Chapter Three - Sources of Impairment in Nevada

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3.1 BACKGROUND

Federal visibility regulations at 40 CFR 51.308(d)(4)(v) require a statewide emission inventory of pollutants that are reasonably anticipated to cause or contribute to visibility impairment in any mandatory Class I area. The pollutants discussed in this chapter are sulfur oxides (SO_x), which include the particulate and gaseous phase, sulfur dioxide (SO_2), which includes the gas phase only, nitrogen oxides (NO_x), volatile organic compounds (VOC), primary organic aerosol (POA), elemental carbon (EC), PM fine (PMF), PM coarse (PMC), and ammonia (NH_3). Emission scenarios that were used for this analysis were the "Plan02d" and "PRP18a" inventories and were obtained from the Technical Support System (TSS) (http://vista.cira.colostate.edu/TSS/Results/Emissions.aspx). These inventories represent a series of refinements to previous inventories reflecting increasing levels of quality control and quality assurance by states and Western Regional Air Partnership's (WRAP) Regional Modeling Center (RMC) contractors.

This chapter presents the analysis of the sources of emissions of visibility impairing pollutants identified above. Emission inventories form one leg of the analysis stool to evaluate sources' impacts on visibility. Emission inventories were created for all critical chemicals or species known to directly or indirectly impact visual air quality. These inventories were input into air quality models to predict concentrations of pollutants over a given space and time. In support of the WRAP Regional Haze effort, RMC developed emissions inventories representing:

- 2002 Actual Baseline Emissions (Base02)
- 2000 Through 2004 Typical Baseline Emissions (Plan02)
- 2018 Base Case Emissions (Base18)
- 2018 Preliminary Reasonable Progress Emissions (PRP18)

The base and plan inventories represent a series of refinements to each inventory reflecting increasing levels of quality control and quality assurance by states and RMC contractors. The purpose of the Base02 inventory is to represent the actual conditions in calendar year 2002 with respect to ambient air quality and the associated sources of visibility impairing air pollutants. The purpose of the Plan02 inventory is to represent baseline emission patterns based on average, or "typical", conditions. It provides a basis for comparison with the 2018 projected emissions, as well as for gauging reasonable progress with respect to future year visibility.

Base18 represents conditions in future year 2018 with respect to sources of criteria and particulate matter air pollutants, taking into consideration growth and controls. The Base18 emissions scenario includes reductions due to "on-the-way" and "on-the-books" controls, consent decree reductions, SIP control measures, and other relevant regulations that have gone into effect since 2002, or will go into effect before the end of 2018. Modeling results based on the Base18 emission inventory are used to define the future year ambient air quality and visibility metrics. The PRP18 inventory was created to establish the most representative source-specific emissions projections data as the basis for preparing regional haze plans. The PRP18 inventory includes reductions to SO_x based on presumptive Best Available Retrofit Technology (BART) emission limits for large electric generating units (EGU)'s subject to BART.

Dispersion modeling predicts daily atmospheric concentrations of pollutants for the baseline year, and these modeled results are compared to monitored data taken from the Interagency Monitoring of Protected Visual Environments (IMPROVE) network. A second inventory is then created to predict emissions in 2018 based on expected controls, growth or other factors. Additional inventories are also created for future years to simulate the impact of different control strategies.

3.2 SOURCES OF VISIBILITY IMPAIRMENT

Emissions have been categorized by pollutant, source category and source area to provide for emissions analyses (Table 3-1).

TABLE 3-1

SUMMARY OF POLLUTANTS, SOURCE CATEGORIES, AND SOURCE AREAS

Pollutants	Source Categories	Source Areas
Sulfur dioxide (SO_2)	Point Sources	Pacific Offshore
Nitrogen oxides (NO_x)	Anthropogenic Fire Sources	Atlantic/Gulf Offshore
Volatile organic carbon (VOC)	Area Sources	WRAP States
Primary organic aerosol (POA)	WRAP Oil and Gas Sources	CENRAP States
Elemental carbon (EC)	On-Road Mobile Sources	Midwest RPO States
Particulate matter fine (PMF)	Off-Road Mobile Sources	MANE - VU States
Particulate matter coarse (PMC)	Road Dust	VISTAS States
Ammonia (NH_3)	Fugitive Dust	Canada
	Natural Fire Sources	Mexico
	Biogenic Sources	
	Wind Blown Dust	

Natural fire sources, biogenic sources and windblown dust are shown in *italics* to denote that they are natural sources; all other sources are anthropogenic.

3.2.1 Natural Sources of Visibility Impairment

Natural sources of visibility impairment include anything not directly attributed to human-caused emissions of visibility-impairing pollutants. Natural events (e.g. natural fire, biogenic emissions, and windblown dust) also introduce pollutants that contribute to haze in the atmosphere. Natural sources contribute to visibility impairment but natural emissions cannot be realistically controlled or prevented by Nevada or other regulatory agencies. In Nevada, natural sources are important contributors of EC, PM fine, PM coarse, POA, and VOC emissions.

3.2.2 Anthropogenic Sources of Visibility Impairment

Anthropogenic or human-caused sources of visibility impairment include anything directly attributable to human-caused activities that produce emissions of visibility-impairing pollutants. Some examples include point sources, area sources, mobile sources, oil and gas sources, road

dust, fugitive dust and anthropogenic fires. Generally anthropogenic emissions include not only those that are generated or originated within the boundaries of the United States, but also international emissions that are generated outside of the United States but transported into the region. Some examples include emissions from Mexico, Canada and maritime shipping emissions in the Pacific Ocean. Note that Mexican and Canadian emission inventories include both anthropogenic and natural emissions.

Although international anthropogenic sources contribute to visibility impairment, they cannot be regulated, controlled or prevented by Nevada and, as with natural emissions, are beyond the scope of this planning document. Any reductions in international emissions would likely fall under the purview of the USEPA administrator. Table 3-2 shows that in Nevada, anthropogenic sources are important contributors of SO_x, NO_x, and NH_3. The source of data summarized in Table 3-2 is shown in more detail in section 3.8.

TABLE 3-2

SUMMARY OF ANTHROPOGENIC AND NATURAL EMISSION SOURCES IN NEVADA

Pollutant	2002		2018	
	Anthropogenic Sources	Natural Sources	Anthropogenic Sources	Natural Sources
SO_x	96%	4%	94%	6%
NO_x	86%	14%	83%	17%
EC	27%	73%	17%	83%
PMF	44%	56%	51%	49%
PMC	38%	62%	47%	53%
NH_3	86%	14%	88%	12%
POA	9%	91%	9%	91%
VOC	10%	90%	10%	90%
Total emissions:	28%	72%	27%	73%

3.3 DEVELOPMENT OF THE 2002 AND 2018 EMISSION INVENTORIES

In general, emission inputs were prepared by individual states and tribes for point, area and most dust emissions categories. With input and review by states, tribes and Federal Land Managers, WRAP forums and workgroups prepared consistent and comparable WRAP region emissions data for the mobile, fire, ammonia, area source oil and gas, eastern Pacific offshore shipping, some dust and biogenics emissions categories. The WRAP RMC gathered the latest, best and most representative emissions estimates at the time from the CENWRAP, Eastern U.S., Canada and Mexico regions in executing the sequence of modeling simulations discussed below. Boundary conditions reaching North America from the rest of the world were jointly prepared by

all five Regional Planning Organizations (RPO)s from the GEOS-Chem global model.

The original 2002 and 2018 stationary point and area source emission inventories were developed by Eastern Research Group, Inc. (ERG) in 2005. At the request of the Western Governors' Association and the WRAP Stationary Sources Joint Forum, ERG calculated point and area sources emission projections for the Base18 inventory. A summary document was prepared by ERG January 25, 2006 (http://wrapair.org/forums/ssjf/documents/eictts/docs/WRAP_2018_EI-Version_1-Report_Jan2006.pdf). The original inventories evolved from states' actual emissions data submitted to USEPA for the 2002 National Emission Inventory (NEI). The 2002 NEI consisted of a complete set of point, non-point and mobile data that had been submitted to EPA. The 2002 emission inventory was chosen to provide a baseline against which reductions in visibility-impairing pollutants could be measured over time. The 2018 emission inventory was developed because 2018 is the year the first regional haze SIP planning period ends. Historical development of the different versions of the emission inventories that were developed for the Base02, the Plan02, the Base18 and the PRP18 inventories is described in detail in Chapter One.

3.4 POINT SOURCE EMISSION INVENTORY

Point sources are identified by point locations, typically because they are regulated and their locations are available in regulatory reports. Point sources can be further subdivided into EGU sources and non-EGU sources, particularly in criteria inventories in which EGUs are a primary source of NO_x and SO_x.

3.4.1 2000-2004 Baseline Emissions

A summary of NO_x and SO_2 emissions for the baseline period (Plan02d) in Nevada is noted in Table 3-3 by total tons and percent of total emissions by pollutant. The Plan02d inventory shows that nine facilities in Nevada contain 99 percent of the total SO_2 point emissions and that 19 facilities contribute to 97 percent of the total NO_x emissions in Nevada.

The data in Table 3-3 was compiled for the baseline period from the Plan02d inventory point source emissions-pivot table (01/14/08), located on the WRAP website (http://www.wrapair.org/forums/ssjf/pivot.html).

TABLE 3-3

SUMMARY OF SO_2 AND NO_X EMISSIONS
FROM NEVADA POINT SOURCES FOR THE BASELINE PERIOD

Annual Emissions (tpy)	SO_2		NO_x	
	Number of Facilities	Cumulative Percent of Total Point Source Emissions	Number of Facilities	Cumulative Percent of Total Point Source Emissions
> 10,000	1	79.5%	2	51.7%
2,000 to 10,000	1	93.1%	5	86.3%
500 to 2000	1	97.0%	4	94.4%
100 to 500	6	99.0%	8	97.0%

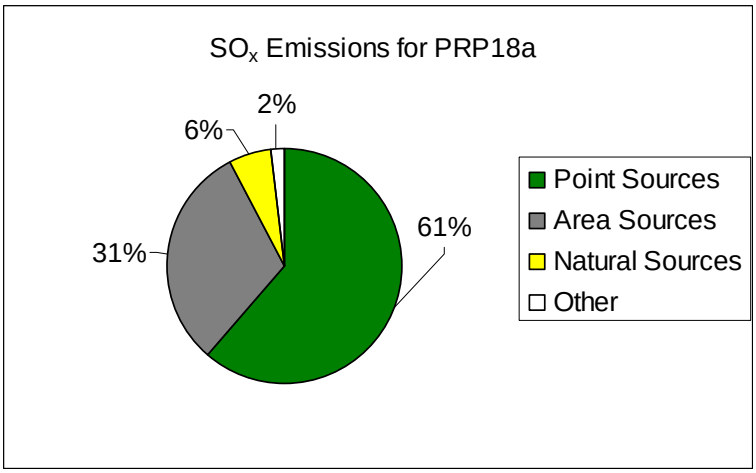
3.4.2 2018 Projected Emissions

SO_x includes emissions from both the particulate and gaseous phase. SO_2 refers only to emissions from the gaseous phase. The pivot tables only included emissions for SO_2. The TSS contained data for both SO_2 and SO_x. SO_2 emissions from point sources in Nevada are projected to total 27,526 tons from 13 facilities (three of which are proposed coal EGU facilities) by 2018. These 13 facilities represent 97.7 percent of the total SO_2 emissions from all point sources (28,167 tons) and 97.2 percent of the total SO_x emissions from all point sources (28,320 tons); see Table 3-4. The increase in point SO_2 vs. point SO_x emissions for the 2018 inventory is 153 tons; a 0.5 percent difference. The difference in total SO_2 emissions vs. total SO_x emissions for Nevada is an increase of 1.8 percent for the plan02d inventory and 2.5 percent for the PRP18a inventory. This equates to an increase in 1,236 tons for the plan02d inventory and 1,105 tons for the PRP18a inventory.

