (**panels b and d**). Modeled and observed nitrate concentrations were also comparable, with modeled concentration being biased low by about 15%. The model performance for particulate sulfate was also reasonably good, with measured

¹⁴<https://documents.deq.utah.gov/air-quality/planning/technical-analysis/research/model-improvements/3-wintertime-episodes/DAQ-2017-014342.pdf>

and modeled concentrations accounting for $5.6 \mu\text{g}/\text{m}^3$ and $4.2 \mu\text{g}/\text{m}^3$ of total $\text{PM}_{2.5}$ mass, respectively (**panels a and c**), resulting in a low model bias of about 25%. Similarly to its performance for sulfate and nitrate, the model was also biased low for ammonium by about 33.5%. This low model bias in particulate ammonium can be attributed to the underestimation of ammonium chloride (NH_4Cl) in the model.

Conversely, the model performance for organic carbon was quite good for January 7, with modeled and observed concentrations being quite comparable. The model, on the other hand, overestimated EC and CM. Crustal material was likely overestimated due to an overestimation of re-suspended road dust in the emissions inventory.

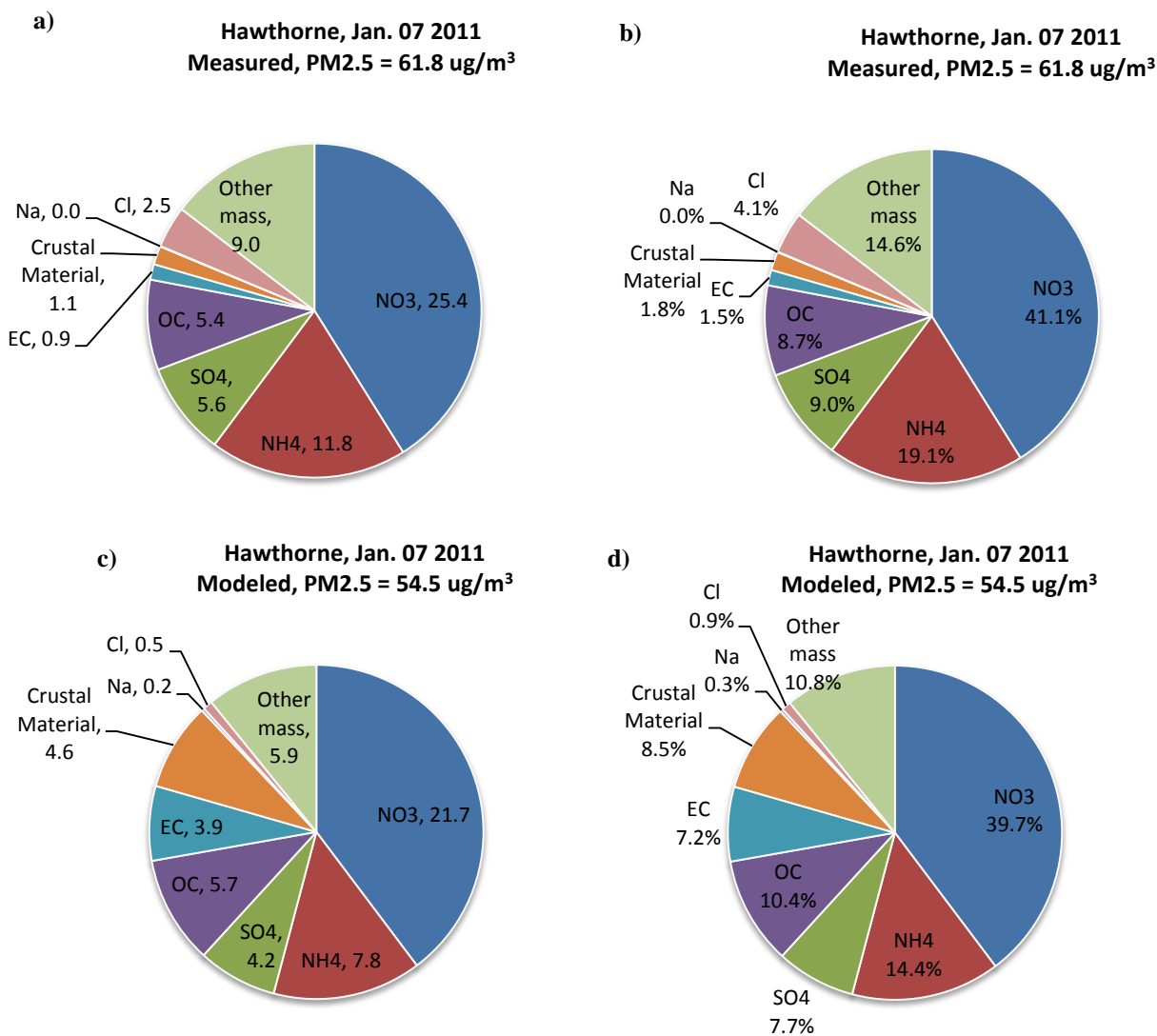


Figure 6.7, a-d: Measured (a,b) and modeled (c,d) mean 24-hour $\text{PM}_{2.5}$ species for January 7, 2011 (MDT) at Hawthorne, Salt Lake County. Panels a and c show absolute concentrations ($\mu\text{g}/\text{m}^3$) of $\text{PM}_{2.5}$ chemical species while panels b and d display their percent contributions to total $\text{PM}_{2.5}$.

The model performance was also evaluated for ammonia (NH_3), which is an important precursor to the formation of ammonium nitrate, ammonium sulfate and ammonium chloride, all of which are important $\text{PM}_{2.5}$ species accounting for over 50% of the $\text{PM}_{2.5}$ mass during inversion events.

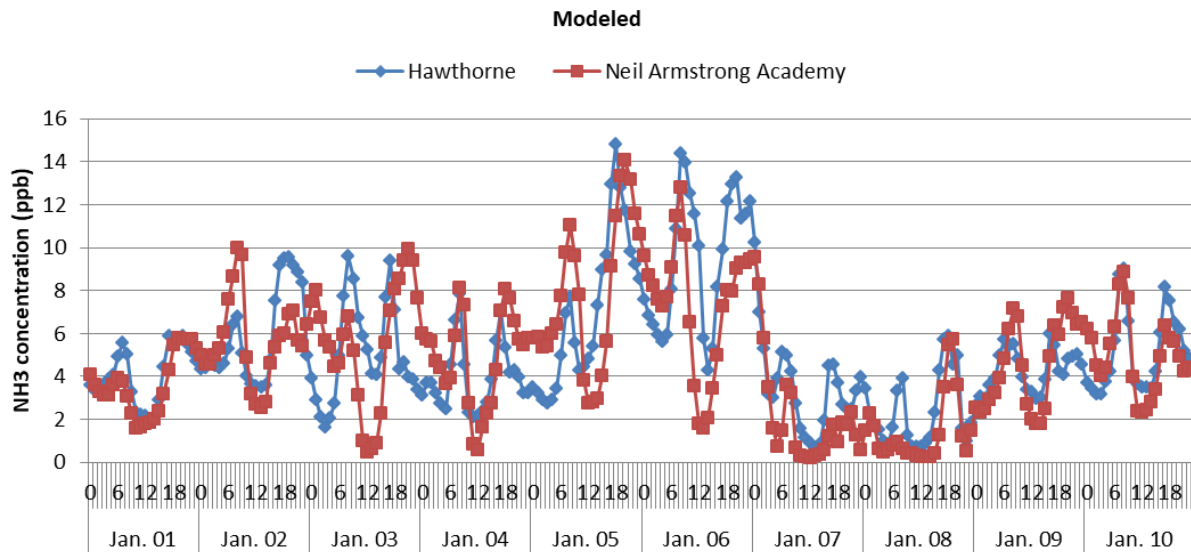


Figure 6.8: Hourly time series of modeled ammonia (ppm) for January 1 - 10, 2011 at Hawthorne, and Neil Armstrong Academy, Salt Lake County.

Modeled ammonia (**figure 6.8**) was compared to hourly ammonia measurements (**figure 6.9**) conducted at Neil Armstrong Academy during a special field study in winter 2016.

Measurements from 2016 were considered since measurements of ammonia were not available during 2011. Hourly measurements were also only available at Neil Armstrong Academy, located in West Valley City in the Salt Lake non-attainment area. However, while these 2016 field study measurements cannot be directly compared to day-specific 2011 model simulations, the measurements are qualitatively useful to assess if the model predicts similar levels of ammonia during strong inversion conditions.

A comparison of measured and modeled ammonia shows that modeled ammonia at Hawthorne and Neil Armstrong Academy is well within the range observed in 2016. It also displays a similar behavior to measured NH_3 , with NH_3 concentration dropping during peak $\text{PM}_{2.5}$ events during which the airshed is saturated and virtually all near-surface ambient ammonia has yielded to particulate ammonium.

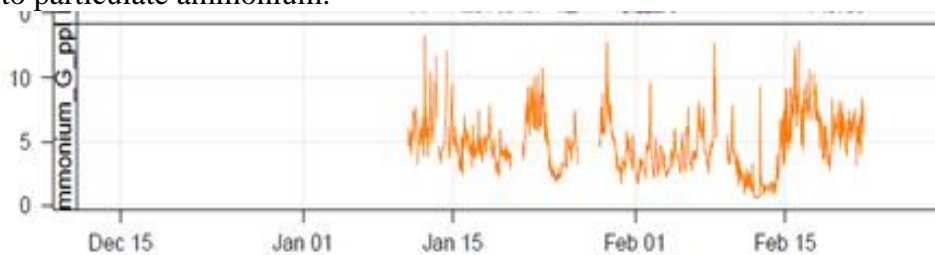


Figure 6.9: Hourly ammonia measurements from Neil Armstrong Academy (West Valley City, Salt Lake County). Note that ammonia drops during the persistent cold air pool period during Feb. 7 - 14, 2016.

Summary of Model Performance

The model performance replicating the buildup and clear out of $\text{PM}_{2.5}$ is good overall. The model captures well the temporal variation in $\text{PM}_{2.5}$. The gradual increase in $\text{PM}_{2.5}$ concentration and its

transition back to low levels are generally well reproduced by the model. The model also predicts reasonably well PM_{2.5} concentration on peak days. It also overall replicates well the composition of PM_{2.5} on exceedance days, with good model performance for secondary nitrate and ammonium which account for over 50% of PM_{2.5} mass. Simulated ammonia concentrations are also within the range of those observed, further indicating that the model overall performs well. Several observations should be noted on the implications of these model performance findings on the attainment modeling presented in the following section. First, it has been demonstrated that model performance overall is good and, thus, the model can be used for air quality planning purposes. Second, consistent with EPA guidance, the model is used in a relative sense to project future year values. EPA suggests that this approach “should reduce some of the uncertainty attendant with using absolute model predictions alone.” Furthermore, the attainment modeling is supplemented by additional information to provide a weight of evidence determination.

Modeled Attainment Test

The UDAQ used the Software for Model Attainment Test - Community Edition (SMAT-CE) v. 1.01 utility from EPA¹⁵ to perform the modeled attainment test for daily PM_{2.5}. SMAT is designed to interpolate the species fractions of the PM mass from the Speciation Trends Network (STN) monitors to the FRM monitors. It also calculates the relative response factor (RRF) for grid cells near each monitor and uses these to calculate a future year design value for these grid cells. A grid of 3-by-3 (9) cells surrounding the monitors was used as the boundary for relative response factor (RRF) calculations.

The State of Utah operates three Chemical Speciation Network (CSN) monitors: Hawthorne, Bountiful, Lindon. Hawthorne is located in Salt Lake County, while Bountiful is in Davis to the North, and Lindon is located in Utah County to the South. Of the three, Hawthorne samples one out of three days, while the other two sample only one in six days.

This mismatch in sampling frequency lead, initially, to interpolated speciation profiles that were unexpectedly non-uniform across the Salt Lake Valley. To create more realistic speciation profiles, the CSN data collected at the Hawthorne monitor were applied to all of the FRM sites in the SLC nonattainment area. UDAQ believes this is a reasonable assumption that is supported by recently conducted special studies. Further discussion may be found in the Technical Support Document.

SMAT results are shown in **Table 6.1** for all projection years as well as the base year 2016.

¹⁵ <https://www.epa.gov/scram/photochemical-modeling-tools>

Monitor ID	Monitor Name	2016 Baseline DV	2017 Milestone FDV	2019 Future DV	2020 Horizon FDV
490030003	Box Elder	31.9	31.9	30.4	29.6
490110004	Bountiful	29.7	29.6	29.3	29.2
490351001	Magna	27.9	27.7	28.0	27.6
490353006	Hawthorne	34.3	34.4	33.8	33.8
490353010	Rose Park	36.3	36.2	35.9	35.6
490570002	Ogden #2	32.4	32.3	32.2	31.9

Table 1: Design values for base year and projected years. Purple numbers highlight design values greater than the NAAQS (35 $\mu\text{g}/\text{m}^3$).

Table 6.1: Design Values for base year and projected years. Purple numbers highlight design values greater than the NAAQS (35 $\mu\text{g}/\text{m}^3$).

Air Quality as of the Attainment Date

The attainment date for this Serious $\text{PM}_{2.5}$ nonattainment area is December 31, 2019. The plan provisions for serious areas call, in Section 189(b)(1)(A), for a demonstration that the plan provides for attainment by the applicable attainment date, or if impracticable, by the most expeditious alternative applicable date practicable.

As shown in the modeled attainment test, the emissions reductions achievable in 2019 do not conclusively allow for a demonstration that the Salt Lake City, UT nonattainment area will attain the 24-hour $\text{PM}_{2.5}$ NAAQS. Although predictions at all other monitors are less than 35.5 $\mu\text{g}/\text{m}^3$, the predicted concentration at the Rose Park monitor is still above the standard.

Nevertheless, the EPA acknowledges that there is other information that may be considered when determining whether attainment may be reached by the attainment date. This is discussed in the next section.

6.2 Weight of Evidence

The requirement for a plan revision that includes assessment of attainment in Section 189(b)(1)(A) calls for a demonstration, “including air quality modeling.” Despite the heavy reliance of photochemical modeling, there is other information that may be considered when determining whether attainment may be reached by the attainment date. The PM_{2.5} Implementation Rule notes that “the modeling guidance continues to describe the opportunity for states to supplement their modeling with a “weight of evidence” demonstration. States may use other information and analyses, in addition to the modeled attainment test to estimate whether future attainment of the NAAQS in an area is likely. Other analyses may include, but are not limited to emissions trends, ambient data trends and analyses, other modeling analyses and documentation of other non-modeled emissions control strategies including voluntary programs.” The following is an assemblage of such additional evidence in support of attainment by 2019.