Figure 3-1 shows the percent contribution by source category for SO_x emissions projected for 2018, while Figure 3-2 shows the same for NO_x. Point sources represent 61 percent, area sources 31 percent, natural sources 6 percent and other source categories 2 percent of the total SO_x emissions. Natural sources include windblown dust, natural fire and biogenic source categories. Other includes on-road and off-road mobile sources, road dust, fugitive dust and anthropogenic fire source categories.

FIGURE 3-1

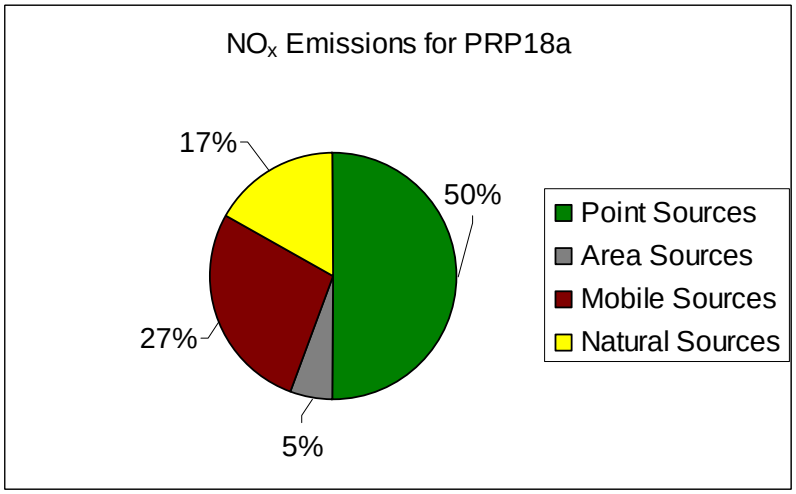
PERCENT CONTRIBUTION BY SOURCE CATEGORY FOR SO_x



NO_x emissions from point sources in Nevada are projected to total 65,581 tons from 15 facilities (three of which are proposed coal EGU facilities and two are natural gas EGU facilities) by 2018. These 15 facilities represent 97 percent of the total NO_x emissions from all point sources (67,632 tons) see Table 3-4. The pie chart shows the percent contribution by source category for NO_x emissions projected for 2018. Point sources represent 50 percent, mobile sources 27 percent, natural sources 17 percent, and area sources 5 percent of the total SO_2 emissions. The remaining one percent consists of emissions from oil and gas, fugitive dust and anthropogenic fire source categories.

FIGURE 3-2

PERCENT CONTRIBUTION BY SOURCE CATEGORY FOR NO_x



The data in Table 3-4 for SO_2 and NO_x was compiled from the 2018 inventory, PRP18a (11/14/07) point source emissions-pivot table, located on the WRAP website (http://www.wrapair.org/forums/ssjf/pivot.html). Nevada anticipates even further reductions in the future for both SO_x and NO_x from the projected controls to be installed at Nevada's four BART facilities. Chapter Five discusses those controls and proposed emission reductions in detail.

TABLE 3-4

SUMMARY OF SO_2 AND NO_X EMISSIONS FROM NEVADA POINT SOURCES FOR 2018

Annual Emissions (tpy)	SO_2		NO_x	
	Number of Facilities	Cumulative Percent of Total Point Source Emissions	Number of Facilities	Cumulative Percent of Total Point Source Emissions
> 10,000	0	0%	1	29.0%
2,000 to 10,000	3	78.7%	6	76.3%
500 to 2000	3	92.5%	8	90.8%
100 to 500	7	97.7%	15	97.0%

Table 3-5 shows emission projections for proposed EGU facilities as estimated for the 2018 emission inventory (PRP18a).

TABLE 3-5

PROPOSED 2018 EGUs AND CURRENT PERMIT ACTIVITY

	NO_x	PM_{10}	SO_2
Proposed EGUs in 2018 Emission Inventory	(tpy)	(tpy)	(tpy)
Future Coal EGU (Newmont - Northern Nevada Energy)	499	89	670
Future Natural Gas EGU (Copper Mountain - Sempra Energy)	887	71	6
Future Natural Gas EGU (Chuck Lenzie - NV Energy)	739	59	5
Future Coal EGU (White Pine Energy Association/LS Power)	3,909	670	4,356
Future Coal EGU (A)	1,340	261	1,452
Total Emissions from proposed 2018 EGUs	7,374	1,150	6,489

VOC, POA, EC, PMF and PMC emissions are dominated by natural sources. Figures 3-3 through 3-8 show a graphical representation for the projected PRP18a emissions. Figure 3-3 shows that natural sources, primarily from biogenic sources, represent 90 percent of the total projected VOC emissions.

FIGURE 3-3

PERCENT CONTRIBUTION BY SOURCE CATEGORY FOR VOC

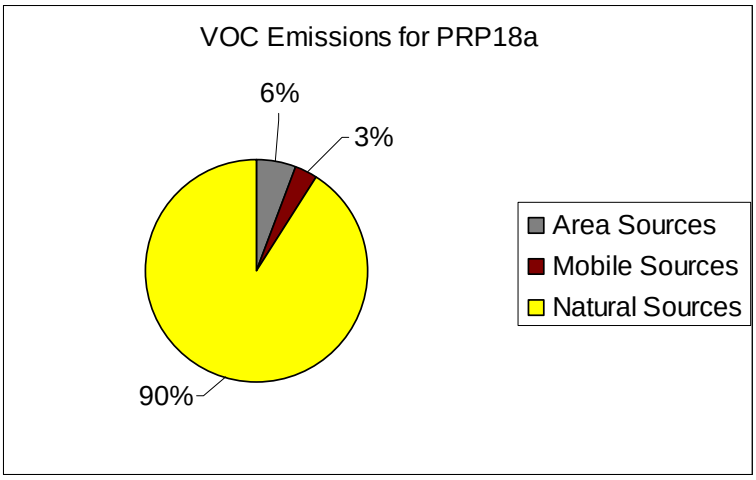


Figure 3-4 shows the percent contribution by source category for POA emissions projected for 2018. Natural fires comprise the majority of POA emissions at 91 percent.

FIGURE 3-4

PERCENT CONTRIBUTION BY SOURCE CATEGORY FOR POA

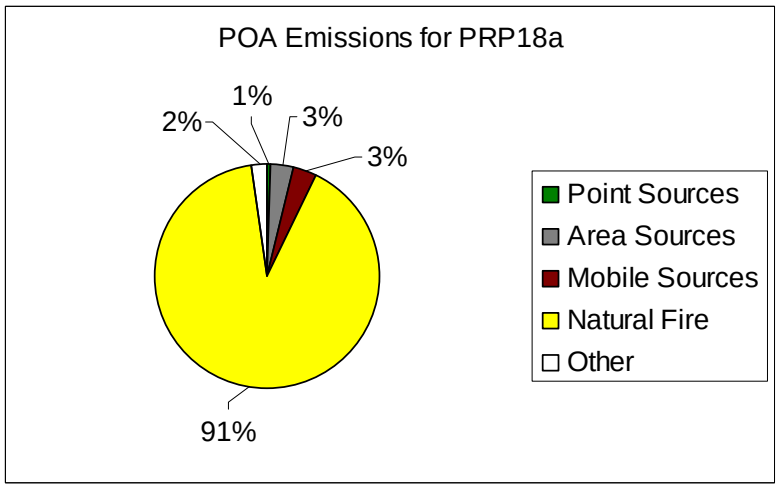


Figure 3-5 shows the percent contribution by source category for EC emissions projected for 2018. Natural fires comprise the majority of EC emissions at 83 percent.

FIGURE 3-5

PERCENT CONTRIBUTION BY SOURCE CATEGORY FOR EC

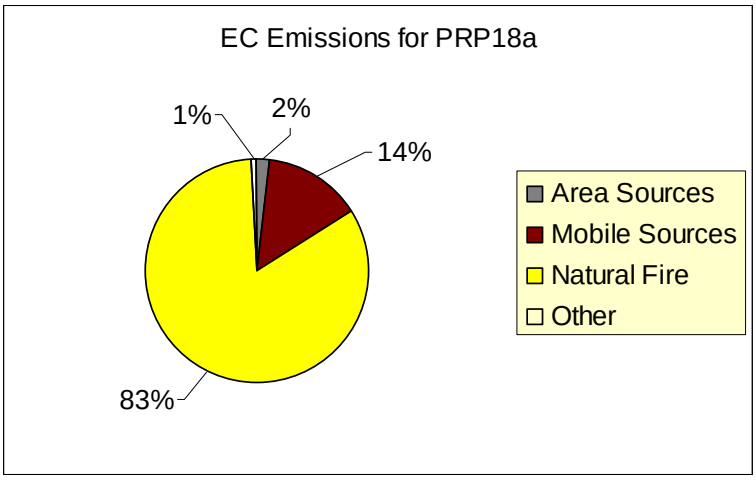


Figure 3-6 shows the percent contribution by source category for PM fine emissions projected for 2018. Natural sources, primarily from windblown dust, 43 percent, and natural fire, six percent, comprise the majority of PM fine emissions. Fugitive Dust is also a significant contributor of PM fine emissions at 30 percent.