Uncertainties in the Analysis

The underlying reason for suggesting other evidence is necessary to assess a finding of attainment, is the inherent uncertainty in a comprehensive analysis such as this. Each subset of information fed to the air quality model is developed using the best information available and steps are taken to minimize bias and uncertainty, but still involves some degree of estimation. *Emissions inventories* make up a significant amount of this information. The approved methods of estimating emissions are continually improving, minimizing to a degree the uncertainties involved, and in some cases the information is quite good. Point sources in particular have a long history of testing results. Wherever possible, the actual stack test results or data from continuous emissions monitors is used to describe emissions. Where this is not feasible, measurements at similar sources have resulted in the development of emission factors that provide users with a good degree of confidence. This is particularly true of the criteria pollutants. Emissions from area sources, however, are far less certain. Estimation of emissions from particular categories of area sources has improved, yet the presence of such source categories within any given airshed is difficult to verify. Typically, population (or in some cases acreage) is used as a surrogate to estimate the amount of activity associated with such source categories. Naturally, this assumes a “standard” urban mix of these source categories that is applied to any given area, such as the Wasatch Front. Emissions from mobile sources are estimated through the use of models developed by EPA. EPA’s NONROAD model serves in that role to estimate emissions from mobile sources such as planes, trains, and miscellaneous non-road engines including construction equipment. Some of the information required by this model is easily verified, such as the number of take-offs and landings at each airport. However, much like any area source, the numbers of miscellaneous engines are estimated using population as a surrogate. MOVES2014a is the current model used to describe emissions from on-road mobile source emissions. These models are developed using both laboratory and in use testing, and again they make use of the most recent information available. Yet 2014a is already the 4th version of this model utilized by UDAQ in preparing its implementation plans, and before MOVES there were ten versions of the MOBILE model. Estimations of NO_x have differed significantly as one model replaced the next. Already there is some discussion that MOVES2014a may be underestimating NO_x emissions from heavy-duty diesel vehicles, and that the model may be revised again in the near future. Additionally, the development of the emission factors for ammonia has undoubtedly received far less attention than those for NO_x, VOC, and PM, itself. Another layer of uncertainty associated with the estimation of on-road

mobile source emissions originates at the transportation planning process. Agencies responsible for efficient transportation planning employ what are called travel demand models to forecast important parameters such as vehicle miles traveled, vehicle speeds on various roadway types, and the number of trips made by the driving public. These are all parameters that make use of the emission factors generated by the MOVES model.

Meteorological data is another subset of information necessary to run the air quality model. It becomes necessary in any gridded model to describe the meteorology at the boundary of every single grid cell in order to derive information about emission transport and chemical activity. Naturally it is not practical to situate a weather station at all of these locations, so the met-data that is available must be interpolated to generate the information for the spaces in between. This task is performed with a whole other layer of modeling. While this step in the air quality modeling is performed using the most advanced techniques available, there is still an inherent degree of uncertainty. It is simply not possible to ground-truth the results of the met-modeling. Furthermore, the terrain surrounding the Salt Lake City nonattainment area is very complex due to the high mountains and numerous canyon mouths that allow exchange with air from above in a diurnal pattern.

The Air Quality Modeling itself is another potential source of uncertainty. In general terms, the air quality model is approved for regulatory purposes and performs well enough in reproducing concentrations experienced in historical episodes to make its predictions in the projection years evaluated herein. Yet, it is still just a model. Any model makes assessments of physical and chemical laws within each of its grid-cells. There is no uncertainty about that. However, the atmosphere itself must be approximated and is certainly more complex than the model can describe. Air quality modeling now is far more accurate than it was in previous decades, but that only implies that there is still room to improve. This is especially the case when considering the understanding and description of photochemistry that is programmed into the model. The Salt Lake City nonattainment area has such a high proportion of secondary chemistry at the heart of its PM_{2.5} problem that any uncertainties associated with the photochemistry will certainly become more prominent than for nonattainment areas that are less complex.

Furthermore, and in a synergistic way, our advances in the understanding of the various photochemical pathways to PM_{2.5} also serve to underscore the afore-mentioned uncertainties in the emissions inventory. As certain compounds reveal their importance in these chemical reactions, it becomes clear that they may have been under-prioritized when the inventories were compiled. These inventories have historically concerned themselves with criteria pollutants such as NO_x and SO₂, and as noted they are generally accurate in their assessment of these emissions. Yet it is becoming evident that additional information will be required to support a greater understanding of secondary PM_{2.5} formation. This is discussed in the next two sections.

Missing HCl and Cl from the Emissions Inventory: Both hydrochloric acid (HCl) and aerosol chloride play an important role in PM_{2.5} formation. In the presence of excess ammonia, HCl will partition to aerosol particles, ultimately forming ammonium chloride, which has been shown to account for 10 – 15% of PM_{2.5} mass during high wintertime PM_{2.5} pollution episodes¹⁶. Aerosol chloride can also contribute to the formation of nitryl chloride (ClNO₂), a source of radicals which act to enhance the daytime photochemical production of ozone and nitrate, both of which are important contributors to PM_{2.5} formation. This formation of ClNO₂ is particularly active in

¹⁶ Kelly, K.E., R. Kotchenruther, R. Kuprov, and G.D. Silcox, Receptor model source attributions for Utah's Salt Lake City airshed and the impacts of wintertime secondary ammonium nitrate and ammonium chloride aerosol. *Journal of the Air & Waste Management Association*, 2013. 63(5): p. 575-590.

the Salt Lake Valley, as shown by recent aircraft measurements (2017 Utah Winter Fine Particulate Study (UWFPS))¹⁷. Measurements of chloride indicate that it is significantly underestimated in the model; however, the sources of HCl and aerosol chloride are unclear, suggesting that significant sources of chloride and HCl are either not included or have been underestimated in the emissions inventory. Potential sources may include the Great Salt Lake, road salt, playa dusts from dry salt beds and the US Magnesium plant. An analysis of chemical speciation data collected at the Hawthorne site over previous years showed that the monthly average sodium ion and chloride concentrations overall increase with snowfall, suggesting that road salt may be a significant contributor to particulate chloride in winter. Emissions from road salt and the Great Salt Lake are not accounted for in the emissions inventory. Measured HCl is also underestimated by the model, particularly in the vicinity of US Magnesium, where values as high as 100 ppb were observed during the 2017 UWFPS¹⁸. By contrast, CAMx expects that only 35ppm would be available to participate in the PM_{2.5} chemistry.

This apparent underestimation in chloride and HCl emissions adds uncertainty to the modeling results. By not accounting for these emissions and their impact on PM_{2.5} formation through the availability of various oxidants, the model's sensitivity to NO_x controls may be limited. The model is likely creating an oxidant-limited regime, and may therefore be less responsive to simulated NO_x controls.

UDAQ is planning a field sampling campaign during winter 2018-2019 and summer 2019 in order to improve the emissions inventory for chloride and HCl.

See the Technical Support Document for a more complete discussion of HCl and chloride.

Uncertainties in Ammonia Emissions: Ammonia is a key precursor to ammonium nitrate, the predominant (up to 60%) PM_{2.5} component during persistent wintertime inversion periods in northern Utah. While NO_x emission sources are generally well understood, there are many uncertainties surrounding the origins and distribution of ammonia emissions. This is examined in the following discussion of recent studies and current modeling progress.

2017 Utah Winter Fine Particulate Study Results: The scope of the UWFPS included all three air basins in northern Utah that are presently designated nonattainment for the 2006 24-hour PM_{2.5} NAAQS. Each of these nonattainment areas sees elevated concentrations of secondary PM as a result of cold pool meteorology. The study indicates that each of these areas is most commonly nitrate limited (2017 UWFPS Final Report¹⁹). These findings are based on measurements made both on the ground and aloft.

However, of the three basins, the Salt Lake Valley is nitrate limited to the least degree, exhibiting generally the largest ratio of total nitrate to reduced nitrogen. Measurements also show the Salt Lake Valley as having lower concentrations of ambient ammonia than the other two areas. This is illustrated in **Figure 6.11** with a comparison between Salt Lake and the Cache Valley. Concentrations in the Provo nonattainment area would likely sit between these other two.

¹⁷ <https://www.esrl.noaa.gov/csd/groups/csd7/measurements/2017uwfps/finalreport.pdf>

¹⁸ <https://www.esrl.noaa.gov/csd/groups/csd7/measurements/2017uwfps/finalreport.pdf>. Chapter 3.

¹⁹ <https://documents.deq.utah.gov/air-quality/planning/technical-analysis/research/northern-utah-airpollution/utah-winter-fine-particulate-study/DAQ-2018-004037.pdf>

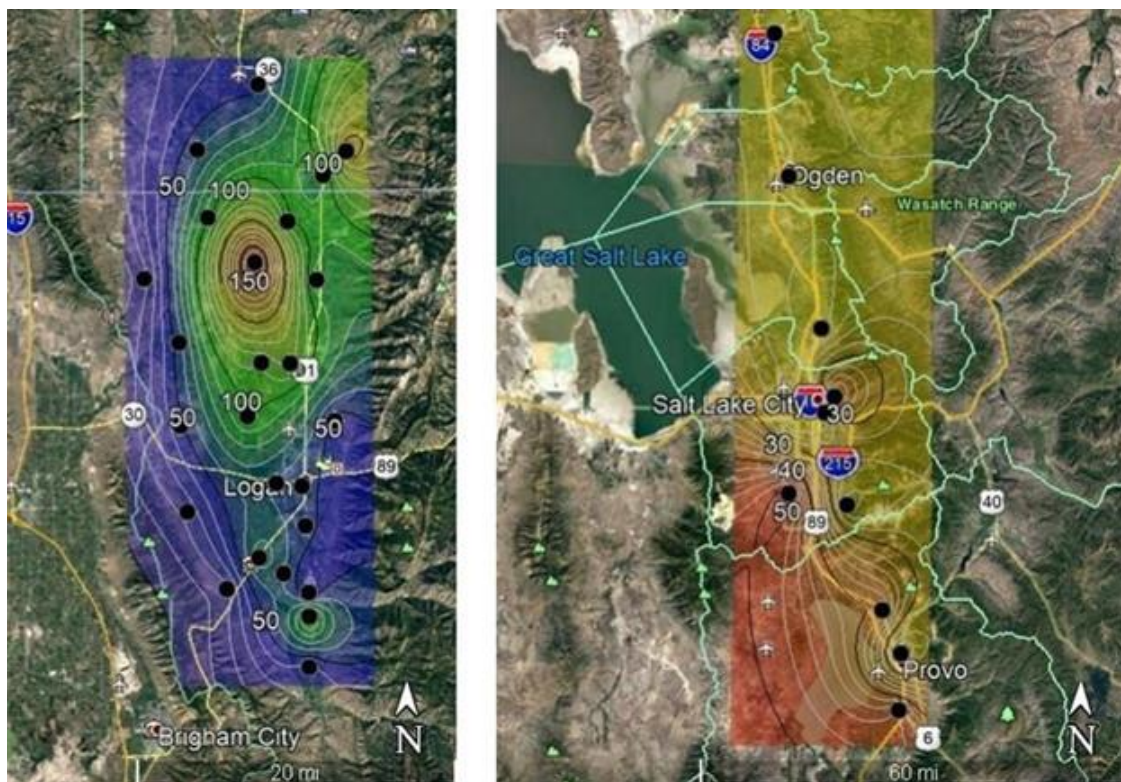


Figure 6.11: Contour plots of average ambient NH_3 concentrations [ppb] for Cache Valley and the Wasatch Front during the 2017 UWFPS. Panel comparison shows concentrations were much lower in the Salt Lake Valley (right) than Cache Valley (left). Sampler locations are depicted by black dots.

However, the emission inventory compiled for ammonia does not reflect these observed regional differences. This can be seen in **Fig. 6.12**, where ammonia emissions for all three air basins appear to be more or less within the same range.

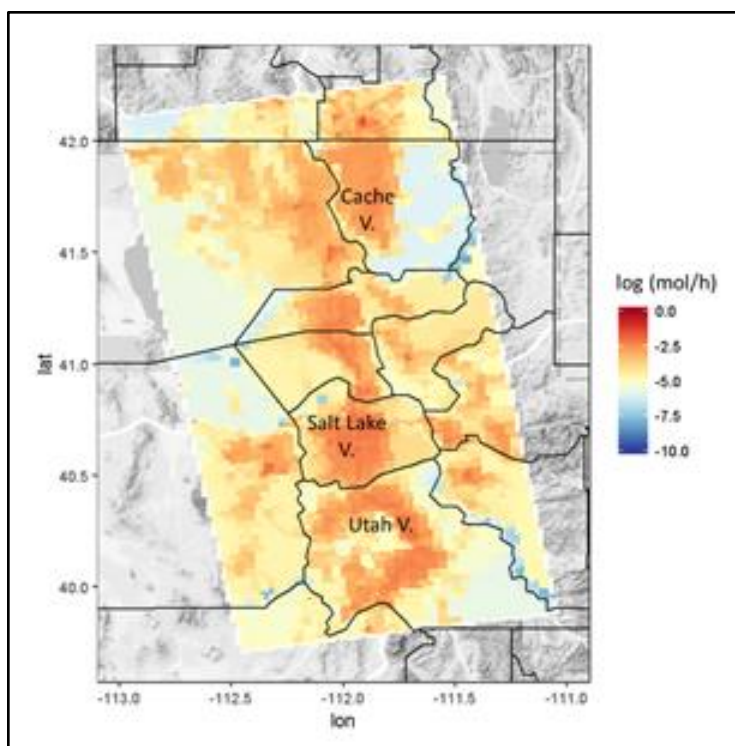


Figure 6.12: 24-hour average of 2014 NEI NH_3 emission rates (moles/hr) allocated across a 1.33 km Northern Utah modeling domain. Emission rates reflect a typical winter weekday in February. Ammonia injection is not included as to highlight the current state of the Utah ammonia emissions inventory.

Clearly, there is an inconsistency between the discernable information presented in **Figures 6.11 and 6.12**. Furthermore, using the emission inventory for ammonia depicted in **Figure 6.12**, CAMx was not able to re-create the observed concentrations of ammonium nitrate.

Ammonia injection: Recognizing that the emission inventory for ammonia was likely not very accurate, this discrepancy was addressed by adjusting the inventory until model results aligned more closely with the actual observations. This is achieved by artificially “injecting” non-inventoried ammonia emissions into the air quality model alongside the inventoried emissions. In order to match modeled ammonia with observations at controlling nonattainment monitors, UDAQ used information from 2016 ammonia measurements (Dr. Randy Martin, Utah State Univ.) to determine how much ammonia would need to be injected.

To account for the spatial differences observed through measurement, the injected ammonia is varied on a county-to-county basis. Also, ammonia is only injected in relatively low elevation areas (< 6,000 ft ASL) in order to better associate the missing ammonia with anthropogenic sources.

Ammonia deposition: Within the modeled simulation, ammonia is emitted and there is a temporal rate ascribed to the emissions. There is also however, an ascribed rate at which ammonia is removed from the system through deposition onto the ground. It is the combination of these two rates that determines the overall abundance of ammonia that would be available to participate in chemical reactions that lead to ammonium nitrate.

Early runs with the model were not able to re-create the concentrations of ammonium nitrate that were observed at the monitoring stations. It seemed this was likely due to a deposition rate that

was too high, and more specifically that the modeled resistance to such deposition was characterized as too low.

To address the high ammonia dry deposition rate in the air quality model, UDAQ modified CAMx to maximize surface resistance to ammonia and keep as much free ammonia available for chemistry as possible²⁰.

While it may be relatively simple to adjust the rates of deposition, and resistance thereto, it is important to keep in mind that the real world is far more complex than what is presently characterized in the model. The CAMx model does not currently account for the re-volatilization of ammonia. Re-volatilization occurs when some forms of nitrogen (e.g., urea) changes to an ammonia gas. Ammonia is then transported from soil and emitted to the atmosphere.

Why it matters to Utah air quality modeling: Like the 2017 Utah Fine Particulate Study (UWFPS) observations, UDAQ PM_{2.5} modeling also shows that the highest sensitivity to ammonia is in Salt Lake Valley. This is perhaps due to the abundance of NO_x emissions in the Salt Lake Valley compared to elsewhere in Utah. The Salt Lake Valley is more urban and features a relatively small animal husbandry sector compared to Cache Valley. The high abundance of NO_x emissions suggests that ammonia potentially plays a more important role in secondary PM_{2.5} formation.

In the absence of any reliable measurements of ambient ammonia, the model performance was used as an indicator of how much ammonia would be injected. In the final configuration, fully 40% of the emission inventory was artificially introduced into the SLC nonattainment area. This represents a large portion of ammonia about which nothing is really known. The spatial location of its release and its deposition are unknown. The temporal characteristics of its abundance are also poorly understood. This includes any daily or seasonal fluctuations. By contrast, NO_x, the other chief constituent of ammonium nitrate is very well characterized in both space and time. NO_x emissions from motor vehicles are spatially distributed within the model to reflect the network of roadways, and it is temporally reflective of vehicle usage by the hour of each day of the week. Point sources of NO_x are precisely located on the grid, and include parameters that affect its release such that a vertical distribution may also be assigned. Each source also reports its hours of operation such that these emissions may be assigned a temporal profile. This is the level of characterization expected in an analysis of this type, yet where ammonia is concerned we see only a static quantity of homogenous distribution.

Furthermore, it is not possible to consider any long-term trends in ammonia emissions.

Therefore, unlike any of the other precursor pollutants, the amount of injected ammonia is assumed to be identical in both base-year and future-year inventories. This has importance beyond the relatively short span of time evaluated in the analysis for this SIP.

Downward trends in NO_x emissions are well established, and as will be discussed in **section 6.9**, have been coincident with downward trends in PM_{2.5} concentrations. Since such trends in PM_{2.5} are skewed by elevated wintertime concentrations it seems likely that the SLC airshed has for a long time existed in a chemical regime that is in fact NO_x (or in past times SO₂) limited. As noted above, this is also the conclusion of the UWFPS, although by comparison to Utah's other two airsheds perhaps less so. Certainly this is not a static condition, yet because of the uncertainties surrounding the origin of ammonia emissions, model projections into the future are left to compare trends in NO_x against a static quantity of ammonia. This should lead to some

²⁰ Recent versions of CAMx released by Ramboll now maximize the surface resistance to ammonia in order to lower the ammonia dry deposition rate. However, bidirectional flux is still not emulated in the model physics at this time.

caution in accepting any prediction concerning a near-term change from what has been a NO_x limited environment to one that is limited by ammonia. This is perhaps especially so if such chemical regimes are described now with a resolution that varies by the hour of the day. The effect of holding the amount of injected ammonia constant potentially makes the model stiff and unresponsive to modeled reductions in NO_x emissions.

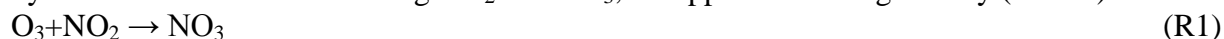
Although the 2017 UWFPS was helpful, more observational studies are needed to further our understanding of ammonia in Salt Lake Valley. The lack of reliable measurements of ammonia impairs UDAQ's ability to properly characterize ammonia in the atmosphere and thus, provides a weak basis for making improvements in Utah's ammonia emissions inventory.

To help address some of this uncertainty, UDAQ plans to take ambient measurements of gaseous ammonia and hydrochloric acid (HCl) during the winter of 2018/2019 and the summer of 2019. Passive sampling will be focused on the Wasatch Front; twenty samplers alone placed within the Salt Lake City airshed. Additional measurements of PM_{2.5} distribution and composition as well as mobile measurements of temporally-refined ammonia will also be conducted.

Missing Nitryl Chloride Chemistry Pathway in CAMx: Beyond the uncertainties in the emission inventories that support the analysis, other uncertainties within the air quality model itself also warrant some discussion. Recent measurements have shown that nitryl chloride (ClNO₂) formation, through the heterogeneous uptake of N₂O₅ onto particles containing chloride, is particularly active in the Salt Lake Valley. However, this is not accounted for in the carbon bond chemistry mechanisms within CAMx.

Halogens play an important role in PM_{2.5} formation during wintertime inversion episodes. They act as radical sources important for the photochemical production of PM_{2.5}. ClNO₂, in particular, is an important source of radicals for daytime photochemical production of ozone and nitrate, as shown by recent aircraft measurements conducted in the Salt Lake Valley (2017 UWFPS²¹).

These measurements showed that ClNO₂ is typically elevated over the Salt Lake City and Provo urban regions, reaching mixing ratios greater than 0.8 ppb at night. Similar levels of ClNO₂ were also detected in the plume of the U.S. Magnesium plant. These measurements also suggested that the chemical pathway, where ClNO₂ is formed through the heterogeneous uptake of N₂O₅ on chloride-containing particles, is particularly active in the Salt Lake Valley, where ammonium chloride aerosol generally accounts for 10 – 15% of PM_{2.5} mass during high-PM_{2.5} episodes²². This formation of ClNO₂ occurs mainly at night since the formation of N₂O₅, which is produced by a chemical reaction involving NO₂ and NO₃, is suppressed during the day (R1-R3).



Once produced ClNO₂ will then photolyze into chlorine radicals and NO_x, thereby contributing to the oxidant budget and NO_x recycling.

However, while this heterologous pathway for N₂O₅ uptake on Cl-containing particles is potentially important for PM_{2.5} formation in the Salt Lake Valley, the carbon bond chemistry mechanisms in CAMx, including cb6r2h that was used in UDAQ's simulations, do not include this pathway. Given ClNO₂'s role in contributing to the oxidants budget, an exclusion of this pathway in CAMx may increase the model's sensitivity to oxidants and may limit its sensitivity

²¹ <https://www.esrl.noaa.gov/csd/groups/csd7/measurements/2017uwfps/finalreport.pdf>

²² Kelly, K.E., R. Kotchenruther, R. Kuprov, and G.D. Silcox, Receptor model source attributions for Utah's Salt Lake City airshed and the impacts of wintertime secondary ammonium nitrate and ammonium chloride aerosol. *Journal of the Air & Waste Management Association*, 2013. 63(5): p. 575-590.

to NO_x emissions. Without this pathway, the model may be less responsive to proposed NO_x controls.

Misrepresentation of Formaldehyde in the Model: The model's sensitivity to changes in NO_x emissions may be obscured by an under-estimation of formaldehyde during mid-day hours. Carbonyls, such as formaldehyde, act as radical sources which are important for the photochemical production of PM_{2.5} during wintertime inversion episodes in the Salt Lake Valley. The photolysis of these compounds may be important for daytime generation of radicals, as shown by recent observations^{23,24}. However, although formaldehyde is important for PM_{2.5} formation, it may be underrepresented in the model during mid-day hours. Given that measurements of VOC species were not available during 2011, the modeling results were compared to observations conducted in winter 2017 at the University of Utah (2017 UWFPS). While these field study measurements from 2017 cannot be directly compared to day-specific 2011 model simulations, they're qualitatively useful to assess if the model predicts similar levels of VOCs during strong inversion conditions.

On average during peak PM_{2.5} exceedance days, measured formaldehyde peaked at about 3 ppb around 11 am (Figure 6.11) while modeled formaldehyde displayed a concentration of 1.8 ppb (figure 6.10) at 11 am. Modeled formaldehyde also displayed a temporal trend different from that of measured formaldehyde, with observations indicating direct emission as well as secondary production of formaldehyde. Similarly, modeled acetaldehyde exhibited a temporal trend different from that measured on peak PM_{2.5} days. This comparison suggests that acetaldehyde and formaldehyde, an important source of radicals, may be underestimated in the model during mid-day hours. Given the role of formaldehyde in the generation of radicals, an underestimation of formaldehyde in CAMx may increase the model's sensitivity to oxidants.

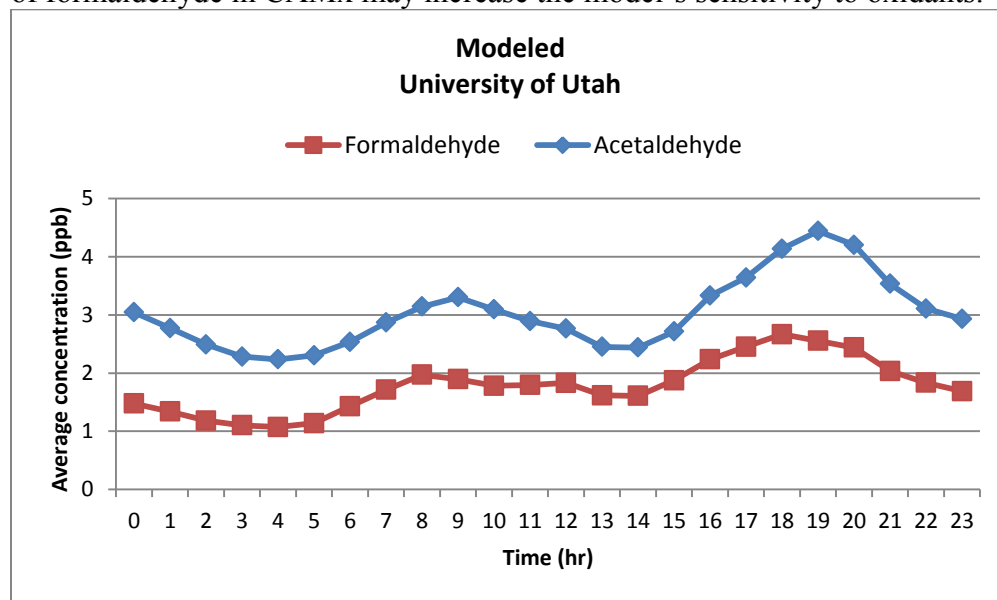


Figure 6.10: Hourly time series of average modeled formaldehyde and acetaldehyde during January 6-8 2011 at the University of Utah.

²³ Baasandorj, M., S.W. Hoch, R. Bares, J.C. Lin, S.S. Brown, D.B. Millet, R. Martin, K. Kelly, K.J. Zarzana, C.D. Whiteman, W.P. Dube, G. Tonnesen, I.C. Jaramillo, and J. Sohl, Coupling between Chemical and Meteorological Processes under Persistent Cold-Air Pool Conditions: Evolution of Wintertime PM_{2.5} Pollution Events and N₂O₅ Observations in Utah's Salt Lake Valley. *Environmental Science & Technology*, 2017. 51(11): p. 5941- 5950

²⁴ <https://www.esrl.noaa.gov/csd/groups/csd7/measurements/2017uwfps/finalreport.pdf>. Chapter 3.

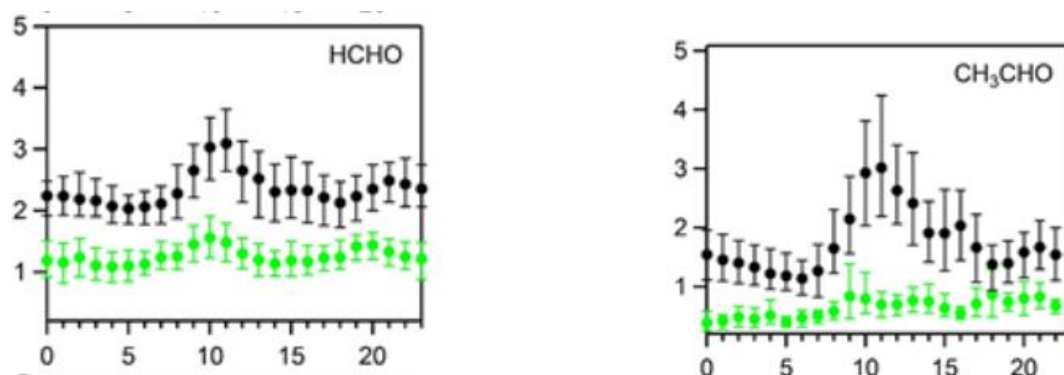


Figure 6.11: Diurnal trend of hourly averaged formaldehyde (HCHO) and acetaldehyde (CH₃CHO) measured at the University of Utah during polluted (black lines) and clean (green lines) conditions in winter 2017. Figure retrieved from the 2017 Utah Winter Fine Particulate Study, final report, Figure 3.59

(<https://www.esrl.noaa.gov/csd/groups/csd7/measurements/2017uwfps/finalreport.pdf>).

The model's sensitivity to formaldehyde emissions was further evaluated by conducting a modeling sensitivity run where formaldehyde emissions from all sectors were increased by 50%. Formaldehyde emissions from the 2019 inventory were considered for this sensitivity simulation. Both modeled ozone and nitrate (Figure 6.12) increased after increasing formaldehyde emissions, suggesting that the model is oxidant-limited and may have a limited sensitivity to a reduction in NO_x emissions. An underestimation of formaldehyde will lead to an underestimation in the production of HNO₃, leading to a reduced response to proposed NO_x controls.

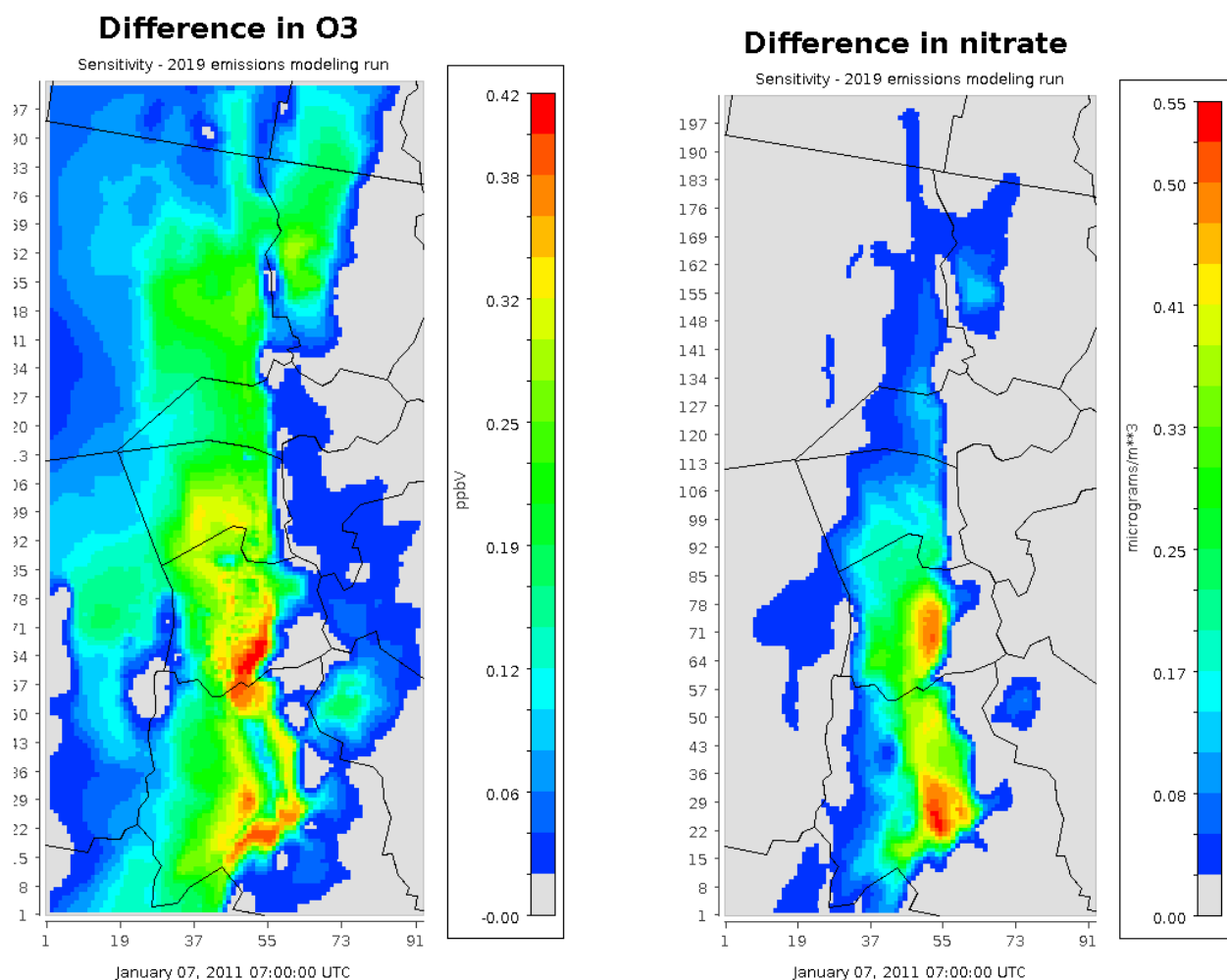


Figure 6.12: Spatial plots of the difference in mean ozone and nitrate levels between the sensitivity modeling run, where formaldehyde 2019 emissions were increased by 50%, and the 2019 emissions modeling run, where formaldehyde emissions were kept unchanged. Plots are shown for January 7 2011.