FIGURE 3-6

PERCENT CONTRIBUTION BY SOURCE CATEGORY FOR PM FINE

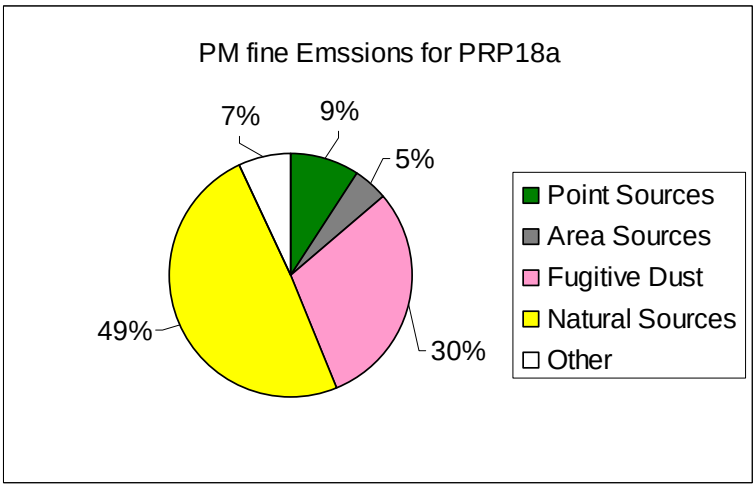


Figure 3-7 shows the percent contribution by source category for PM coarse emissions projected for 2018. Natural sources, primarily from windblown dust, 50 percent, and natural fire, three percent, comprise the majority of PM fine emissions. Fugitive Dust is also a significant contributor of PM coarse emissions at 36 percent.

FIGURE 3-7

PERCENT CONTRIBUTION BY SOURCE CATEGORY FOR PM COARSE

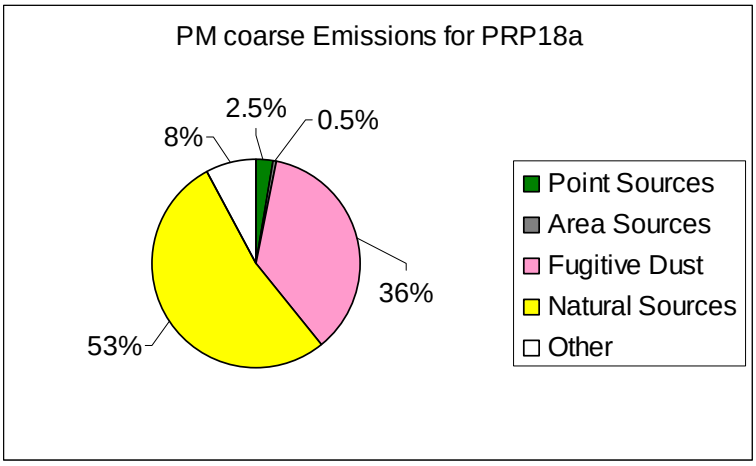
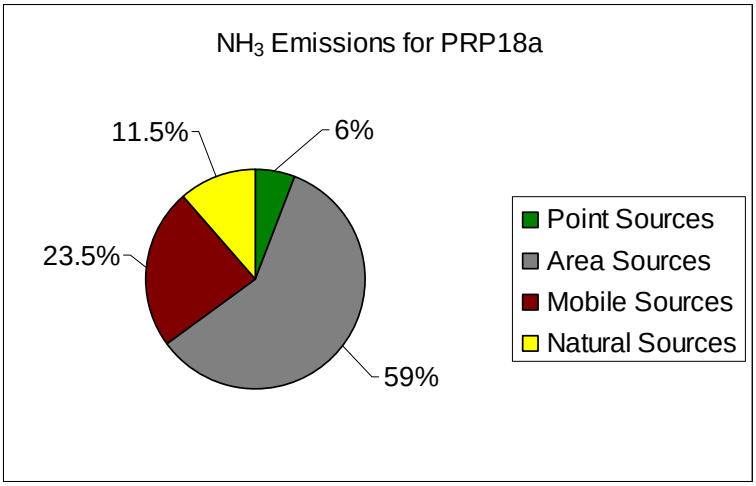


Figure 3-8 shows the percent contribution by source category for NH_3 emissions projected for 2018. Area sources, 59 percent, comprise the majority of NH_3 emissions. Mobile sources also a significant contributor of NH_3 emissions at 23.5 percent.

FIGURE 3-8

PERCENT CONTRIBUTION BY SOURCE CATEGORY FOR AMMONIA



3.5 FIRE EMISSION INVENTORY

The Fire Emissions Joint Forum of the WRAP, through a contract issued by the WGA to Air Sciences Inc. and E C/R incorporated, prepared Phase III baseline period (2000-2004) and Phase

IV projection year (PRP18a) fire emission inventories. A document was produced May 2007 describing these inventories. http://www.wrapair.org/forums/fejf/documents/task7/Phase3-4EI/WRAP_Fire_Ph3-4_EI_Report_20070515.pdf. Inventory years 2000 through 2004 were used to estimate the emissions for the 2000 through 2004 baseline period.

For the fire inventories in the Base02 inventory, actual 2002 data developed by the Regional Planning Organization' for the United States, version 2 of the year 2000 Canadian inventory and actual 2002 data for Ontario, Canada were used. There were no fire emissions in the 1999 Mexico inventories, so Mexican fires were not included in the Base02 inventories. The fire emission inventories developed for the WRAP modeling efforts were organized into seven source categories: wildfires, agricultural fires, wildland fire use, natural prescribed, anthropogenic prescribed, non-Federal rangeland fires and non-WRAP fires. The baseline period fire emission inventories were built based upon the Fire Emissions Joint Forum's Phase II (historical 2002) inventories for wildfire, wildland fire use, prescribed burning, agricultural burning and non-federal rangeland burning.

The difference between the Base02 and the Plan02 inventories was that actual fire data was used in Base02 and an average of fire data for years 2000 through 2004 was used to smooth out the high 2002 fire year to give a more typical fire inventory for Plan02. Thus, the Base02 was used for model performance evaluation and to represent actual emissions for comparison with actual data. Plan02 data was used for planning purposes as a typical dataset for the baseline period.

In the Base18b inventory for WRAP, CENRAP, and VISTAS, the baseline fire emission inventories were held constant at Plan02 typical emission levels. The Natural Fire source category emission inventory projection was held constant from 2002 to 2018 (PRP18a).

3.6 AREA SOURCE INVENTORY

The area source emission inventory was primarily driven by population and/or economic growth as expressed by growth factors from USEPA's EGAS growth factor model. EGAS Version 5.0 generates SCC-specific growth factors for a specified geographic area using various socio-economic data. For area sources, growth factors were obtained from one of three sources: the EGAS growth factor model, energy projections from Energy Information Administration or agricultural crop projections from the U.S. Department of Agriculture.

3.7 OVERVIEW OF EMISSION INVENTORY SYSTEM - TSS

The WRAP developed the Technical Support System (TSS) as an Internet access portal to all the data and analysis associated with the development of the technical foundations of regional haze plans across the Western US. The TSS provides state, county and grid cell level emissions information for typical criteria pollutants such as SO_2 and NO_x and other secondary particulate forming pollutants such as VOC and NH_3. Eleven different emission inventories were developed comprising the following source categories: point, area, on-road mobile, off-road mobile, oil and gas, anthropogenic fire, natural fire, biogenic, road dust, fugitive dust and windblown dust. More detailed information on the emission inventory information can be found on the WRAP TSS website at the following link: http://vista.cira.colostate.edu/TSS/Results/Emissions.aspx .

Additional emission information including regional emissions can be found on the WRAP RMC website at: http://pah.cert.ucr.edu/aqm/308/.

3.8 EMISSIONS IN NEVADA

The pollutants inventoried by the WRAP include SO_2, SO_x, NO_x, VOC, POA, EC, fine particulate (Soil-$PM_{2.5}$), coarse particulate ($PM_{2.5}$ to PM_{10}), and NH_3. An inventory was developed for the baseline year 2002, and projections of future emissions have been made for 2018. Nevada will provide updates to the WRAP on this inventory on a periodic basis. For purposes of the Regional Haze SIP, the WRAP developed emission inventories for each state with input from participating stakeholders.

The process for inventorying sources is similar for all species of interest. The number and types of sources is identified by various methods. For example, major stationary sources report actual annual emission rates to the USEPA national emissions database. Nevada collects annual emission data from both major and minor sources and this information is used as input into the emissions inventory. In other cases, such as mobile sources, a USEPA mobile source emissions model is used to develop emission projections. Nevada vehicle registration, vehicle mile traveled information and other vehicle data are used to tailor the mobile source data to best represent statewide and area specific emissions. Population, employment and household data are used in other parts of the emissions modeling to characterize emissions from area sources such as home heating. Thus, for each source type, emissions are calculated based on an emission rate and the amount of time the source is operating. Emission rates can be based on actual measurements from the source, or USEPA emission factors based on data from tests of similar types of emission sources. In essence, all sources go through a similar process. The number of sources is identified, emission rates are determined by measurements of those types of sources and the time of operation is determined. Annual emissions can be obtained by multiplying the emission rate times the number of hours of operation in a year.

Table 3-6 summarizes Nevada's statewide emissions for 2002 and 2018 projections in tons and are noted as either anthropogenic sources or natural sources. The percent change in tons from 2002 to 2018 is shown on a pollutant basis. Detailed discussions of each pollutant are described in the following sections. Based on the information presented in Table 3-6 the projected (PRP18a) sum of anthropogenic emissions for SO_x and NO_x for all source categories is 11.7 percent of the total 2018 projected sum of emissions statewide.

The figures and tables in this section and the remainder of this chapter are based on the Plan02d and PRP18a emission inventories. These inventories are described in detail in Chapter One, Section 1.3.2.

TABLE 3-6

EMISSIONS SUMMARY TABLE FOR NEVADA FOR 2002 AND 2018:
NATURAL VS. ANTHROPOGENIC SOURCES

Emissions Summary Table (tons per year)							
	2002			2018			
	Anthro-pogenic Source	Natural Source	Total Tons 2002	Anthro-pogenic Source	Natural Source	Total Tons 2018	Percent Change
SO_x	66,195	2,784	68,979	43,440	2,784	46,224	-33.0%
NO_x	139,372	23,102	162,475	112,394	23,102	135,496	-16.6%
EC	1,735	4,674	6,409	964	4,674	5,638	-12.0%
PMF	9,125	11,845	20,969	12,289	11,845	24,134	15.1%
PMC	62,020	99,122	161,142	89,165	99,122	188,287	16.8%
NH_3	10,408	1,684	12,092	12,819	1,684	14,503	19.9%
POA (OC)	2,233	22,501	24,734	2,321	22,501	24,822	0.4%
VOC	85,357	811,745	897,102	85,962	811,745	897,707	0.1%
Total emissions:	376,444	977,458	1,353,902	359,354	977,458	1,336,811	-1.3%

3.8.1 Nevada SO_x Emission Inventory for 2002 and 2018

Sulfur dioxide gases (SO_2) are formed when sulfur-containing fuels, such as diesel or coal, are burned, when gasoline is extracted from oil or when metals are extracted from ore. SO_2 dissolves in water vapor to form acid, and contributes to the formation of sulfate compounds [e.g. $(NH_4)_2SO_4$] when ammonia is available. These compounds can scatter the transmission of light, thus contributing to visibility reduction on a regional scale at our Class 1 Area.