Trends in Monitored Data

Certainly the most significant information to assess would be the ambient air quality data collected throughout the nonattainment area, and in particular, any observable trends in the data. The Salt Lake City nonattainment area is designated such only for the 24-hour health standard, so it should be simple to focus on the 24-hour $PM_{2.5}$ values. This, however, is somewhat confounding because of the nature of the problem. As described in Section 1.3, concentrations in excess of the 24-hour NAAQS are only incurred during winter months when cold-pool conditions drive the formation of and trap secondary $PM_{2.5}$. The actual cold-pool temperature inversions vary in strength and duration from year to year, and the $PM_{2.5}$ concentrations measured during those times reflect this variability far more than they reflect gradual changes in the emissions of $PM_{2.5}$ and $PM_{2.5}$ precursors. This variability may easily be seen in **Figure 6.14** below. Still, if one fits a line through the data collected at the Hawthorne site, the NCORE site for the SLC metropolitan statistical area, the trend is noticeably downward and indicates an improvement of about one microgram per cubic meter, per year.

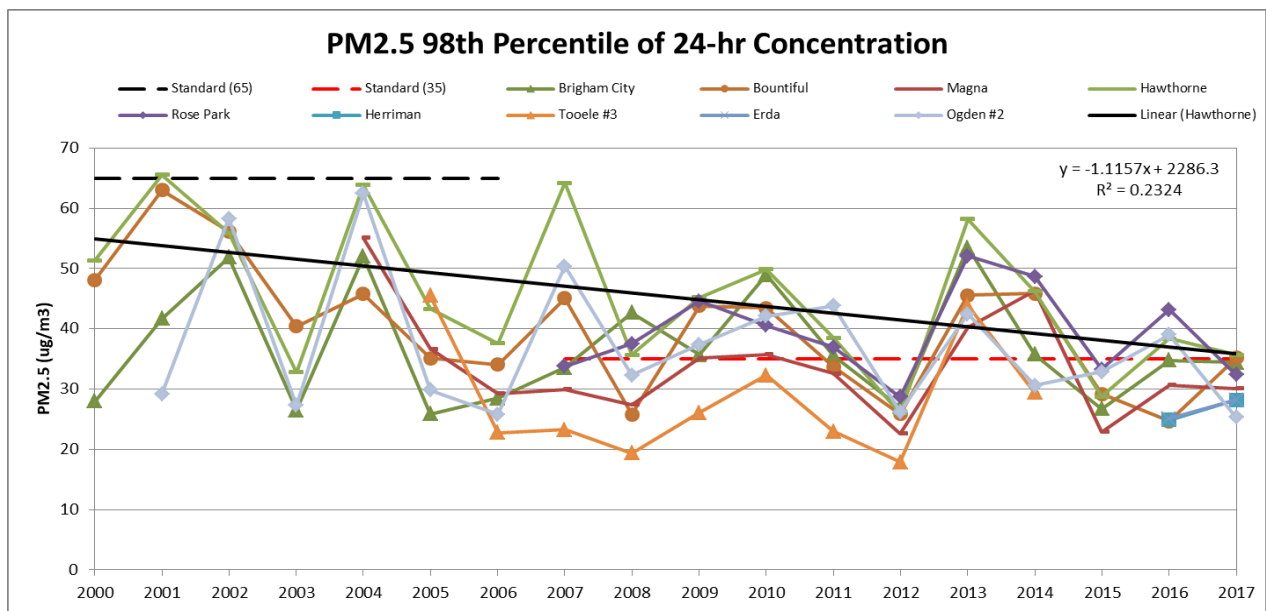


Fig. 6.14 Trend in Monitored PM_{2.5} (98th Percentiles of 24-hour Concentrations)

This episodic variability is generally removed by looking at annual mean values of PM_{2.5} concentrations as shown in **Fig 6.15**. This data is still skewed more by winter data than summer data. It includes all of the high values identified as the 98th percentiles, as well as the values ranked even higher. Still the trend is downward. Fitting a line through the data collected at the Hawthorne site reveals a trend that is noticeably downward, and indicates an improvement of about 4.5 micrograms per cubic meter, over the 17-year span. Such improvement is noteworthy in the face of this area's rapid growth in both population and vehicle miles traveled (vmt).

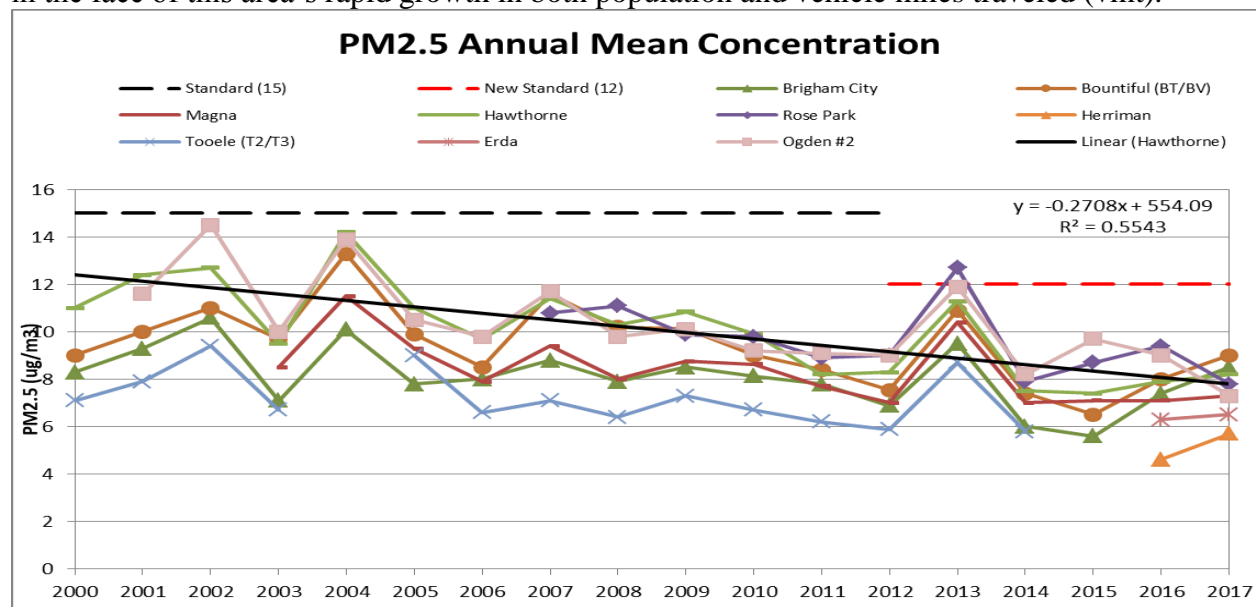


Fig. 6.15 Trend in Monitored PM_{2.5} (Annual Mean Concentrations)

UDAQ also monitors two of the four PM_{2.5} precursors, NO_x and SO₂, and it is also useful to observe the trends in their concentrations.

Figures 6.16 and 6.17 chart trends in nitrogen dioxide, from which NO_x concentrations may be inferred. Whether measured as peak concentrations or long-term averages, the trend has remained steadily downward for a long time.

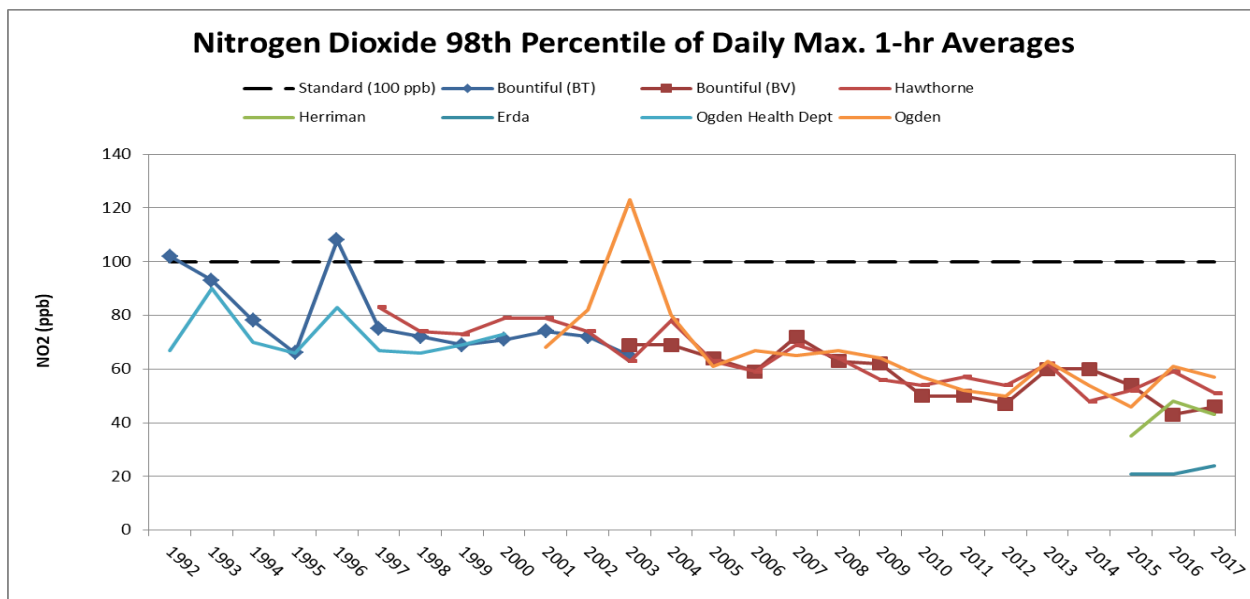


Fig. 6.16 Trend in Monitored NO₂ (98th Percentiles of Daily 1-hour Max.)

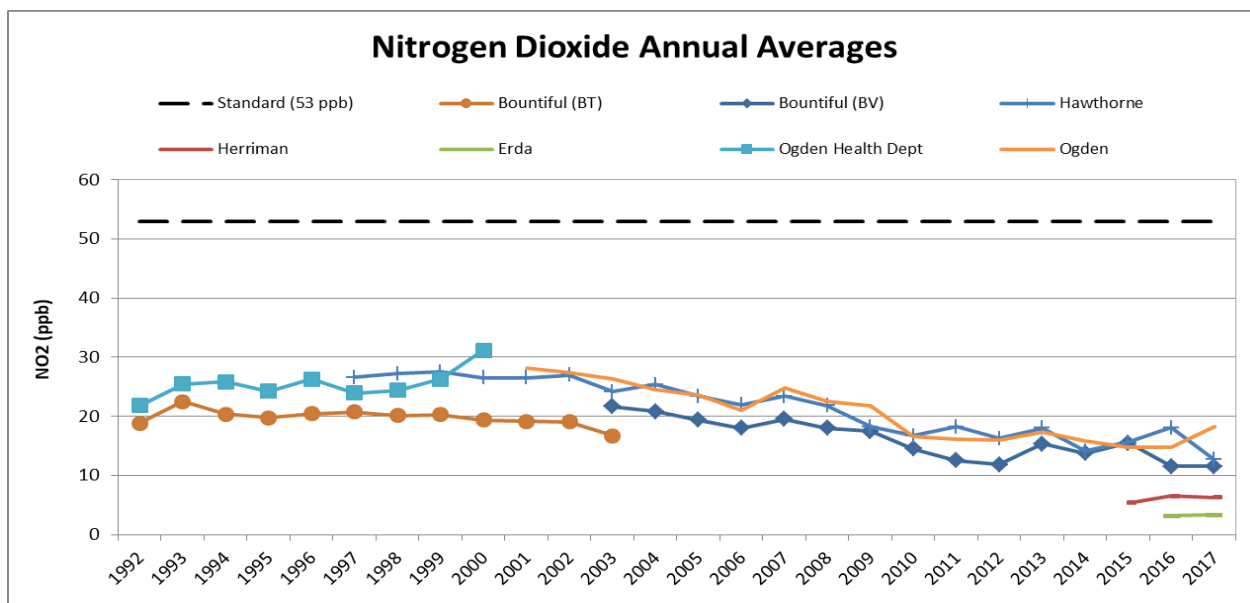


Fig. 6.17 Trend in Monitored NO₂ (Annual Averages)

Sulfur dioxide has also diminished over time, from a sharp decline in the 1990s to a steady degree of progress over the last 20 years. This is shown in **Fig. 6.18**.

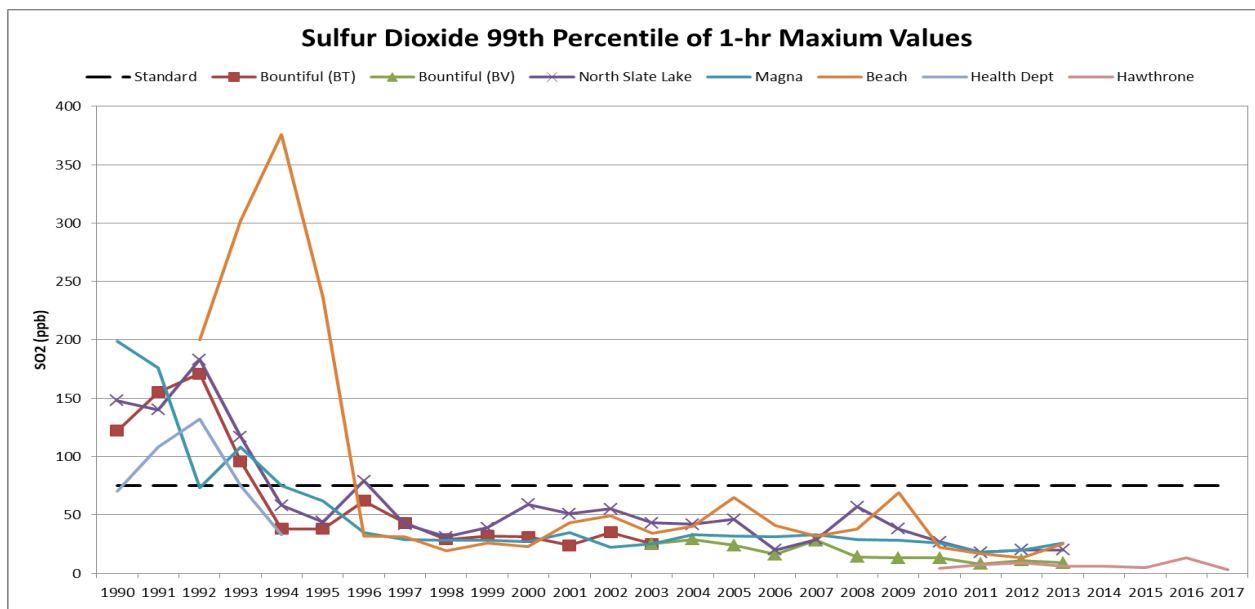


Fig. 6.18 Trend in Monitored SO₂ (99th Percentiles of Daily 1-hour Max)

Trends in Emissions

Another way to evaluate trends in air quality is to compare inventories of emissions on a periodic basis. For purposes of this SIP, UDAQ has developed a suite of emissions inventories for several years between 2011 and 2024. These inventories are based on the 2014 tri-annual emissions inventory and are tailored to suit wintertime conditions pertinent to this SIP. Specifically, these emissions inventories reflect winter weekday emissions for all five Salt Lake nonattainment area counties and include parts of the counties that are outside the nonattainment boundary. For this reason, the values shown here may not match nonattainment area emissions summaries shown elsewhere in this document. Still, these emission inventories provide a useful tool for comparing emissions trends over time.

Figure 6.19 below charts the emissions of NO_x, VOC, PM_{2.5} and SO₂ throughout the period of time represented in some way by this Serious Area SIP.

Because wintertime emissions inventories are unavailable prior to 2011, it is useful to consider the tri-annual emissions inventories routinely compiled by UDAQ to evaluate longer-term emissions trends.