Sulfur dioxide emissions produce sulfate particles in the atmosphere. Ammonium sulfate particles have a significantly greater impact on visibility than other pollutants like dust from unpaved roads due to the physical characteristics causing greater light scattering from the particles. Sulfur dioxide emissions come primarily from coal combustion at electrical generation facilities but smaller amounts come from natural gas combustion, mobile sources and even wood combustion.

A 33 percent statewide reduction in SO_x emissions is expected by 2018 due to planned controls on existing sources; even with the growth consideration in electric generating power for the state. Point sources account for 74 percent of SO_x emissions in the Plan02d inventory and decrease to 60 percent for 2018 projections as a result of stationary source controls. The PRP18 inventory included reductions to SO_x presumptive limits for subject to BART large EGU's. Power plants with a total generating capacity in excess of 750 MW must meet specific control levels for SO_2 of either 95 percent control or 0.15 lbs/MMBtu, for each EGU greater than 200 MW. Reductions seen in mobile source emissions are a result from the implementation of low-sulfur

diesel fuel standards and other control programs discussed in Chapter Six. SO_x emissions from road dust and fugitive dust and to a lesser extent from area sources are anticipated to increase by 2018. Similar reductions in the west are expected from other states as BART and other planned controls take effect by 2018.

Figure 3-9 and Table 3-7 show the overall net decrease in emissions from 2002 to 2018 for Sulfur Oxides by source category. In all instances, ND means that you would never see these pollutants for these source categories (i.e. they do not exist from these emission sources).

FIGURE 3-9

NEVADA SO_x EMISSION INVENTORY – 2002 AND 2018

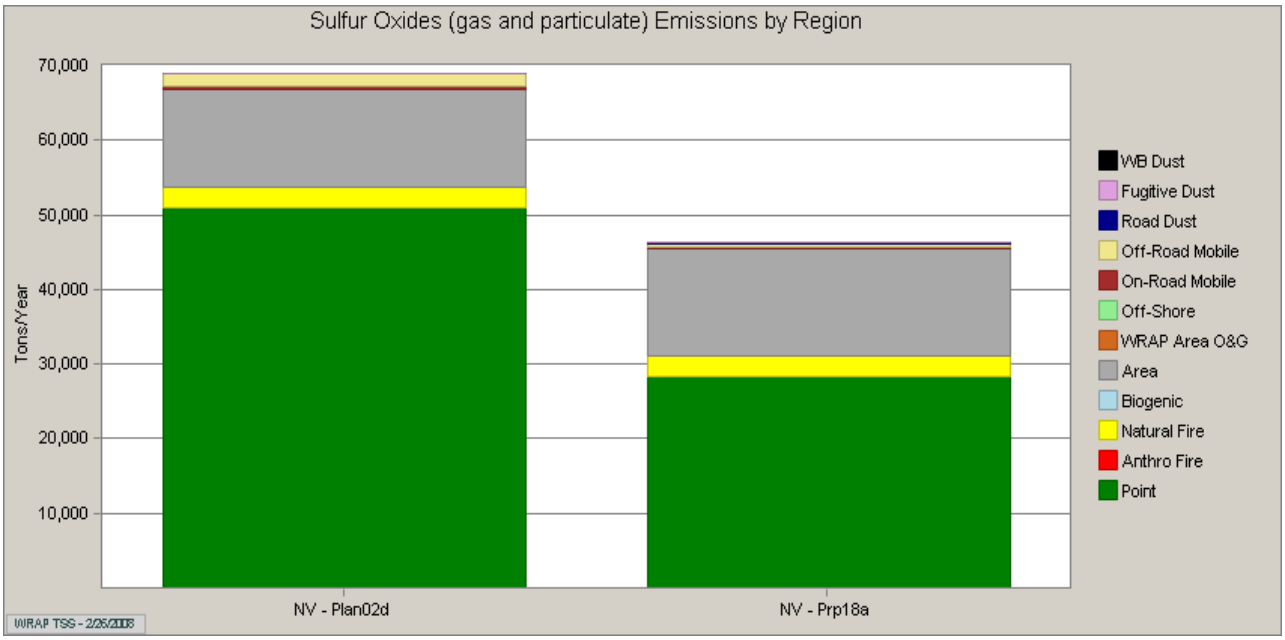


TABLE 3-7

NEVADA SO_x EMISSIONS BY SOURCE CATEGORY FOR 2002 AND 2018

Nevada Planning and Baseline Emission Inventories			
Source Category	Statewide SO_x		
	Plan 02d (tpy)	PRP 18a (tpy)	Net Change
Point	50,947	28,320	-44%
Area	13,037	14,280	10%
On-Road Mobile	510	336	-34%
Off-Road Mobile	1,672	473	-72%
Oil and Gas	1	0	-94%
Road Dust	3	5	53%
Fugitive Dust	10	13	35%
Windblown Dust	ND	ND	ND
Anthro Fire	14	12	-14%
Natural Fire	2,784	2,784	0%
Biogenic	ND	ND	ND
Total:	68,979	46,224	-33%

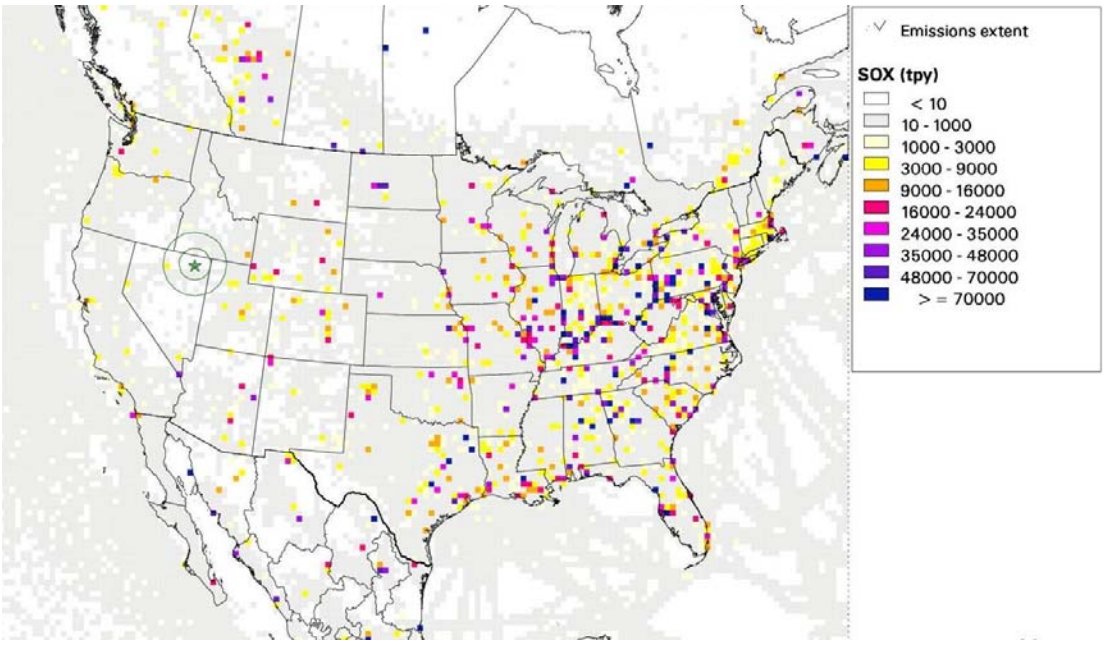
Figure 3-10, "Regional Maps of SO_x Emissions for 2002 and 2018," shows extensive areas within Nevada with less than 10 tons per year of SO_x emissions. Areas with more color are from urban/industrial areas of Reno and Las Vegas; a few larger areas of greater emissions are due to EGUs or other large point sources.

Figure 3-11, provides the Plan02d and PRP18a regional sulfur oxides (SO_x) emission maps with the location of the JARB1 IMPROVE monitor identified with a green star surrounded by 100 km and 200 km radius concentric circles.

FIGURE 3-10

REGIONAL MAPS OF SO_x EMISSIONS FOR 2002 AND 2018

2002



2018

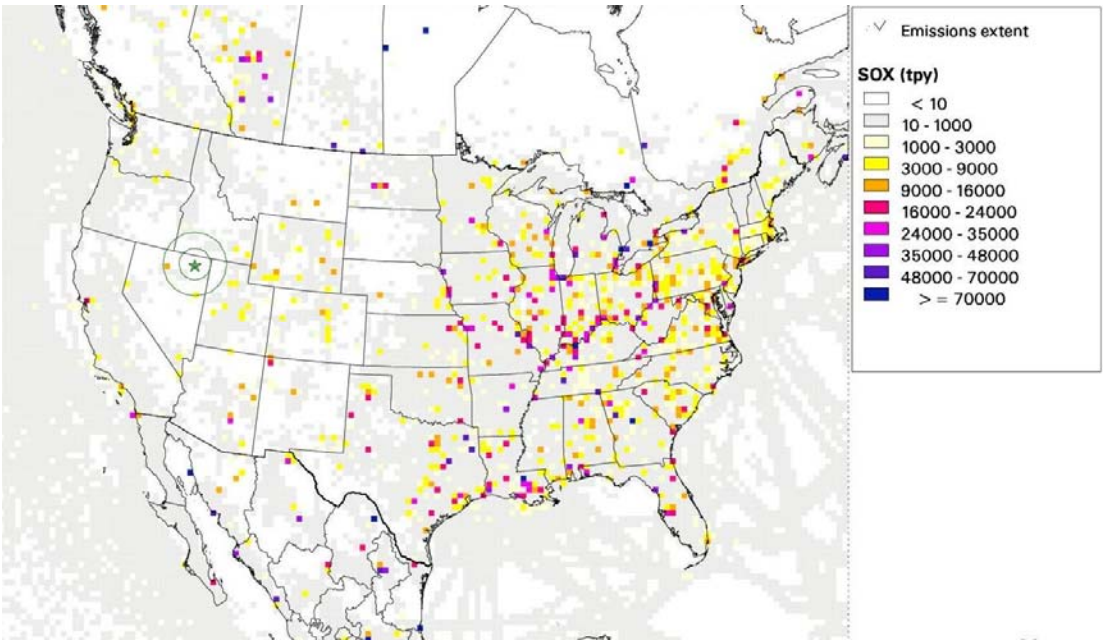
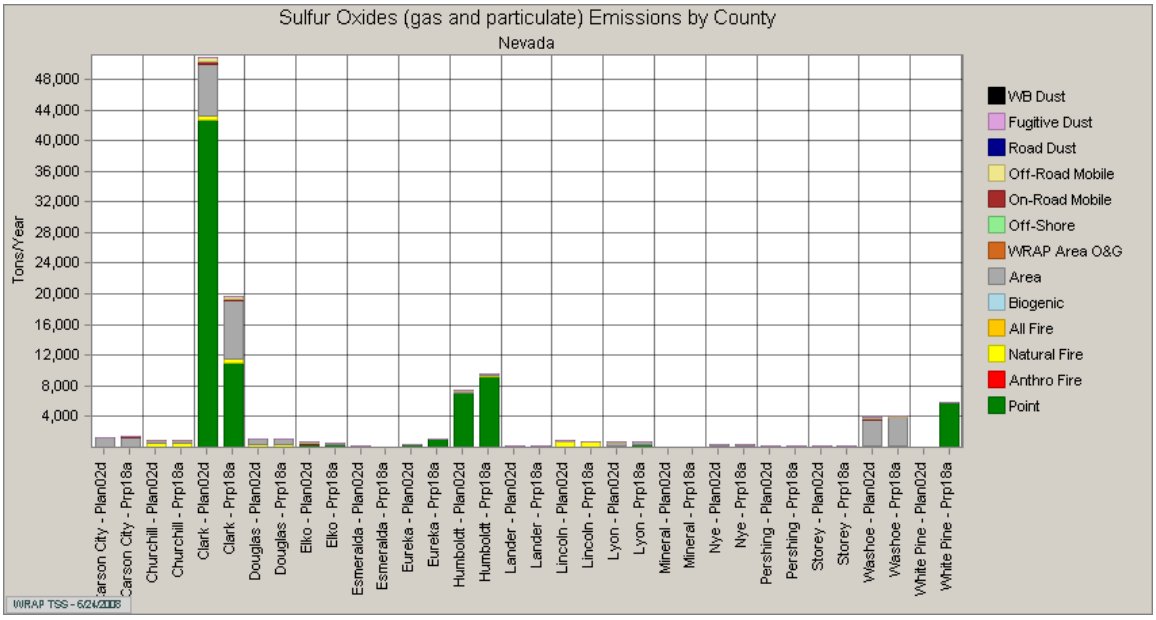