Annual emissions trends from the 1999-2014 tri-annual inventories for the five Salt Lake nonattainment area counties are shown in **Figure 6.20** below.

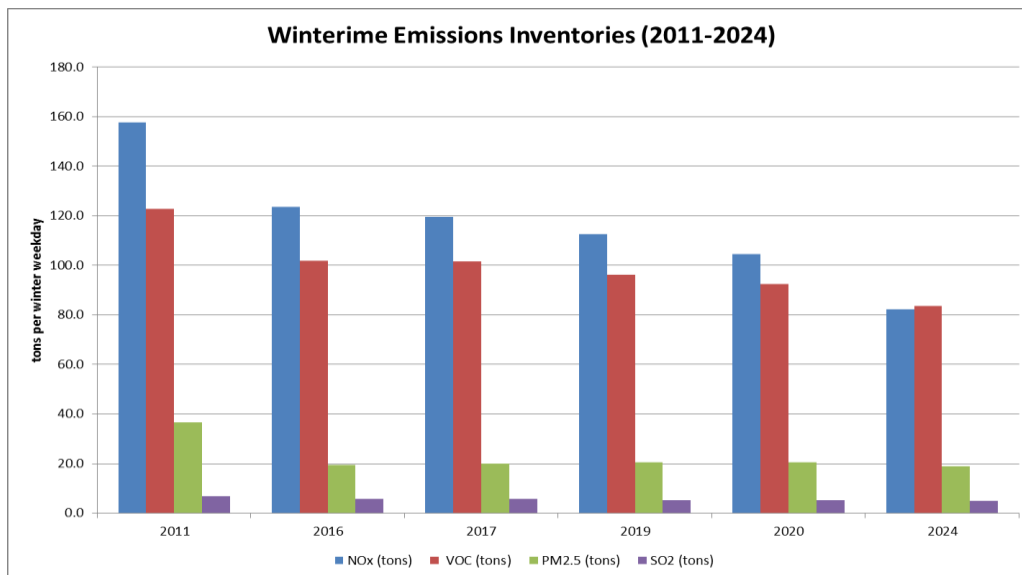


Fig. 6.19 Emissions Trends (2011 – 2024)

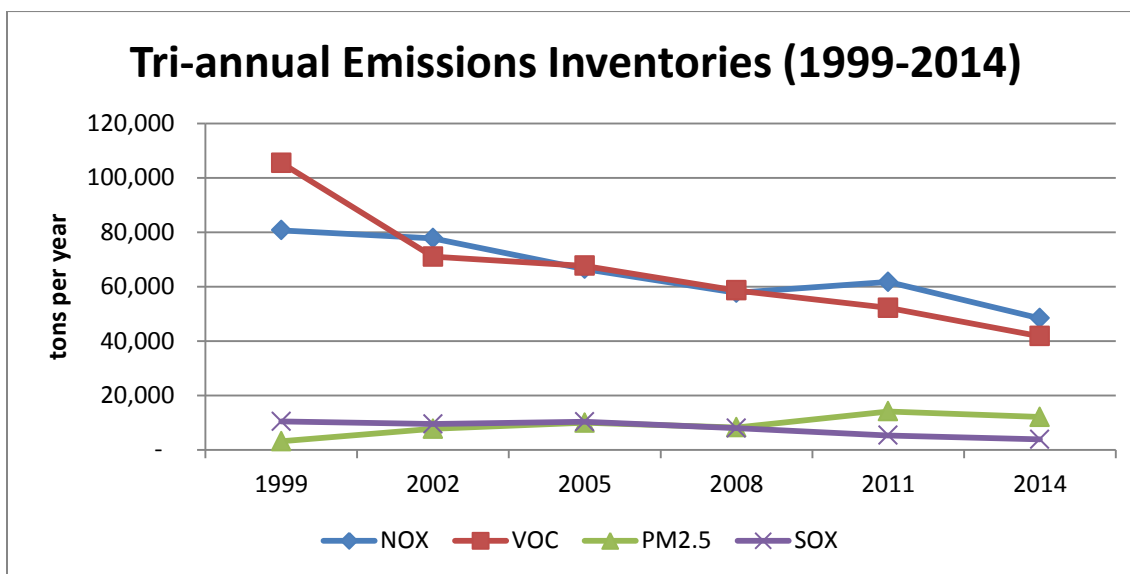


Fig. 6.20 Emissions Trends (1999 – 2014)

Seen together, **Figs. 6.19 and 6.20** illustrate trends in $PM_{2.5}$ and $PM_{2.5}$ precursor emissions that reach back almost as far as the establishment of $PM_{2.5}$ as the indicator of fine particulate matter. Qualitatively, it is easy to see that NO_x and VOCs are emitted in much larger quantities than are $PM_{2.5}$ or SO_2 . Also, the trend in each of these $PM_{2.5}$ precursors has been steadily downward for roughly the last 20 years. This is largely attributable to Tiers 1 and 2 of the federal motor vehicle control program, but there are other drivers.

Looking back at the trend charts showing ambient NO_x concentrations (**Figs. 6.16 and 6.17**), one finds good agreement between the diminishing emissions and the ambient NO_x .

UDAQ does not monitor ambient concentrations of VOC, but one would assume that the reductions in VOC emissions would be detected as a continuous trend over this same period.

Where SO₂ is considered, it is again useful to refer back to **Fig. 6.18** where the ambient concentrations are charted. Here one may observe that by 1999 the airshed had seen an end to what had been a history of NAAQS violations due to very large emissions of SO₂ at a local copper mine. This decline in ambient concentrations was driven first by a SIP addressing SO₂ itself in 1982, and then by a focus on SO₂ control in a 1992 PM₁₀ SIP that required SO₂ reductions at not only the copper smelter, but also five oil refineries and a steel mill. From 1999 forward, SO₂ emissions and SO₂ concentrations have remained relatively flat, perhaps trending slightly downward, but at levels that might be described as “background”.

PM_{2.5} emissions have also remained somewhat constant over this period, perhaps even trending upward. It is instructive, therefore, to refer back to **Figs. 6.14 and 6.15** showing the monitored trends in ambient PM_{2.5} concentrations.

Both of these charts show that PM_{2.5} concentrations have been declining over the same span of time depicted in the emissions trends charts.

Taken together, this would suggest that the persistent decline in NO_x and VOC emissions is most directly responsible for the commensurate improvement in PM_{2.5} concentrations, particularly with respect to the secondary PM_{2.5} that dominates the highest exceedances.

Throughout any calendar year, PM_{2.5} concentrations in Northern Utah exhibit a background level well beneath the annual standard, marked by episodes of very high concentrations predominantly in the months of December through February which are dominated by secondary PM_{2.5} (as shown in **Figure 6.2.2**). Since the early 1990s, Utah has addressed these “spikes” in fine particulate by focusing emission control on precursor emissions (SO₂, and NO_x), and maintained that by reducing the magnitude of such exceedances that the annual standard (which has never been violated) would be kept in check. This seems to have been supported by the data concerning both emissions and concentrations.

Over this same period of time, it has always been assumed that the Salt Lake City airshed was NO_x (or even SO₂) limited with respect to the atmospheric chemistry that supports formation of secondary PM during periods of cold pool meteorology.

Looking forward at the emissions projected in **Fig. 6.19**, one will see a continuation of the trends of NO_x and VOC emissions, from the present out to 2024. Again, this reflects the continued implementation of Tier 2 standards and now the introduction of Tier 3.

Given the apparent co-benefit of ambient PM_{2.5} improvement between 2000 and 2017, one would expect this co-benefit to continue between now and 2024.

Additionally, direct PM_{2.5} emissions are projected to decrease from 20.5 tons per winter weekday in 2019 to 19.0 tons per winter weekday in 2024, and SO₂ emissions are projected to decrease from 5.2 tons per winter weekday to 4.9 tons over the same span.

Supplemental Analyses

Additional Modeling Result / Exceptional Event

As discussed in Chapter 3, data captured during the years important to the SIP was initially found to be invalid for a number of reasons, including some values identified by UDAQ is perhaps being influenced by exceptional events (EEs). EPA’s Exceptional Events Rule allows for data that has been heavily influenced by wild land fires, fireworks, etc. to be excluded from the data set in its use for regulatory purposes. The rule requires that states first identify such incidences by affixing a flag to the data it submits, and then submit supporting documentation for EPA to consider. If EPA concurs with the state, it will affix a second flag to the value.

As mentioned already in the discussion surrounding **Tables 3.1 & 3.2**, UDAQ has flagged several values in 2017 that have yet to be concurred with, but with agreement from EPA, excluded these values from the Monitored Design Value (MDV) calculations.

There is, however, another value in 2015 that may warrant additional scrutiny. August 20, 2015 was a day influenced by wildland fire. In fact, UDAQ flagged and documented a number of values affected by that event at other monitoring stations (Logan, Brigham City and Ogden). Although smoke from wildfires filled all of Northern Utah, only these three monitors recorded exceedances of the NAAQS. UDAQ; however, UDAQ believes that all monitors in Northern Utah were impacted by smoke.

Even though monitored values at Rose Park were impacted by the smoke event, UDAQ did not flag the value collected at Rose Park because those values did not exceed the standard. This value presently sits as the 8th highest value collected at Rose Park during 2015, and is identified as the 98th percentile value for that year. The reason this value was not flagged is because, at 33.3 µg/m³, it did not exceed the 24-hr NAAQS; perhaps an oversight on the part of UDAQ.

Nevertheless, if this value were to be documented as an exceptional event, the 98th percentile value for Rose Park would become the next highest value which was measured as 31.2 µg/m³, a difference of 2.1 µg/m³. Furthermore, when averaged with the 98th percentile values for 2016 and 2017, the 3-year Monitored Design Value (MDV) for Rose Park would drop from 36.3 to 35.6 µg/m³.

Taking the next step and applying the Relative Response Factor (RRF), calculated for 2019 by the CAMx model, to the reduced MDV, would yield a lower prediction for the future concentration in 2019. This is shown in **Table 6.2**.

Rose Park Monitor	98th Percentile Values (µg/m ³)			2016 Baseline DV	2019 Future DV
	2015	2016	2017		
As presented in Table 6.1	33.3	43.2	32.4	36.3	35.9
Excluding data from 8/20/15	31.2	43.2	32.4	35.6	35.2

Table 6.2 Air Quality Modeling Results; as affected, or not, with the inclusion of data potentially qualifying as an Exceptional Event

The predicted concentration at Rose Park for 2019, the attainment year, was just over the NAAQS at 35.9 µg/m³ (**see Table 6.1**). This of course was the controlling monitor within the nonattainment area, and accounted for the only value in the analysis that was over the 24-hour standard.

Using the new MDV, with the value for August 20, 2015 excluded as an EE, would change the prediction for 2019 to 35.2 µg/m³ and change the conclusion of the modeling result to a likelihood of attainment by 2019 (35.5 rounds up to 36... numbers below 35.5 round to 35).

How likely is it then, that this value could actually be excluded as an EE? It's true that 33.3 does not exceed the 24-hour standard (35 µg/m³), and for only this reason did UDAQ not include the value for Rose Park in the documentation compiled for that event, yet it is greater than the annual NAAQS.

EPA has acknowledged that even if a value does not exceed the standard for a 24-hr averaging period, it may still affect a determination of compliance with the 24-hr standard. This is certainly true of the PM_{2.5} standard, where the form of the standard requires the averaging of

three distinct 24-hr values. In such cases, EPA indicates that the level of a longer averaging period, in this case the annual standard, can serve as the cut-point for whether the rule may be used to determine that the value was influenced by an exceptional event. In fact, this interpretation was codified into the EE rule, but not until 2016, after the event in 2015.

Whether in fact this value receives additional attention in the data set, it remains pertinent to a discussion surrounding a weight of evidence to be considered in the assessment of whether attainment of the PM_{2.5} standard can likely be reached by the attainment date in 2019.

Overstated Conservatism in Projected Emissions:

We have mentioned some of the uncertainties inherent in the modeled demonstration of attainment already. However, there is another aspect of the analysis that bears some mention, and that is the conservatism that is also built into such a demonstration.

The SIP is a legal document, with consequences to be enforced in the event certain conditions are not met. For this reason a certain amount of conservatism is built into the estimates used to construct the attainment demonstration, its quantitative foundation.

Thus, the discussion herein is not to suggest that such conservatism is misplaced. Rather it is to help, in the context of evaluating a weight of evidence, where perhaps one might give more or less weight.

The aforementioned conservatism might be broken into two distinct categories: 1) overstating the emissions to be expected throughout the projection years, and 2) omission of some controls that are expected to help mitigate PM_{2.5} concentrations, but which may not be suited to the assignment of SIP credit. Examples of each are presented below.

Emissions from Point Sources – are depicted differently in the base-year inventory than they are in the projection-years. Actual emissions are used in the base-year, whereas the SIP takes more of a worst-case view of these emissions in the projection years and uses in some cases the legal potentials to emit. While this makes legal sense, it tends to overstate a somewhat artificial “growth” in emissions from this sector.

Actually, most point sources included in this analysis were already operating in the base year at or near their potentials to emit. Therefore, emissions from these sources remained essentially flat throughout the analysis period.

Emission totals for the point source category did in fact exhibit some growth between 2016 and 2019. PM_{2.5}, NO_x, and VOC emissions increased by 20, 14, and 13 percent. Virtually all of this increase is shown to be associated with three sources that were not operating near their respective PTEs in 2016, Hill Air Force Base, Proctor & Gamble, and Kennecott. The inventories are detailed in the technical support document.

On-Road Mobile Source Emissions – like point sources, are legally bound to remain within the emission totals that are included in the SIP. This leads to some conservatism in the establishment of the projected emissions. Actual data is available to calculate emissions in the base-year, whereas projections are made using a travel demand model to estimate what emissions will likely be in the future. Transportation planning considers time horizons well beyond those used for air quality planning, and many assumptions are made when projecting transportation tendencies well into the future.

Again this makes legal sense, but tends to overstate a somewhat artificial “growth” in emissions from this sector.

In addition to the assumptions inherent in a travel demand model, there is another factor at play concerning mobile source emissions in the Salt Lake Valley. Tier 3 of the federal motor vehicle control program becomes effective in 2017, and it requires refiners of gasoline to limit the sulfur content of the fuel in order to achieve better overall performance in catalytic converters. The default value for sulfur in fuel beginning in 2017 is 10 ppm. The limit under Tier 2 had been 30 ppm. All of the refiners in the Salt Lake Valley are small (< 75,000 barrels per day) and have until 2020 to comply with the Tier 3 sulfur limit. Furthermore, corporate producers may average their compliance over the aggregation of their individual refineries. This means there is no legal guarantee that the Salt Lake Valley will see the Tier 3 fuel slated for 2017, even by 2020. For this reason, mobile source emissions in the analysis underlying the attainment demonstration were assumed to remain at 30 ppm. This is a conservative approach that feeds the air quality model more emissions in 2019, the attainment year.

UDAQ used the model to assess what affect some of this conservatism may be having on the determination of attainment.

No adjustments were made to the point source emissions, but for 2019, on-road mobile sources were adjusted by first assuming a 5% reduction to vehicle-miles-traveled (VMT) throughout the nonattainment area. Secondly, the fuel sulfur parameter was changed in MOVES from 30 ppm to 10 ppm.

Table 6.3 lists the reduction percentages in on-road mobile emissions using the modifications in VMT and fuel sulfur content.

On-road Mobile Emissions Reduction in the Salt Lake Nonattainment Area				
PM _{2.5}	NO _x	VOC	NH ₃	SO ₂
4%	12%	4%	5%	60%

Table 6.3: Percentage of 2019 on-road mobile inventory reduced in Salt Lake nonattainment area by lowering VMT by 5% and reducing fuel sulfur loading to 10 ppm. Reductions are with respect to on-road mobile sector only.

UDAQ re-ran the SMAT-CE v1.01 tool to develop another set of future design values, which could be compared to the existing set for 2019. **Table 6.4**, below, shows this comparison. At both the Rose Park and Hawthorne monitors, these adjustments to the on-road mobile source inventory effectively decreased the predicted future design value by 0.2 µg/m³. While notable, a decrease of this magnitude would not change the conclusion of the modeled attainment test. However, it does serve to illustrate that the result presented in the attainment test is likely conservative by at least this amount.

In addition, this exercise serves to underscore the insensitivity of the air quality model to what might be considered significant reductions in NO_x emissions throughout the Salt Lake City nonattainment area.

Monitor Name	Monitor ID	County	Baseline DV	Future DV (2019 baseline)	Future DV (5pVMT_10ppm)
Brigham City	490030003	Box Elder	31.9	29.4	28.4
Bountiful	490110004	Davis	29.3	29.3	29.2
Magna	490351001	Salt Lake	27.8	28	27.7
Hawthorne	490353006	Salt Lake	34.3	34.4	34.2
Rose Park	490353010	Salt Lake	36.7	36.5	36.3
Ogden #2	490570002	Weber	32.1	31.7	31.4

Table 6.4: Comparison of future design values using two different 2019 on-road mobile emissions inventories: baseline (Column 5), reduced VMT and fuel sulfur content (Column 6).

Note that the future design values presented in the column labeled (2019 baseline) do not exactly agree with those presented in section 6 as the modeled attainment test. Additional refinements were made to the entire analysis between the time this exercise was completed and the final modeling runs. Nevertheless, one would not expect these refinements to change the 0.2 µg/m³ result of the exercise.

Controls Unaccounted for in the SIP:

Another example of conservatism in the analysis would be the omission of certain control measures that would be expected to improve air quality. Again, these controls were not made part of the quantitative attainment demonstration because they are not suited to the assignment of SIP credit. Still, they are expected to mitigate PM_{2.5} concentrations. Examples include:

VW Settlement Monies

Utah is a beneficiary of over \$35 million of the Volkswagen Diesel Emissions Environmental Mitigation Trust as a result of over 7,000 of the non-compliant VW cars operating in Utah. Utah has allocated \$25.7 million of this funding specifically for heavy-duty diesel vehicle replacements. The goal for the settlement money is to fully mitigate the excess lifetime NO_x from the non-compliant vehicles that operated in Utah. PM_{2.5} and VOC reductions will occur as well by removing old diesel vehicles from operation.

It is estimated that the non-compliant cars in Utah emitted between 351-1,556 tons of excess NO_x. Depending on VW project applications and selection, Utah has the opportunity to reduce between 351-1,556 tons of NO_x, between 26-115 tons of PM_{2.5}, and between 35-156 tons of VOCs. Utah expects to accomplish these reductions in calendar years 2019-2024. The projects will be focused in Utah's nonattainment areas, with greater weight applied to areas of the state that bear a disproportionate amount of the air pollution burden.

Utah has an additional \$1.4 million in funding for projects such as lawnmower and snowblower exchanges, where gas-powered equipment is exchanged for electric equipment at a reduced cost.

Targeted Airshed Grant Money

The EPA has awarded the State over \$9.5 million to reduce pollution from woodstoves. The UDAQ will use the funding to offer Utah residents generous financial incentives to convert their woodstoves and fire places to cleaner sources of heat. Changing-out an old uncertified woodstove for an EPA-certified stove can reduce the amount of PM_{2.5} by as much as 60%. Converting a wood stove to a natural gas stove is even more beneficial, reducing PM_{2.5} by 99.9%.

Estimates show that the five year program will result in: 1) the destruction or recycling of 503 wood-stoves/inserts, 2) conversion of 496 wood-burning units to gas stoves, and 3) replacement of 1,006 uncertified wood stoves/inserts by EPA-certified wood-burning appliances. On a yearly basis, the change-out program would result in the destruction/recycling of 101 units, conversion of 99 wood-burning units to gas-fueled devices as well as the replacement of 201 uncertified wood-burning units by EPA-certified ones.

Implementation of the program is expected to result in the reduction of nearly 72% (or 18 tons) of PM_{2.5} and 87% (or 36 tons) of VOCs emissions from wood-smoke over the duration of the program. This is equivalent to a reduction of about 3.6 and 7.3 tons/year of PM_{2.5} and VOCs from wood-smoke, respectively.

Diesel Emission Testing

Currently there are three counties within the Salt Lake City Nonattainment Area (Davis, Salt Lake, and Weber) that have implemented a diesel emission inspection program. Each of the three programs is administered by its local health department, which may manage its program somewhat differently than the others. Although each is an independent program, they all share the same purpose of improving air quality through the detection and repair of excessively emitting vehicles.

In Davis County, all light, medium and heavy duty diesel powered vehicles are required to undergo an emission test. The program consists of an On-Board Diagnostic (OBD) and visual tampering inspection for model year 1996 and newer light duty (under 8,500 lbs Gross Vehicle Weight Rating (GVWR)) diesel vehicles and model year 2008 and newer medium duty (between 8,501 and 14,000 lbs GVWR) diesel vehicles. Davis also tests model year 1968 to 2007 medium duty diesel vehicles using an opacity inspection test using a dynamometer, and finally, 1968 and newer Heavy Duty vehicle (over 14,001 lbs GVWR) are tested using Society of Automotive Engineers (SAE) J1667 or snap acceleration procedure. Salt Lake County's diesel program consists of an OBD and visual tampering inspection for 1998 and newer light and medium duty diesel powered vehicle 14,000 lbs GVWR and less. Salt Lake County also tests 1968 and newer Heavy-Duty diesel vehicles over 14,001 lbs GVWR using the SAE J1667 Snap Acceleration Smoke Test Procedure. Weber County's program consists of an OBD inspection for 2008 and newer vehicles light-and medium duty vehicles (under 14001 lbs GVWR). Weber County also conducts a visual tampering inspection for model year 1998 through 2007 diesel vehicles.

In any of the three counties, the frequency of inspection depends on the age of the vehicle. Vehicles less than two years old, as of January 1 on any given year, are exempt from an emissions inspection. Vehicles that are two years old but less than six are inspected every other year, as per Utah Code 41-6a-1642(6). All vehicles six years old and older are inspected annually.

Davis County reported a total of 9,096 diesel inspections completed during 2017. In aggregate, 816 of these vehicles failed the particular inspection, which amounts to a 9% fail rate. Of the total inspections performed, 3,346 were OBD inspections (12.8% fail rate), 1,556 were snap-idle inspections (4.2% fail rate), and 4,194 were opacity inspections (7.6% fail rate).

Weber County inspected 10,727 diesel vehicles in 2017. OBD inspections resulted in a 19 % failure rate (1999 vehicles), and visual tampering inspections produced a 7.5% failure rate (801 vehicles).

Salt Lake County inspected a total of 42,002 diesel vehicles in 2017; 26,956 OBD inspections with a 4.8% fail rate (1,295 vehicles), and 14,735 snap acceleration inspections with a 2.8% fail rate (419 vehicles failed).

6.3 Conclusion: Air Quality as of the Attainment Date

This demonstration began with a modeled analysis that predicted $PM_{2.5}$ concentrations in 2019, the attainment year, beneath the NAAQS at all stations but one, the Rose Park station. Even at Rose Park, the prediction was very close ($35.9 \mu\text{g}/\text{m}^3$). Additional analysis was presented to supplement the modeled demonstration, including: an alternate conclusion that did show a concentration beneath the NAAQS in 2019, trends in ambient concentrations of $PM_{2.5}$, NO_2 , and SO_2 , trend in emissions of $PM_{2.5}$ and its precursors, some examples of how the modeled analysis might be considered conservative in its assessment of emissions improvement, and perhaps most importantly, some examination of what might be the shortcomings of the model as presently configured.

To this final point, one might consider the following when deciding how much the model may be relied upon.

Despite a significant projected decrease in NO_x and VOC emissions between 2016 and 2019, the modeled $PM_{2.5}$ results only show a slight decrease in predicted nitrate (NO_3). The model simulates an ammonia-limited and oxidant-limited regime in the Salt Lake Valley. However, observations from the recent 2017 UWFPS report suggest that the Salt Lake Valley airshed is actually close to the equivalence point between NH_3 limited and NO_x limited regimes during a wintertime inversion. This implies that if the model more accurately represented the wintertime inversion episode, then one would certainly see a bigger $PM_{2.5}$ decrease relative to the sizable reduction in NO_x and VOC emissions projected for 2019.

To improve modeled NO_3 (and hence, $PM_{2.5}$) performance, ammonia was artificially injected into the emissions inventory. While this adjustment improved NO_3 performance, it is associated with multiple uncertainties. As applied, the model assumes a uniform temporal distribution and a coarse spatial variation in artificial ammonia emissions across the Salt Lake Valley. Even with the additional ammonia, the model was still ammonia-limited during the extent of the episode. The model may also be too sensitive to oxidants levels. Carbonyls and $ClNO_2$, which are sources of oxidants that promote $PM_{2.5}$ and O_3 production, as shown by recent aircraft measurements in the Salt Lake Valley, are underestimated in the model. Carbonyls, particularly formaldehyde, are misrepresented in the model and the chemical pathway responsible for $ClNO_2$ formation is not emulated at all.

These uncertainties in the model with regard to both the characterization of the regional chemistry to the inventorying of certain constituents, ammonia in particular, may lead one to give more weight to some of the empirical evidence. Past trends in emissions reductions, particularly reductions in NO_x and SO_2 , compare favorably with commensurate trends in monitored $PM_{2.5}$. Against a more-or-less constant background of direct $PM_{2.5}$ emissions, these trends suggest that the area has experienced large improvements in the magnitude of $PM_{2.5}$.

exceedances incurred during wintertime episodes of cold pool meteorology. These episodes are dominated by secondary PM_{2.5}.

All indications are that PM_{2.5} precursor emissions, particularly NO_x and VOC, are expected to decline markedly over the next 5 years. Based on past experience, there is no reason to think that this would not continue to provide an improvement in ambient PM_{2.5}.

It is worth noting again that the model would in fact show attainment at all monitor locations in 2019 if the data for August 20, 2015 is documented as being affected by an exceptional event.

Finally, it should be noted that, based on historic monitoring trends and current monitoring values, it is highly likely that the nonattainment area will attain the standard and qualify for a clean data determination as soon as the 2018 monitored data can be certified.

In summary, UDAQ is persuaded by these additional analyses and pieces of information, and after considering the entire weight of evidence, conclude that it is in fact likely that the Salt Lake City, UT PM_{2.5} nonattainment area will attain the 2006 24-hour PM_{2.5} health standard by the attainment date in 2019.

Chapter 7 – TRANSPORTATION CONFORMITY

7.1 Introduction

The federal Clean Air Act (CAA) requires that transportation plans and programs within the Salt Lake City, Utah PM_{2.5} nonattainment area conform to the air quality plans in the region prior to being approved by the Wasatch Front Regional Council (WFRC) Metropolitan Planning Organization. Demonstration of transportation conformity is a condition to receive federal funding for transportation activities that are consistent with air quality goals established in the Utah State Implementation Plan (SIP). Transportation conformity requirements are intended to ensure that transportation activities do not interfere with air quality progress. Conformity applies to on-road mobile source emissions from regional transportation plans (RTPs), transportation improvement programs (TIPs), and projects funded or approved by the Federal Highway Administration (FHWA) or the Federal Transit Administration (FTA) in areas that do not meet or previously have not met the National Ambient Air Quality Standards (NAAQS) for ozone, carbon monoxide, particulate matter less than 10 micrometers in diameter (PM₁₀), or particulate matter 2.5 micrometers in diameter or less (PM_{2.5}), or nitrogen dioxide.

The Fixing America's Surface Transportation Act or "FAST Act" and section 176(c)(2)(A) of the CAA require that all regionally significant highway and transit projects in air quality nonattainment areas be derived from a "conforming" transportation plan. Section 176(c) of the CAA requires that transportation plans, programs, and projects conform to applicable air quality plans before being approved by an MPO. Conformity to an implementation plan means that proposed activities must not (1) cause or contribute to any new violation of any standard in any area, (2) increase the frequency or severity of any existing violation of any standard in any area, or (3) delay timely attainment of any standard or any required interim emission reductions or other milestones in any area.

The plans and programs produced by the transportation planning process of the WFRC are required to conform to the on-road mobile source emissions budgets established in the SIP, or absent an approved or adequate budget, required to meet the interim conformity test. Approval of conformity is determined by the FHWA and FTA.

7.2 Consultation

The Interagency Consultation Team (ICT) is an air quality workgroup in Utah that makes technical and policy recommendations regarding transportation conformity issues related to the SIP development and transportation planning process. Section XII of the Utah SIP established the ICT workgroup and defines the roles and responsibilities of the participating agencies. Members of the ICT workgroup collaborated on a regular basis during the development of the PM_{2.5} SIP. They also meet on a regular basis regarding transportation conformity and air quality issues. The ICT workgroup is comprised of management and technical staff members from the affected agencies associated directly with transportation conformity.

ICT Workgroup Agencies

- Utah Division of Air Quality (UDAQ)
- Metropolitan Planning Organizations MPOs
 - Cache MPO
 - Mountainland Association of Governments
 - Wasatch Front Regional Council
- Utah Department of Transportation (UDOT)
- Utah Local Public Transit Agencies
- Federal Highway Administration (FHWA)
- Federal Transit Administration (FTA)
- U.S. Environmental Protection Agency (EPA)

The regional emissions analysis is the primary component of transportation conformity and is administered by the lead transportation agency located in the EPA designated air quality nonattainment area. The responsible transportation planning organization for the Salt Lake City, UT nonattainment area is the Wasatch Front Regional Council (WFRC). During the SIP development process the WFRC coordinated with the ICT workgroup and developed PM_{2.5} SIP motor vehicle emissions inventories using the latest planning assumptions and tools for traffic analysis and the EPA-approved Motor Vehicle Emission Simulator (MOVES2014a) emissions model. The WFRC and the ICT worked cooperatively to develop local MOVES2014a modeling data inputs using EPA recommended methods where applicable.

7.3 Transportation Conformity PM_{2.5} Components

The transportation conformity requirements found in 40 CFR 93.102 requires that the PM_{2.5} SIP include motor vehicle emissions budgets for PM_{2.5} precursor emissions of Oxides of Nitrogen (NO_x) and Volatile Organic Compounds (VOC), and direct PM_{2.5} (primary exhaust PM_{2.5} + brake and tire wear) emissions. VOC emissions precursor budgets are required because UDAQ has identified VOCs as a PM_{2.5} precursor that significantly impact PM_{2.5} concentrations. The EPA conformity rule presumes that PM_{2.5} re-entrained road dust does not need to be included in the interim conformity test unless either the State or EPA decides that re-entrained road dust emissions are a significant contributor to the PM_{2.5} nonattainment problem. The UDAQ conducted a re-entrained road dust study that concluded that PM_{2.5} re-entrained road dust emissions are negligible in the Salt Lake City, Utah PM_{2.5} nonattainment area, and thus meet the criteria of 40 CFR 93.102(b)(3). EPA Region 8 reviewed the study and concurred with the UDAQ's findings. The re-entrained road dust insignificant finding is located in the On-Road Mobile Sources PM_{2.5} Episodic Inventory TSD.

7.4 Interim PM_{2.5} Conformity Test

The EPA interim conformity test, for the purposes of this plan revision, will require that PM_{2.5} precursor emissions of NO_x and VOC, and direct PM_{2.5} (primary exhaust PM_{2.5} + brake and tire wear) emissions from RTPs, TIPs, and projects funded or approved by the FHWA or the FTA not exceed 2008 levels.