Figure 3-11 shows SO_x emissions by county and contribution by source category. Clark and Humboldt counties are dominated by point source emissions for 2002. Eureka, Humboldt and White Pine counties' projected emission increases for 2018 are primarily due to EGU sources. Area sources are the second most dominant contributor to SO_x emissions for Clark and Washoe counties.

FIGURE 3-11

SULFUR OXIDE EMISSIONS BY COUNTY (Plan02d) AND (PRP18a)



3.8.2 Nevada NO_X Emission Inventory for 2002 and 2018

NO_x is generated during any combustion process where nitrogen and oxygen from the atmosphere combine together under high temperature to form nitric oxide and to a lesser degree nitrogen dioxide and in much smaller amounts other odd oxides of nitrogen. These particles have a slightly greater impact on visibility than do sulfate particles and are four to eight times more effective at scattering light than mineral dust particles. These compounds can scatter the transmission of light, contributing to visibility reduction on a regional scale.

Point sources in Nevada contribute 37 percent of the total NO_x emissions from the Plan02d inventory and are projected to contribute 50 percent of the overall inventory for PRP18a. This net increase of 13 percent in point emissions does not incorporate any projected decrease in emissions due to installation of Nevada BART controls. Overall, NO_x emissions in Nevada are expected to decline by 17 percent, primarily due to significant reductions in emissions from mobile sources (from 45 percent in 2002 decreasing to 27 percent in 2018) primarily due to new federal vehicle emission standards. This equates to a 36,423 ton decrease in NO_x emissions from mobile sources. The 29 percent increase in area sources is largely due to forecasted increases in activity levels based on population growth. Figure 3-12 and Table 3-8 show the breakdown of NO_x emissions by source category for 2002 and 2018.

FIGURE 3-12

NEVADA NO_x EMISSION INVENTORY – 2002 AND 2018

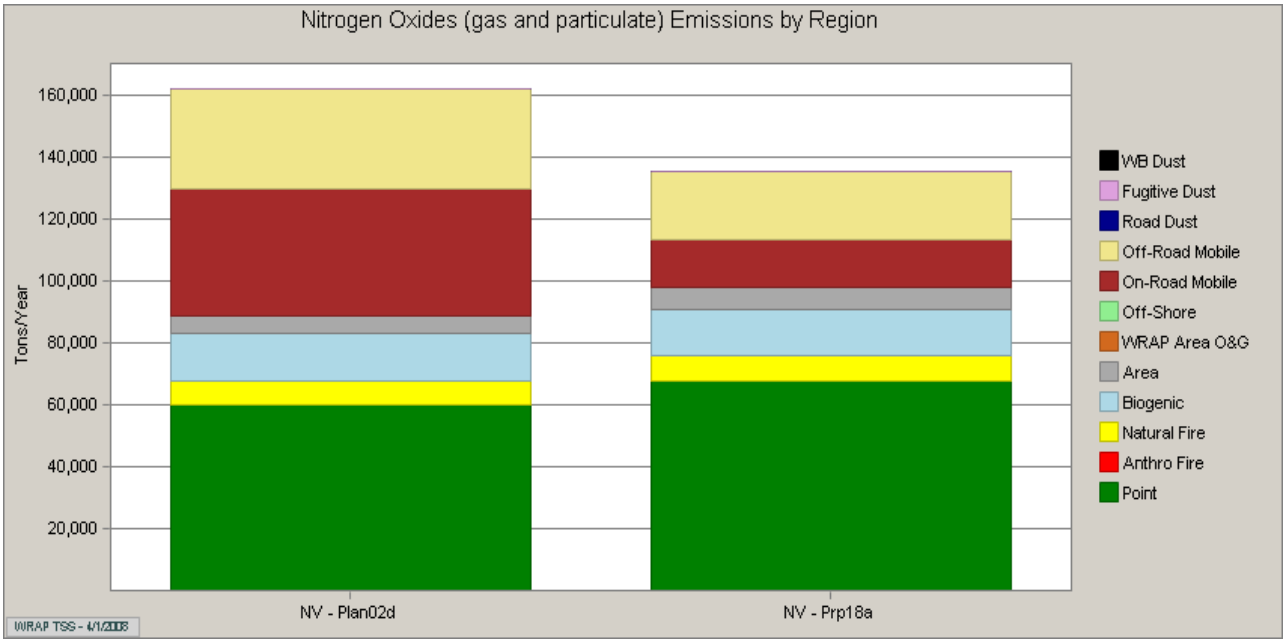


TABLE 3-8

NEVADA NO_x EMISSIONS BY SOURCE CATEGORY FOR 2002 AND 2018

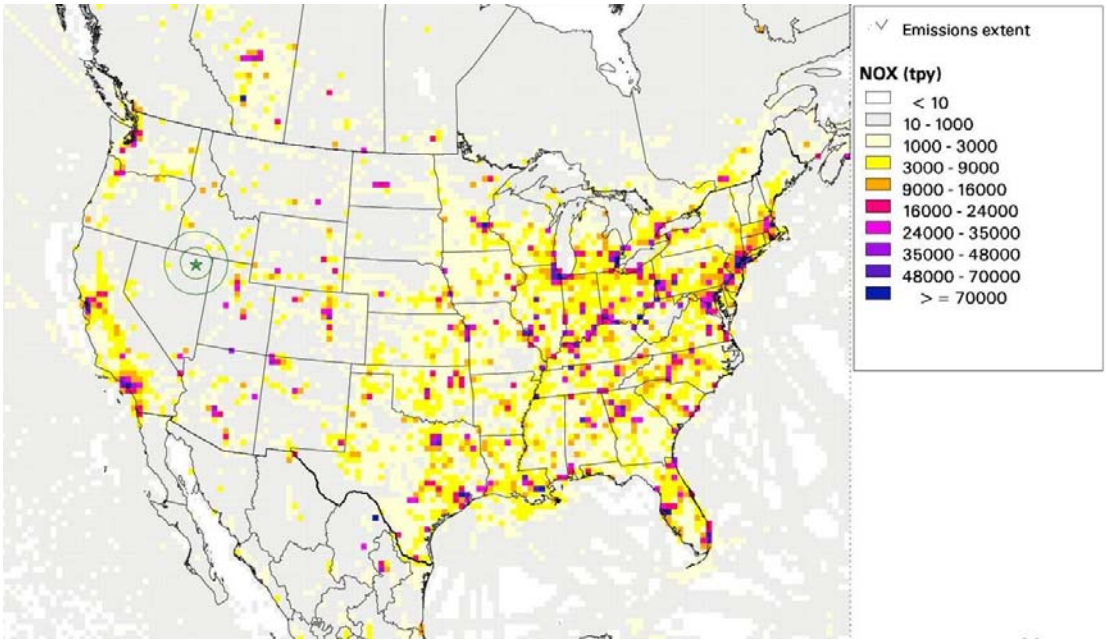
Nevada Planning and Baseline Emission Inventories			
Source Category	**Statewide NO_x**		
	Plan 02d	PRP 18a	Net Change
	(tpy)	(tpy)	
Point	59,873	67,632	13%
Area	5,728	7,418	29%
On-Road Mobile	41,089	15,049	-63%
Off-Road Mobile	32,565	22,182	-32%
Oil and Gas	63	63	1%
Road Dust	1	2	53%
Fugitive Dust	5	8	54%
Windblown Dust	ND	ND	ND
Anthro Fire	48	41	-16%
Natural Fire	8,085	8,085	0%
Biogenic	15,018	15,018	0%
Total:	162,475	135,496	-17%

Figure 3-13 provides the Plan02d and PRP18a regional NO_x emission maps with the location of the JARB1 IMPROVE monitor identified with a green star surrounded by 100 km and 200 km radius concentric circles.