The Interim conformity test requirements apply until EPA has declared the motor vehicle emissions budgets adequate for transportation conformity purposes or until EPA approves the budget in the Federal Register.

7.5 Transportation Conformity PM_{2.5} Budgets

In this SIP, the State is establishing transportation conformity MVEBs for the Salt Lake City, PM_{2.5} nonattainment area. The MVEBs are established for tons per average winter weekday (tpww) for PM_{2.5} precursors NO_x and VOC, and for direct PM_{2.5} (primary exhaust PM_{2.5} + brake and tire wear). WFRC applied an increased growth rate of 5% to the Vehicle Miles of Travel. This growth rate adjustment was applied to allow for unanticipated fluctuations in future VMT. VMT growth rate assumptions may be found in the Technical Support Document (TSD) for On-Road Mobile Sources (at Chapt. 3.e, see: iii. MOVES Modeling Procedure: 3. MOVES2014 Local Model Inputs).

Table 7.1, Emissions Budgets for Transportation Conformity Purposes (EPA MOVES2014a).

	Direct PM _{2.5} (tpww)	NO _x (tpww)	VOC (tpww)
2017	2.68	59.92	32.67
2019	2.27	50.07	28.85
2020	2.11	45.84	26.88

Note: TPWW: Tons Per Average Winter Weekday. Direct PM_{2.5} is Primary Exhaust PM_{2.5} total + brake and tire wear. VOC emissions do not include refueling spillage and displacement vapor loss. Budgets are rounded to the nearest hundredth ton. Derivation of the MVEBs may be found in the Technical Support Document for On-Road Mobile Sources (at Chapt. 3.e, see: iv. Quantifiable Nonattainment Modeling Results and Motor Vehicle Emissions Budget Derivation).

It is important to note that the MVEBs presented in Table 7.1 are somewhat different from the Summary Emissions Inventory (EI) presented in **Table 4.1**.

Overall the emissions established as MVEBs are calculated using MOVES to reflect an average winter weekday. The totals presented in the Summary EI, however, represent an average-episode-day. The episode used to make this average (December 31, 2010 through January 10) includes seven such winter weekdays, but also includes two weekends. Emissions produced on weekdays are significantly larger than those produced on both Saturdays and Sundays. Therefore, the weighted average of daily emissions calculated for an episode-day will be less than that of a weekday.

There are also some conventions to be considered in the establishment of MVEBs. In particular: PM_{2.5} in the Summary EI totals includes direct exhaust, tire & brake wear, and fugitive dust. For the MVEBs PM_{2.5} includes direct exhaust, tire & brake but no fugitive dust.

VOC emissions in the Summary EI totals include refueling spillage and displacement vapor loss. These emissions were included in the Summary EI as belonging to the On-Road Mobile Source. MVEBs for VOC do not include these emissions because, in this context, they are regarded as an Area Source.

7.6 Trading Ratios

Per section 93.124 of the conformity regulations, for transportation conformity analyses using these budgets in analysis years beyond 2020, a trading mechanism is established to allow future increases in on-road direct PM_{2.5} emissions to be offset by future decreases in plan precursor emissions from on-road mobile sources at appropriate ratios established by the air quality model. Future increases in on-road direct PM_{2.5} emissions may be offset with future decreases in NO_x emissions from on-road mobile sources at a NO_x to PM_{2.5} ratio of 12.67 to 1 and/or future decreases in VOC emissions from on-road mobile sources at a VOC to PM_{2.5} ratio of 31.96 to 1. This trading mechanism will only be used if needed for conformity analyses for years after 2020. To ensure that the trading mechanism does not impact the ability to meet the NO_x or VOC budgets, the NO_x emission reductions available to supplement the direct PM_{2.5} budget shall only be those remaining after the 2020 NO_x budget has been met, and the VOC emissions reductions available to supplement the direct PM_{2.5} budget shall only be those remaining after the 2020 VOC budget has been met. Clear documentation of the calculations used in the trading should be included in the conformity analysis. The assumptions used to create the trading ratios may be found in the following document, "Trading Ratios for Conformity Salt Lake Serious PM_{2.5}", included in Chapter 8 Misc. of the TSD.

Chapter 8 – QUANTITATIVE MILESTONES DEMONSTRATING REASONABLE FURTHER PROGRESS

8.1 Introduction

Clean Air Act Section 172(c)(2) requires that plans for nonattainment areas “shall require reasonable further progress (RFP).” This general requirement is interpreted for PM_{2.5} areas in EPAs’ Implementation Rule for Fine Particulate Matter (81 FR, 58010). The definition of RFP is given in 40 CFR 51.1000. It means “such annual incremental reductions in emissions of direct PM_{2.5} and PM_{2.5} plan precursors as are required for the purpose of ensuring attainment of the applicable PM_{2.5} NAAQS in a nonattainment area by the applicable attainment date.”

In general terms, the goal of these RFP requirements is for areas to achieve continual progress toward attainment, rather than perhaps deferring implementation of all measures until the attainment deadline.

The pollutants to be addressed in the RFP plan are those pollutants that are identified for purposes of control measures in the attainment plan: PM_{2.5}, SO₂, NO_x, VOC, and ammonia.

8.2 Serious Area Planning Requirements

The planning requirements RFP and Quantitative Milestones within PM_{2.5} nonattainment areas are given in 40 CFR 51 paragraphs 1012 and 1013. In summary:

The RFP plan must demonstrate annual incremental reductions in emissions (direct PM_{2.5} and precursors) to ensure attainment by the attainment date. It shall include:

- A schedule describing the implementation of control measures during each year of the plan.
- RFP projected emissions for each applicable milestone year, based on the anticipated implementation schedule for control measures.
- An analysis that demonstrates that by the end of each milestone year emission levels will reflect progress that is either generally linear or stepwise.
- Also, there must be a tracking mechanism for the progress that is expected.
- Finally, for purposes of establishing motor vehicle emissions budgets... (as required in 40 CFR part 93) for a PM_{2.5} nonattainment area, the state shall include in its RFP submission an inventory of on-road mobile source emissions in the nonattainment area for each milestone year.

For areas like the SLC, UT area that were designated nonattainment for the 2006 PM_{2.5} NAAQS prior to January 15, 2015, the first milestone is December 31, 2017. Additional milestones will occur every three years thereafter, up until and including the first such milestone after the

attainment date. The attainment date for this plan is December 31, 2019. Therefore, the second and final milestone will come due at December 31, 2020.

8.3 RFP for the Salt Lake City, UT Nonattainment Area

The attainment demonstration for the SLC, UT PM_{2.5} nonattainment area shows that the 2006, 24-hr NAAQS can be achieved by the attainment date of December 31, 2019. Essentially, this may also be considered to demonstrate that the area is achieving RFP.

The emissions reductions associated with the application of BACM and BACT were factored into an inventory for 2019 that was assessed using air quality modeling as well as other information and analyses. The entire analysis demonstrates that these reductions in emissions are likely sufficient to demonstrate attainment of the applicable standard by the applicable attainment date.

The starting point for evaluating RFP should be the baseline year used in the modeling analysis. This is a year (2016) selected to coincide with the period used to establish the monitored design value for the modeling analysis; a period in which the area was violating the applicable NAAQS. Thus, the magnitude of emissions reductions should be evaluated over a period spanning from 2016 through 2019.

Quantitatively, the following assessment of emissions and incremental emissions reductions in **Table 8.1** will show that RFP is met using the criteria discussed above:

Reasonable Further Progress										
Salt Lake City, UT PM _{2.5} Nonattainment Area										
*Emissions by Year			Base Yr.	Projection Years with Growth & Controls						
			2016	2017	2018	2019	2020	2021	2022	**RFP
PM _{2.5}			15.4	15.8	16.0	16.1	16.0	16.0	16.0	0.2
NO _x			103.6	100.2	99.0	94.9	87.9	87.9	87.9	-2.9
SO ₂			5.6	5.6	5.6	4.9	4.9	4.9	4.9	-0.2
VOC			91.7	91.5	91.5	86.8	83.5	83.5	83.5	-1.6
NH ₃			16.0	16.0	16.0	16.0	15.9	15.9	15.9	0.0
PM _{2.5} Precursors			216.9	213.2	213.2	202.6	192.2	192.2	192.2	-4.8
Total			232.3	229.0	229.0	218.7	208.2	208.2	208.2	-4.5
*Emissions are reported in tons per average-episode-day										
**Emission change per year, (ton/day) averaged from Base Year (2016) through Attainment Year (2019)										

Table 8.1, Reasonable Further Progress in the SLC, UT Nonattainment Area

Emissions in **Table 8.1** have been aggregated to include all four source categories. RFP projected emissions, however, are defined to look at each source category individually. That information appears already in **Table 4.1**, but is included here also as **Table 8.2** for the ease of discussion.

Emissions in both tables show not just the effect of BACM and BACT, but also growth in population and vehicle miles traveled. Even with the inclusion of growth, the trends are still downward.

Emissions [tons/day]	Sector	PM2.5	NO _x	VOC	NH ₃	SO ₂
2016 Base Year	Area Sources	6.13	13.63	45.96	14.22	0.17
	Mobile Sources	4.98	55.38	31.84	1.29	0.41
	NonRoad Sources	1.01	16.41	8.70	0.02	0.32
	Point Sources	3.26	18.18	5.25	0.44	4.70
	Total	15.38	103.61	91.74	15.97	5.60
2017 Milestone Year	Area Sources	6.19	13.57	46.02	14.21	0.22
	Mobile Sources	5.02	52.53	30.87	1.30	0.43
	NonRoad Sources	0.96	15.77	8.47	0.02	0.33
	Point Sources	3.58	18.32	6.13	0.44	4.61
	Total	15.75	100.18	91.48	15.97	5.59
2019 Attainment Year	Area Sources	6.23	11.84	44.34	14.21	0.22
	Mobile Sources	4.78	44.02	27.26	1.25	0.43
	NonRoad Sources	0.88	15.18	9.01	0.02	0.35
	Point Sources	4.25	23.86	6.21	0.48	3.90
	Total	16.13	94.90	86.82	15.96	4.89
2020 Milestone Year	Area Sources	6.24	9.54	43.73	14.20	0.20
	Mobile Sources	4.68	40.38	25.42	1.23	0.42
	NonRoad Sources	0.82	14.08	8.10	0.02	0.36
	Point Sources	4.26	23.86	6.22	0.49	3.90
	Total	16.00	87.86	83.47	15.94	4.88

* Salt Lake nonattainment area only

Table 8.2, RFP Projected Emissions in the SLC, UT Nonattainment Area

From **Table 8.2** it can be seen that the overall decrease in total NO_x and VOC emissions is, as expected, dominated by improvements in the On-Road Mobile Source category. Yet, there are significant improvements in the Area Source category as well. Point Sources are responsible for the increase in PM_{2.5} emissions, but also account for the decline in SO₂. Ammonia emissions are essentially flat, but most of the reported ammonia is not attributed to any of the source categories. Rather, it has been artificially introduced into the analysis to improve model performance.

Table 8.2 also shows the emissions from on-road mobile sources in the milestone years. As noted in **section 7.5**, these totals differ somewhat from the MVEBs.

Control Measures: The inventory for 2019 “with growth and controls” reflects the implementation of all the best available control measures and best available control technologies identified in this plan, as well as all pre-existing control measures. As such, this inventory takes into account all controls that “may reasonably be required by the Administrator.”

For a complete discussion of BACM and BACT, and the control measures factored into the modeled demonstration for 2019, see Chapter 5 of the Plan.

For purposes of Milestone tracking, it is worth distinguishing those controls relied upon by this SIP that have been required by the State of Utah. Since these control measures have been required specifically for the purpose of this SIP it will be incumbent on the State to make sure they are implemented, and then to verify as much in any subsequent milestone reporting requirement. These controls differ from controls that are already on the books or controls that

are implemented at the federal level. Specifically, such State-specific controls reside in the categories of area and stationary point sources. A listing of these State-specific control measures appears, for area and stationary point source categories, in Tables 8.3 and 8.4 respectively.

EPA-Approved/Conditionally Approved Control Measures for UT Moderate PM _{2.5} SIPs	Implementation Schedule	Estimated Reductions in the SLC NAA*
R307-302 Solid Fuel Burning Devices ¹ EPA conditionally approved October 19, 2016 (81 FR 71988).	February 1, 2017	See Table 5-1 residential wood burning ban
R307-303 Commercial Cooking ¹ EPA approved February 25, 2016 (81 FR 9343).	December 15, 2015	See Table 5-1 commercial cooking
R307-304 Solvent Cleaning ¹	December 6, 2017	See Table 5-1 a subset of degreasing
R307-309 Nonattainment and Maintenance Areas for PM ₁₀ and PM _{2.5} : Fugitive Emissions and Fugitive Dust ¹ EPA approved February 25, 2016 (81 FR 9343).	Salt Lake County, Utah County, and the City of Ogden – January 1, 2013. Remaining NAAs – April 1, 2013. Amended August 4, 2017	See Table 5-1 fugitive dust
R307-312 Aggregate Processing Operations for PM _{2.5} Nonattainment Areas. EPA approved October 19, 2016 (81 FR 71988).	February 4, 2016	See Table 5-1 aggregate operations
R307-335 Degreasing and Solvent Cleaning Operations ¹ EPA approved February 25, 2016 (81 FR 9343).	All sources within Salt Lake and Davis Counties R307-335-3 through R307-335-6 – January 1, 2013. All other sources defined in R307-335-2 – September 1, 2013. All sources within Box Elder, Cache, Utah, Weber, and Tooele Counties R307-335-7 – August 1, 2014 Amended October 29, 2017 by removing sections 6 & 7 to for rule R307-304	See Table 5-1 a subset of degreasing
R307-342 Adhesives & Sealants ¹ EPA approved February 25, 2016 (81 FR 9343).	December 1, 2014	See Table 5-1 adhesive/sealants
R307-343 Emissions Standards for Wood Furniture Manufacturing Operations ¹ EPA approved February 25, 2016 (81 FR 9343)	Sources in Salt Lake and Davis Counties – September 1, 2013. Sources in Box Elder, Cache, Tooele, Utah, and Weber Counties – January 1, 2014. Amended December 6, 2017	See Table 5-1 wood furniture manufacturing

EPA-Approved/Conditionally Approved Control Measures for UT Moderate PM _{2.5} SIPs	Implementation Schedule	Estimated Reductions in the SLC NAA*
R307-344 Paper, Film & Foil Coatings ¹ EPA approved February 25, 2016 (81 FR 9343)	Sources in Salt Lake and Davis Counties – February 1, 2013. Sources in Box Elder, Cache, Tooele, Utah, and Weber Counties – January 1, 2014. Amended December 6, 2017	See Table 5-1 paper/film/foil
R307-345 Fabric & Vinyl Coatings ¹ EPA approved February 25, 2016 (81 FR 9343)	Sources in Salt Lake and Davis Counties – February 1, 2013. Sources in Box Elder, Cache, Tooele, Utah, and Weber Counties – January 1, 2011. Amended December 6, 2017	See Table 5-1 fabric/vinyl
R307-346 Metal Furniture Surface Coatings ² EPA approved February 25, 2016 (81 FR 9343)	Sources in Salt Lake and Davis Counties – February 1, 2013. Sources in Box Elder, Cache, Tooele, Utah, and Weber Counties – January 1, 2014. Amended December 6, 2017	See Table 5-1 metal furniture
R307-347 Large Appliance Surface Coatings ² EPA approved February 25, 2016 (81 FR 9343)	Sources in Salt Lake and Davis Counties – February 1, 2013. Sources in Box Elder, Cache, Tooele, Utah, and Weber Counties – January 1, 2014. Amended December 6, 2017	See Table 5-1 appliance
R307-348 Magnet Wire Coatings ² EPA approved February 25, 2016 (81 FR 9343)	Sources in Salt Lake and Davis Counties – February 1, 2013. Sources in Box Elder, Cache, Tooele, Utah, and Weber Counties – January 1, 2014. Amended December 6, 2017	See Table 5-1 magnet wire
R307-349 Flat Wood Panel Coatings ¹ EPA approved February 25, 2016 (81 FR 9343)	Sources in Salt Lake and Davis Counties – February 1, 2013. Sources in Box Elder, Cache, Tooele, Utah, and Weber Counties – January 1, 2014. Amended December 6, 2017	See Table 5-1 flat wood
R307-350 Miscellaneous Metal Parts and Products Coatings ¹ EPA approved February 25, 2016 (81 FR 9343)	Sources in Salt Lake and Davis Counties – September 1, 2013. Sources in Box Elder, Cache, Tooele, Utah, and Weber Counties – January 1, 2014. Amended December 6, 2017	See Table 5-1 misc. metal

EPA-Approved/Conditionally Approved Control Measures for UT Moderate PM_{2.5} SIPs	Implementation Schedule	Estimated Reductions in the SLC NAA*
R307-351 Graphic Arts ¹ EPA approved February 25, 2016 (81 FR 9343)	Sources in Salt Lake and Davis Counties – February 1, 2013. Sources in Box Elder, Cache, Tooele, Utah, and Weber Counties – January 1, 2014. Amended December 6, 2017	See Table 5-1 graphic art
R307-352 Metal Containers, Closure, and Coil Coatings ² EPA approved February 25, 2016 (81 FR 9343)	January 1, 2014 Amended December 6, 2017	See Table 5-1 coil/containers
R307-353 Plastic Parts Coatings ¹ EPA approved February 25, 2016 (81 FR 9343)	January 1, 2014 Amended December 6, 2017	See Table 5-1 plastic
R307-354 Automotive Refinishing Coatings ¹ EPA approved February 25, 2016 (81 FR 9343)	January 1, 2014 Amended December 6, 2017	See Table 5-1 autobody
R307-355 Control of Emissions from Aerospace Manufacture and Rework Facilities ¹ EPA approved February 25, 2016 (81 FR 9343)	January 1, 2014 Amended March 8, 2018	See Table 5-1 aerospace
R307-356 Appliance Pilot Light ¹ EPA approved February 25, 2016 (81 FR 9343)	January 1, 2013	See Table 5-1 pilot light
R307-357 Consumer Products ¹ EPA approved February 25, 2016 (81 FR 9343)	May 8, 2014	See Table 5-1 consumer products
R307-361 Architectural Coatings ¹ EPA approved February 25, 2016 (81 FR 9343)	October 31, 2013	See Table 5-1 paint

Table 8.3, RFP / Quantitative Milestone Tracking Table for Area Sources. *uncontrolled to controlled 2019 emissions. ¹ Potential 2020 quantitative milestone reporting metrics: control measure implementation schedule and confirmation that measures have been implemented. ² Potential 2020 quantitative milestone reporting metrics: control measure implementation schedule and review if any new sources located in the NAA.

Company	RACT Equipment Update(s)	BACT Requirement(s)	Implementation Schedule	Quantify Reduction (tons/yr)	Compliance Mechanism
ATK Launch Systems Inc.	Two (2) 25 MMBTU/hr Natural Gas Boilers	Ultra Low Nox Burners	31-Dec-24	NOx ~ 10.44 tons/yr	AO Issuance
Big West Oil Company	Hydrocarbon Flares	Limited routine flaring between Oct 1st and March 31st.	Date of SIP Approval	N/A	AO Issuance
	Carbon Canisters/Fire Pumps	Miscellaneous Carbon Canister and Fire Pump Changes	31-Dec-19	VOC ~ 15.4 tons/yr	AO Issuance
Chemical Lime Company	Lime Kiln	Selective Non-catalytic Reduction	Upon Source Start-up	N/A	AO Issuance
		New Baghouse	Upon Source Start-up	N/A	AO Issuance
Chevron Products Co.	Boilers/Compressor Drivers	Replacement of 4 Compressor Drivers	31-Dec-19	N/A	AO Issuance
	Tier 3 Fuels	Removal of Boilers 1, 2, & 4; Replacement with Boiler 7	31-Dec-19	N/A	AO Issuance
Compass Minerals	Boilers #1 & #2 - Required Nox Limitations	Ultra low Nox burners/Upgrades to Baghouses	31-Dec-19	NOx ~ 10 tons/yr	AO Issuance
	PM2.5 Filterable and Condensable emission limits required for 14 emission points				
Hexel Corporation	Carbon Fiber Lines	Addition of Filter Boxes on Lines 13 & 14	31-Dec-19	PM 2.5 ~ 20 tons/yr	AO Issuance
		De-NOx Water Direct Fired Thermal Oxidizer on Lines 13, 14, 15 & 16	31-Dec-24	NOx ~ 75 tons/yr	AO Issuance
		Low-Nox Burners w/fuel gas re-circulation on Lines 3, 4, & 7	31-Dec-24	NOx ~ 25.5 tons/yr	AO Issuance
Hill Air Force Base	Painting and De-painting	VOC emission limitation for painting activities.	31-Dec-24	PM2.5 ~ 11.8 tons/yr	AO Issuance
	Boilers	Requirement that no boilers manufactured after January 1, 1989 over 30 MMBtu/hr be operated.		NOx ~ 434.38 tons/yr VOC ~ 8.53 tons/yr	
Holly Corporation	Wet Gas Scrubber & Boiler	Installation of Wet Gas Scrubber and Boiler Replacement	N/A	N/A	N/A
Kennecott Utah Copper					
Mine	Mine	Mileage limitation and Required lower emission rate for in-pit crusher	Date of SIP Approval	PM2.5 ~ 4.33 tons/yr NOx ~ 1,268.8 tons/yr (8760 hrs of operation)	AO Issuance
Power Plant	Power Plant upgrades	Unit #4: Installation of SCR and Overfired Air;	1-Jan-19	NOx ~ 302.43 tons/yr (2088 hrs of operation)	AO Issuance
		Unit #4: Lower ppm and lb/hr testing requirement.		NOx ~ 35.04 tons/yr (8760 hrs of operation)	AO Issuance
Smelter & Refinery	Smelter & Refinery upgrades	Replacement of one (1) 82 MMBtu/hr Tankhouse Boiler	1-Dec-20		
Nucor Steel Mills	No Changes	No BACT Changes	N/A	N/A	N/A
Pacificorp Energy					
Gadsby Power Plant	No Changes	No BACT Changes	N/A	N/A	N/A
Proctor & Gamble	Utility Boilers	PM2.5 Filterable and Condensable Limits & Nox Limits	N/A	N/A	AO Issuance
		Workload changes at facility			
Tesoro Refining	Refinery Operations	Installation of Wet Gas Scrubber	31-Oct-19	N/A	AO DAQE-103350075-18
University of Utah	Heating Plant	Replacement of Boiler #4. Installation of Boiler #9.	31-Dec-19	NOx ~ 44.29 tons/yr	AO Issuance
		Natural Gas limitations on Boilers #1, #3, & #4.	30-Sep-19	NOx ~ 4.27 tons/yr	AO Issuance
Utah Municipal Power Agency	Power Plant	No BACT required changes	N/A	N/A	N/A
Vulcraft	Steel Fabrication	No BACT required changes	N/A	N/A	N/A

Table 8.4, RFP / Quantitative Milestone Tracking Table for Point Sources

Schedule for the Implementation of BACM and BACT: RFP must be considered in light of the attainment date as well as the date by which all BACT and BACM must be implemented. Consideration is also given to the attainment demonstration which must make its assessment as of the attainment date. For the SLC-UT nonattainment area the attainment date is December 31, 2019. 40 CFR 51.1011 establishes that control measures must be implemented no later than the beginning of the year containing the applicable attainment date. Thus, for purposes of RFP and SIP credit, the deadline for implementation of all BACT and BACM is January 1, 2019. Any control measures implemented beyond such date are instead regarded as additional feasible measures.

Implementation dates for the State-specific control measures have been included in Tables 8.3 and 8.4.

The improving trends in emissions are evident from **Table 8.1**, but it is important to look more closely and determine whether the downward trends are either generally linear in character or whether they reveal a more stepwise shape. **Figure 8.1** is included to make this assessment.

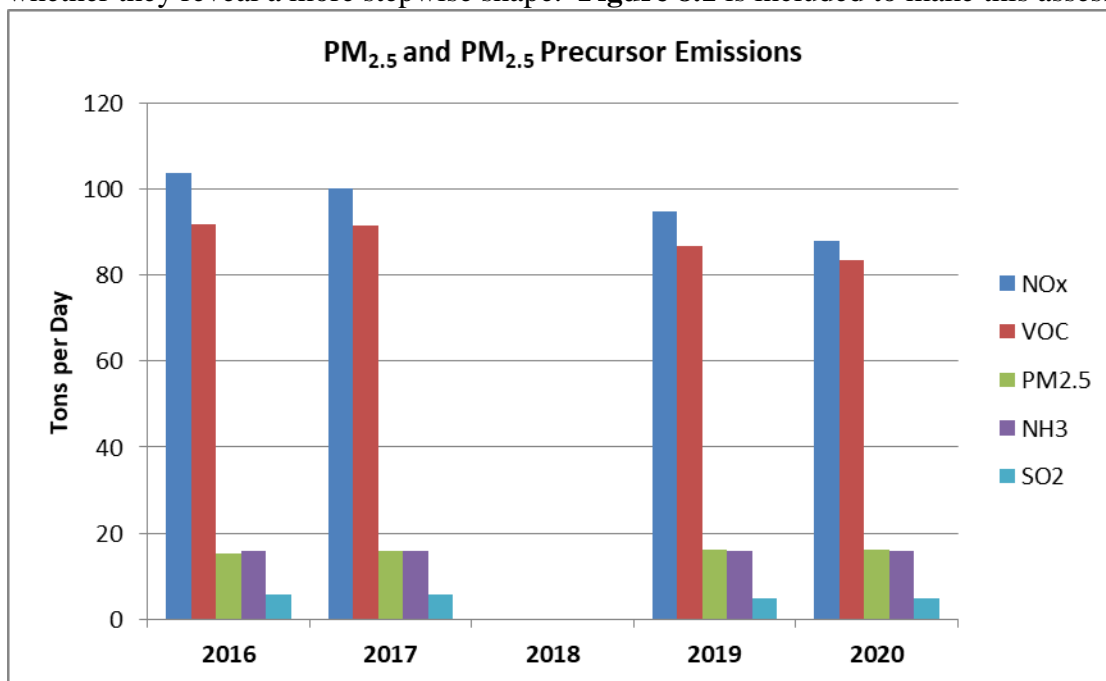


Figure 8.1 Emissions totals for PM_{2.5} and PM_{2.5} precursors in the Base Year (2016), Attainment Year (2019), and Milestone Years (2017 and 2020)

From the figure, it may be seen that the trends in SO₂ and VOC show a stepwise decline between 2017 and 2019. This is supported by the implementation date (Dec. 31, 2018) for BACM & BACT. In particular, Area Source BACM rules were projected to become fully effective by 2019, and most of these rules targeted VOC emissions. The decline in SO₂ emissions is explained by the installation of a wet-gas scrubber at Tesoro Refining & Marketing Co. LLC in 2018.

The trend in NO_x is more linear, remaining steadily downward with the continued implementation of Tier 2 of the federal motor vehicle control program. The introduction of Tier 3 in 2017 is likely accelerating the downward trend from 2019 to 2020.

The trend of primary PM_{2.5} emissions is seen to be relatively flat. This is consistent with the trend seen since all the way back to about 2000 (see **Fig. 6.20**).

It is also interesting to note in light of the improvement shown in the ambient monitoring data for $PM_{2.5}$ (**Figs. 6.14 and 6.15**). As noted in the Weight of Evidence discussion (**section 6.2**), the actual improvement in monitored $PM_{2.5}$ concentrations, both peak and annual values, is likely due to reductions in $PM_{2.5}$ precursor emissions; effectively shaving the peaks off of the wintertime exceedances composed mainly of secondary nitrate.

8.4 Milestones for the SLC, UT Nonattainment Area

The PM Implementation Rule requires quantitative milestones, which demonstrate reasonable further progress, to be achieved every three years.

Not later than 90 days after the milestone comes due, Utah must submit a milestone report that certifies that the SIP control strategy is being implemented. The report must also include a discussion of whether the area will attain the NAAQS by the applicable date.

In order that it may make such certification, Utah will need to track the implementation of BACM and BACT. This will be accomplished for the point sources by the issuance of Approval Orders authorizing construction of any required modifications as well as on-site inspections to verify that any operating practices have been implemented. Utah will also work with the EPA to ensure that any rulemaking actions taken to implement BACM at the many area sources in the nonattainment area have been approved into the Utah SIP.

If it fails to submit the quantitative milestone demonstration, or if EPA determines that the milestone was not met, The State is required to submit a SIP revision ensuring that the next milestone will be met or alternately that the NAAQS will be attained.

UDAQ herein commits to prepare and submit a milestone report no later than 90 days from the attainment date.

Chapter 9 – CONTINGENCY MEASURES

9.1 Background

The Fine Particulate Matter National Ambient Air Quality Standards: State Implementation Plan Requirements; Final Rule details under the contingency measure requirements (40 CFR 51.1014) that the state must include contingency measures that shall take effect with minimal further action by the State or the EPA following a determination by the EPA Administrator that the area has failed to:

- 1) meet the RFP requirements set forth in this SIP,
- 2) meet any quantitative milestone detailed in this SIP,
- 3) submit a quantitative milestone report for this SIP; or
- 4) attain the standard by the attainment date set forth in this SIP.

The PM Implementation Rule states that the contingency measure(s) shall include control measures that are not already included in the SIP. Each contingency measure shall specify the timeframe that the requirements will become effective following determination by the EPA Administrator that the area has failed to meet one of the requirements listed above in 1-4. The SIP must also contain a description of the specific trigger mechanisms for the contingency measure(s).

The rule does not include any specific level of emission reductions that must be adopted to meet the contingency measures requirement under section 172(c)(9).

9.2 Contingency Measures and Implementation Schedules for the Nonattainment Area

Nothing precludes a State from implementing a contingency measures before it is actually triggered, but the credit for a contingency measure may not be used in either the attainment or reasonable further progress demonstrations.

The following measure is already fully functioning, and it is not currently being used as a control strategy in this SIP:

Heavy-duty diesel engine emissions reduction programs: Through the EPA's Clean Diesel Program funded by the Diesel Emissions Reduction Act (DERA), Utah currently has an estimated \$5 million in grants to reduce diesel emissions by replacing or retrofitting old diesel engines that have outdated emissions standards with new, cleaner vehicles or emissions reduction retrofit equipment.

For calendar years 2015-2017, the average annual emissions reductions from Clean Diesel projects within the nonattainment area are as follows:

	NO_x	PM_{2.5}	VOC
2015	49 tons	3.4 tons	4.2 tons

2016	49 tons	3.4 tons	4.2 tons
2017	49 tons	3.4 tons	4.2 tons

Funding amounts have increased in recent years and the projected average annual emissions reduction based on funding sources already in place for the NAA for calendar years 2018-2020 are:

	NO_x	PM_{2.5}	VOC
2018	182 tons	14 tons	20 tons
2019	182 tons	14 tons	20 tons

The grant funding amounts are expected to stay similar or increase, resulting in the following minimum annual emissions reductions in the future:

	NO_x	PM_{2.5}	VOC
2020	182 tons	14 tons	20 tons
2021	182 tons	14 tons	20 tons
2022	182 tons	14 tons	20 tons
2023	182 tons	14 tons	20 tons

Since Clean Diesel projects are continuously being carried out in the State, it is not necessary for a trigger mechanism or implementation schedule. Therefore, this contingency measure will already be fully functioning and implemented in the case that it becomes necessary for credit.