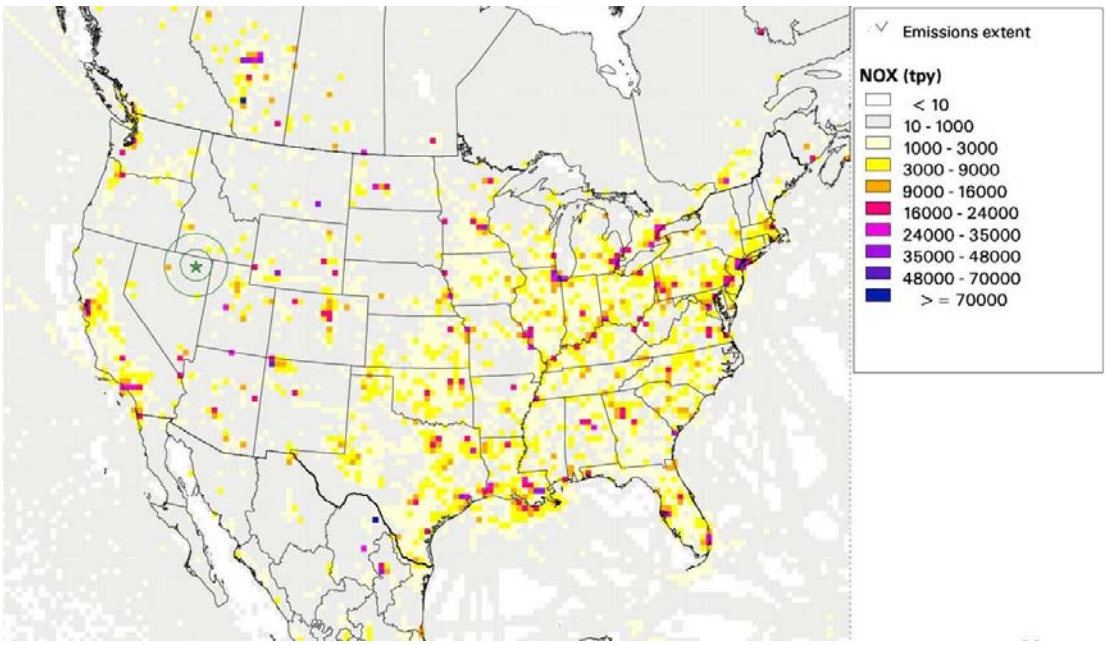
FIGURE 3-13

REGIONAL MAP OF NO_x EMISSIONS FOR 2002 AND 2018

2002



2018

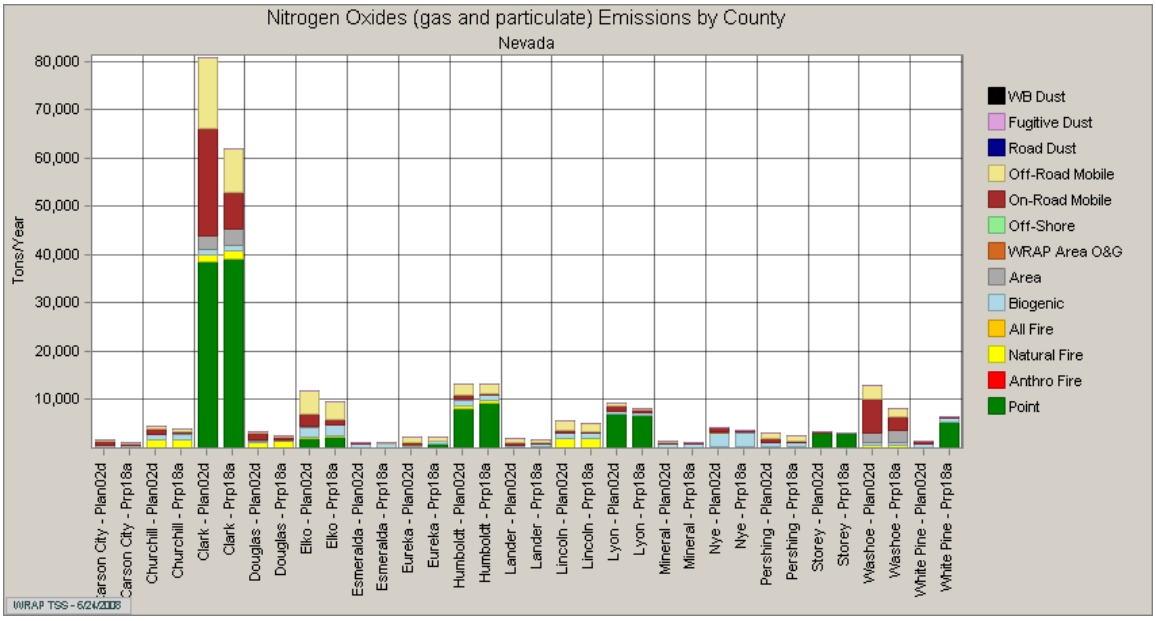


In Figure 3-14, note that for both 2002 and 2018, NO_x emissions in Nevada are primarily in the 10-1,000 tons per year range, except for the urban and industrial centers in Washoe and Clark counties.

Figure 3-14 shows NO_x emissions by county and contribution by source category. Clark, Humboldt, Lyon and Storey counties are dominated by point source emissions for 2002 as well as 2018 due to projected EGUs. Note the increase in point source emissions for White Pine County for 2018 due to proposed power plant(s). On-road mobile sources are the second most dominant contributor to NO_x emissions for Clark and Washoe counties for 2002, but with significant reductions by 2018, primarily due to the new federal vehicle emission standards.

FIGURE 3-14

NITROGEN OXIDE EMISSIONS BY COUNTY (Plan02d) AND (PRP18a)



3.8.3 Nevada VOC Emission Inventory for 2002 and 2018

VOCs are emitted as gases from certain solids or liquids. VOCs are emitted by a wide array of products numbering in the thousands. Examples include paints and lacquers, paint strippers, cleaning supplies, pesticides, building materials and furnishings, office equipment such as copiers and printers, correction fluids and carbonless copy paper, craft materials including glues and adhesives, permanent markers and photographic solutions (http://www.epa.gov/iedweb00/voc.html). Automobiles, industrial and commercial facilities, and refueling of automobiles all contribute to VOC loading in the atmosphere. Substantial natural emissions of VOCs come from vegetation; these emissions are categorized as biogenics. VOCs can directly impact visibility as emissions condense in the atmosphere to form an aerosol. Of more significance is the role VOCs play in the photochemical production of ozone in the troposphere. VOCs react with nitrogen oxides to produce nitrated organic particles that impact

visibility in the same series of chemical events that lead to ozone. Thus, strategies to reduce ozone in the atmosphere often lead to visibility improvements. VOCs in Nevada are expected to increase slightly (0.07 percent) by 2018.

Figure 3-15 and Table 3-9 show the overall net zero percent change in emissions from 2002 to 2018 for VOCs. Biogenic sources, primarily from terpenes, dominate VOC emissions at approximately 90 percent for both 2002 and 2018. Area source emissions show a net increase in emissions, but area sources account for only 3.2 percent and 5.9 percent of the 2002 and 2018 VOC emission inventory respectively. Point VOC emissions show a net change of 75 percent, but point sources account for only 0.25 percent of the 2002 and 0.4 percent of the 2018 VOC emission inventory.

FIGURE 3-15

NEVADA VOC EMISSION INVENTORY – 2002 AND 2018

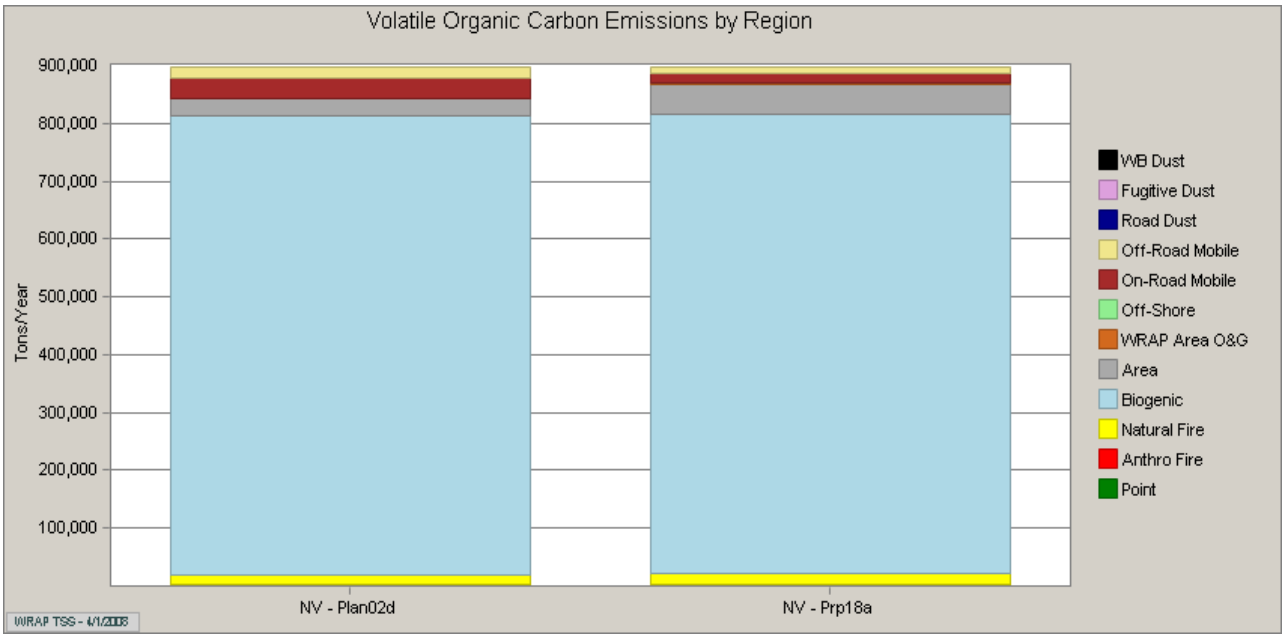


TABLE 3-9

NEVADA VOC EMISSIONS BY SOURCE CATEGORY FOR 2002 AND 2018

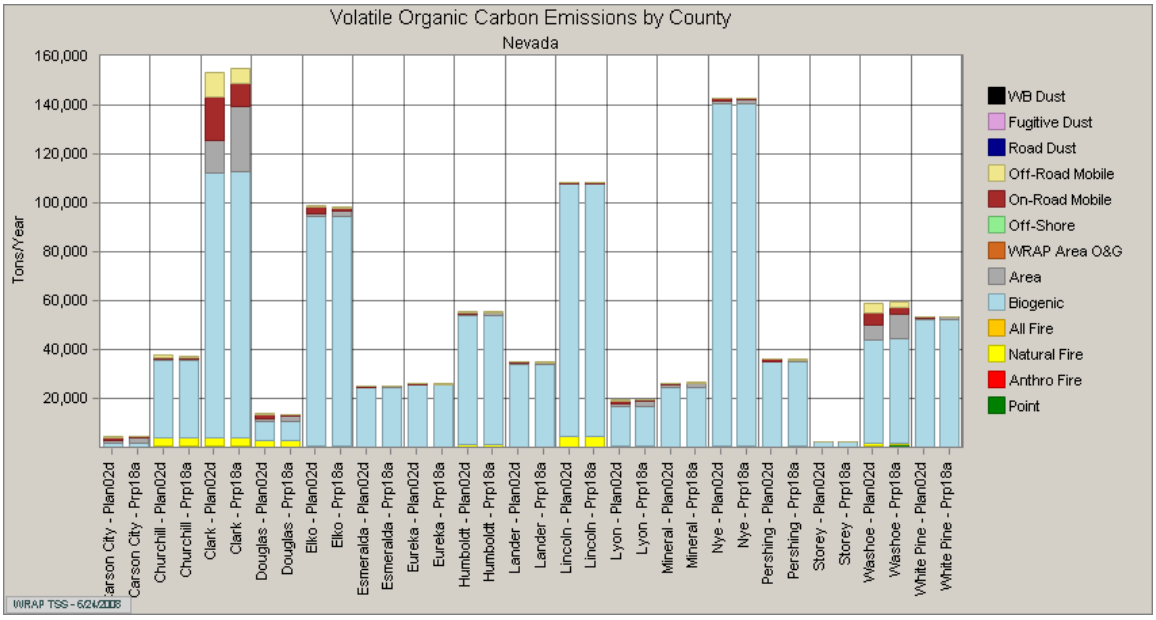
Nevada Planning and Baseline Emission Inventories			
Source Category	Statewide VOC		
	Plan 02d (tpy)	PRP 18a (tpy)	Net Change
Point	2,215	3,866	75%
Area	28,592	53,014	85%
On-Road Mobile	36,257	17,085	-53%
Off-Road Mobile	18,094	11,784	-35%
Oil and Gas	129	163	26%
Road Dust	ND	ND	ND
Fugitive Dust	ND	ND	ND
Windblown Dust	ND	ND	ND
Anthro Fire	70	50	-28%
Natural Fire	17,606	17,606	0%
Biogenic	794,139	794,139	0%
Total:	897,102	897,707	0%

There were no regional emission maps for VOCs created in the TSS.

Figure 3-16 shows VOC emissions by county. Biogenic sources dominate the VOC emissions for all counties in Nevada. Clark and Washoe counties show decreases to mobile source emissions and increases in area source emissions. Biogenic and natural fire emissions were held constant for the 2018 projections.

FIGURE 3-16

VOLATILE ORGANIC CARBON EMISSIONS BY COUNTY (Plan02d) AND (PRP18a)



3.8.4 Nevada POA Emission Inventory for 2002 and 2018

Primary organic aerosol (POA) includes organic molecules or compounds that are directly emitted from the combustion of organic material. These organic compounds include organic carbon (OC), hydrogen, oxygen as well as other organic atoms. Wide varieties of sources contribute to this classification, and include: combustion byproducts from wood and agricultural burning, diesel emissions, and the cooking of meat. Natural fire emissions however dominate this classification for Nevada, contributing to more than 90 percent of the total statewide emissions. Note that natural fire emissions were held constant for 2018 projections. Road dust and fugitive dust also show increases in POA emissions, but the projected emissions for these two source categories is only 2 percent of the total. Area sources, on-road mobile, road dust and fugitive dust increases are minimal and are likely due to growth projections. POAs are projected to have a small increase of 88 pounds of emissions by 2018.

Figure 3-17 and Table 3-10 show an overall negligible increase in total POA emissions from 2002 to 2018.

FIGURE 3-17

NEVADA POA EMISSION INVENTORY – 2002 AND 2018

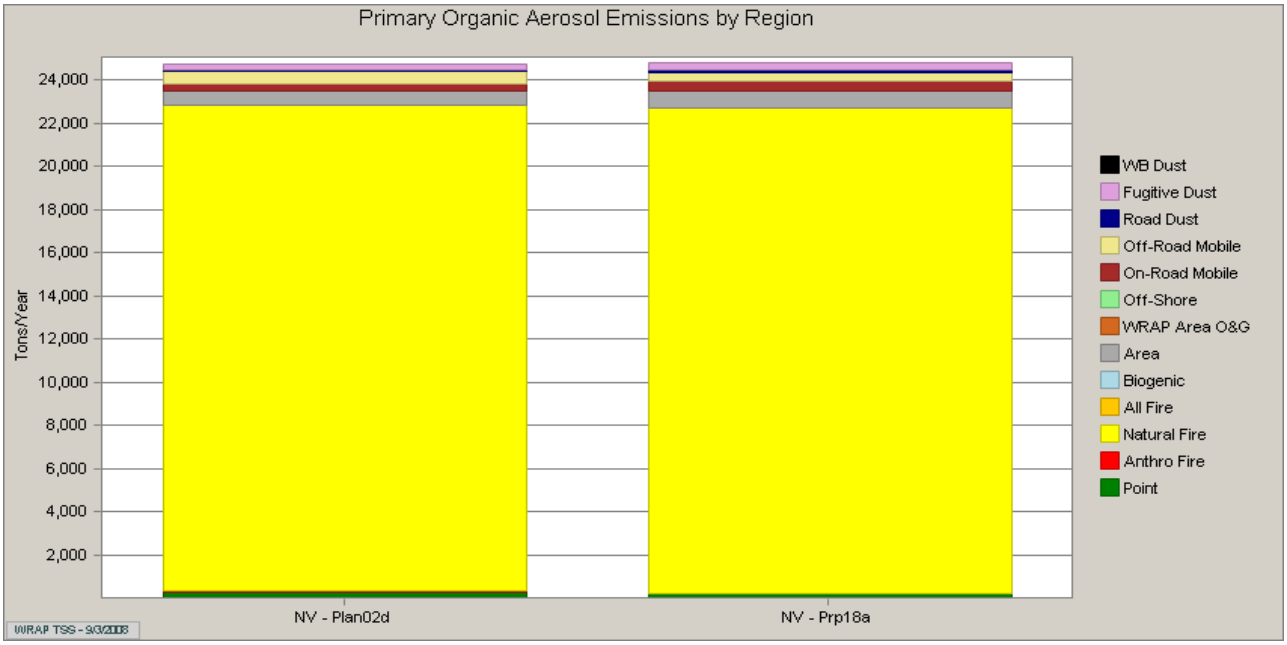


TABLE 3-10

NEVADA POA EMISSIONS BY SOURCE CATEGORY FOR 2002 AND 2018

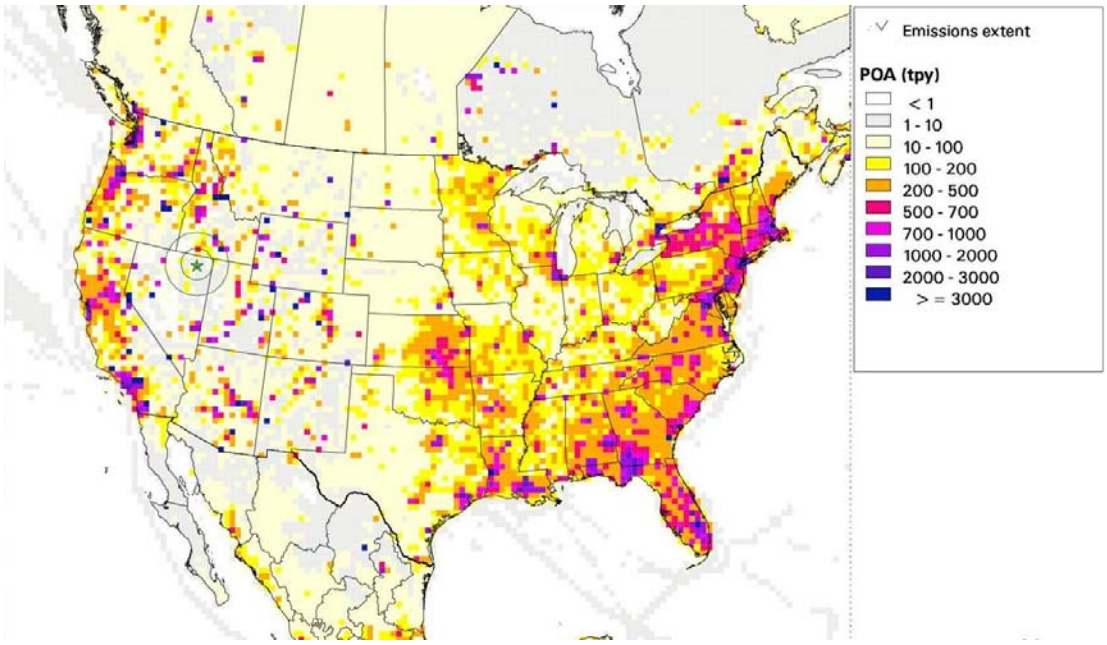
Nevada Planning and Baseline Emission Inventories			
Source Category	Statewide POA		
	Plan 02d (tpy)	PRP 18a (tpy)	Net Change
Point	256	168	-34.2%
Area	687	776	13.0%
On-Road Mobile	314	422	34.4%
Off-Road Mobile	572	393	-31.3%
Oil and Gas	0	0	0.0%
Road Dust	91	139	53.2%
Fugitive Dust	241	370	53.6%
Windblown Dust	ND	ND	ND
Anthro Fire	73	52	-28.2%
Natural Fire	22,501	22,501	0.0%
Biogenic	ND	ND	ND
Total:	24,734	24,822	0.4%

Figure 3-18, provides the Plan02d and PRP18a regional POA emission maps with the location of the JARB1 IMPROVE monitor identified with a green star surrounded by 100 km and 200 km radius concentric circles.

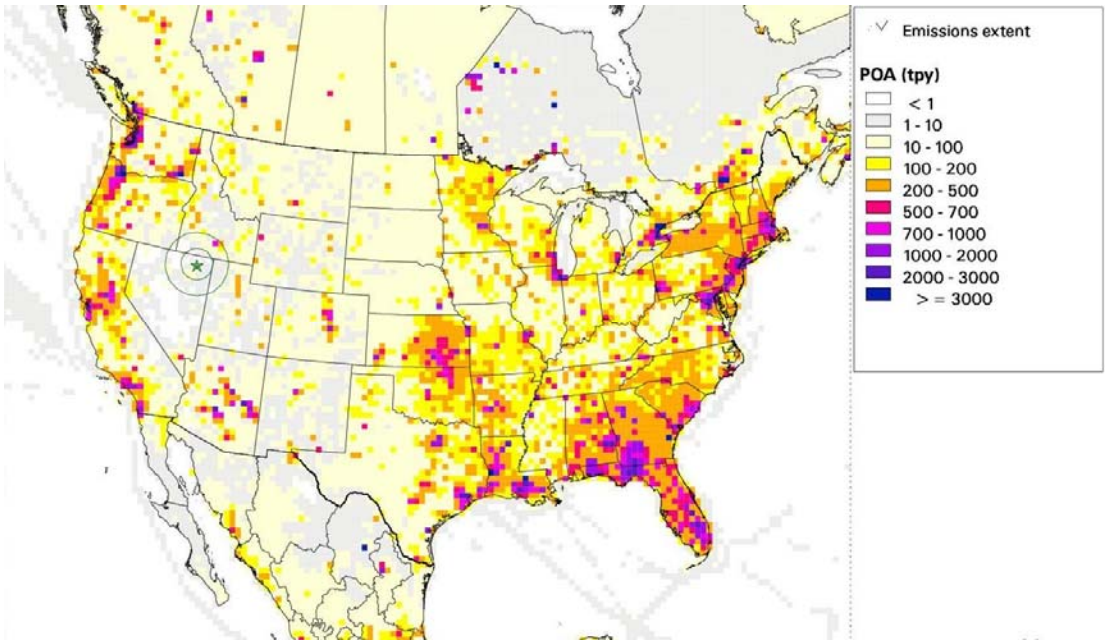
FIGURE 3-18

REGIONAL MAPS OF POA EMISSIONS FOR 2002 AND 2018

2002



2018



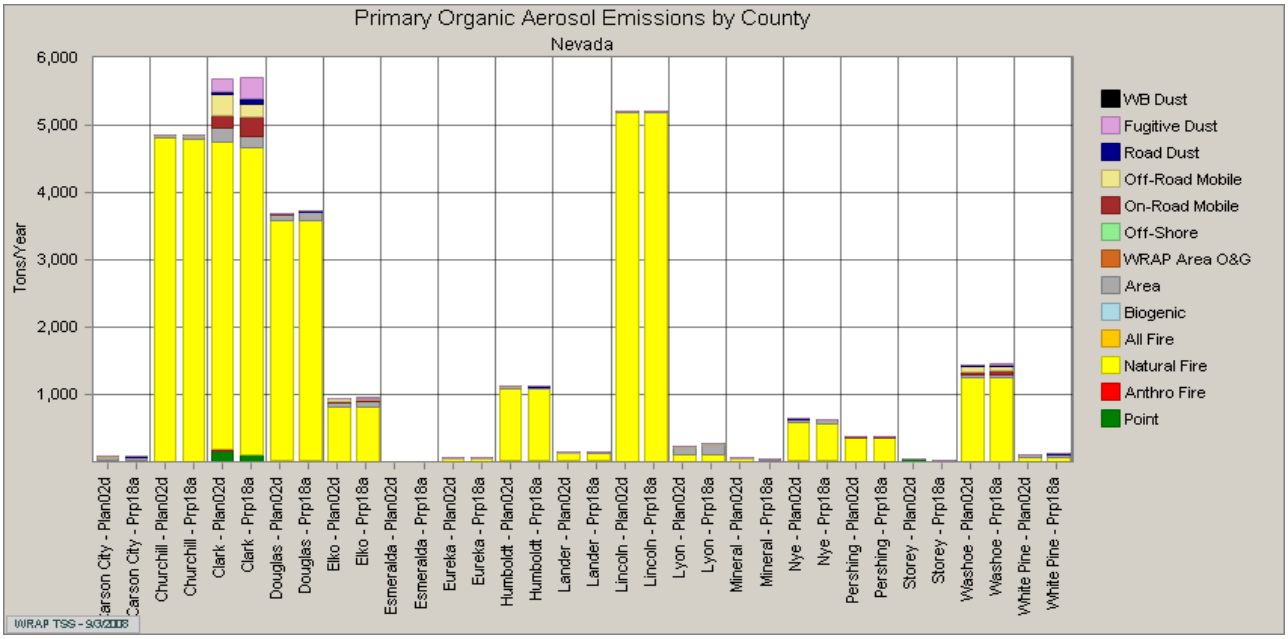
In Figure 3-18, note that there are significant decreases in POA emissions for Nevada. Large

portions of Nevada show less than one ton per year of POA emissions for 2002, and even fewer cell with emissions less than 10 tons per year for 2018. Even though the POA net change is zero for Nevada, controls implemented in other states are reflected in Nevada's projections.

Figure 3-19 shows that Lincoln, Churchill, Clark, and Douglas counties were dominated by natural fire events in 2002, and since those projections were held constant, those same counties show identical emissions in 2018.

FIGURE 3-19

PRIMARY ORGANIC AEROSOL EMISSIONS BY COUNTY (Plan02d) AND (PRP18a)



3.8.5 Nevada EC Emission Inventory for 2002 and 2018

Elemental carbon (EC) particulates are directly emitted as a primary aerosol. For example, sources of elemental carbon include fossil fuel combustion (vehicles, boilers and other industrial processes), wildfires and all other types of burning. EC particulates absorb the transmission of light that contributes to visibility reduction on a regional scale at Class I areas. Elemental carbon is carbon black, or soot, a byproduct of incomplete combustion. It is the partner to primary organic aerosols and represents the more complete combustion of fuel, producing carbon particulate matter as the end product. By comparison, a carbon particle has a sixteen times greater impact on visibility than a coarse particle of granite has.

Figure 3-20 and Table 3-11 show statewide EC emission reductions of 12 percent. There are significant reductions in the mobile source categories resulting from new federal emission standards for mobile sources, especially for diesel engines. Natural fire emissions dominate this classification for Nevada, contributing to 83 percent of the total statewide emissions.

FIGURE 3-20

NEVADA EC EMISSION INVENTORY – 2002 AND 2018

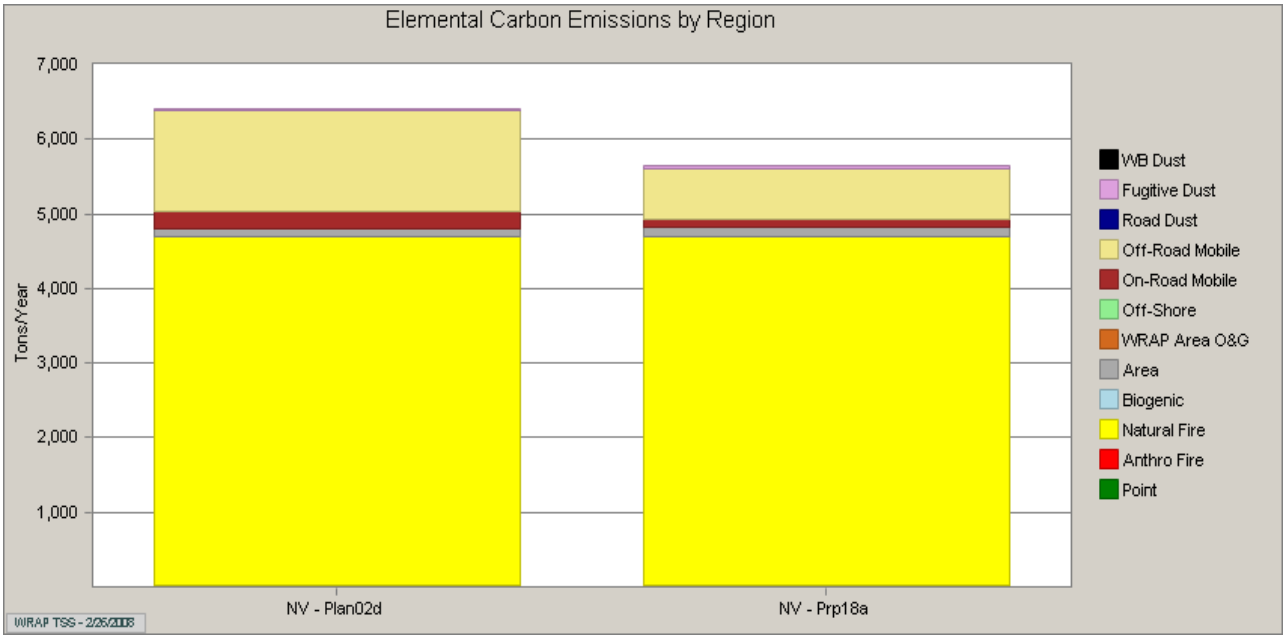


TABLE 3-11

NEVADA EC EMISSIONS BY SOURCE CATEGORY FOR 2002 AND 2018

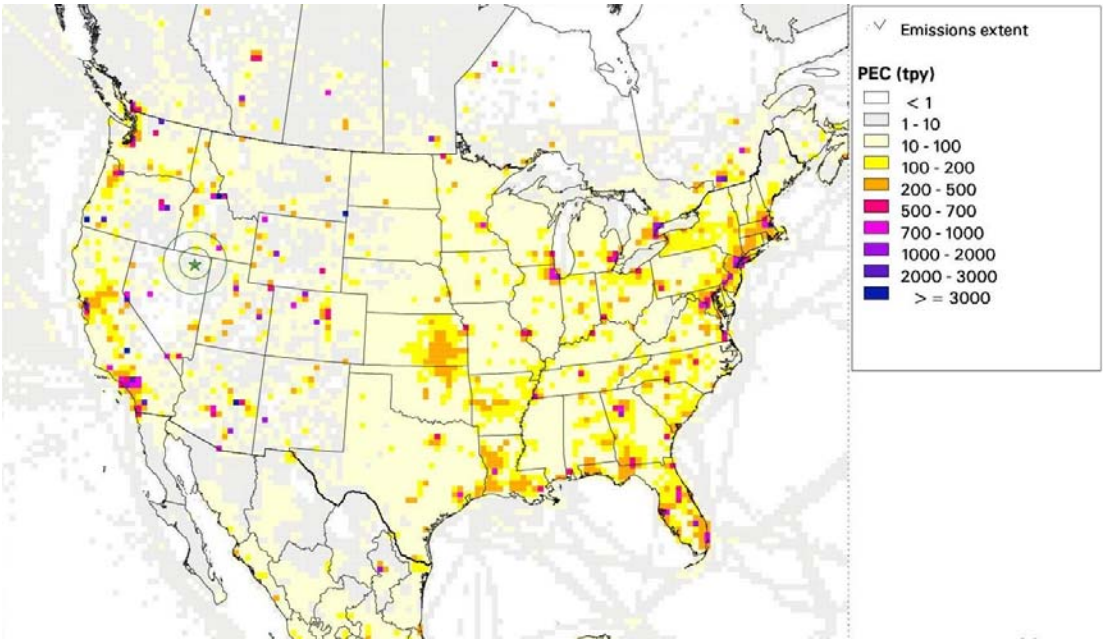
Nevada Planning and Baseline Emission Inventories			
Source Category	Statewide EC		
	Plan 02d (tpy)	PRP 18a (tpy)	Net Change
Point	13	13	-4%
Area	96	115	20%
On-Road Mobile	235	121	-48%
Off-Road Mobile	1,354	668	-51%
Oil and Gas	0	0	0%
Road Dust	7	11	53%
Fugitive Dust	17	26	54%
Windblown Dust	ND	ND	ND
Anthro Fire	13	10	-23%
Natural Fire	4,674	4,674	0%
Biogenic	ND	ND	ND
Total:	6,409	5,638	-12%

Figure 3-21 provides the Plan02d and PRP18a regional elemental carbon emission maps with the location of the JARB1 IMPROVE monitor identified with a green star surrounded by 100 km and 200 km radius concentric circles. Note that EC is the same as PEC (primary elemental carbon).

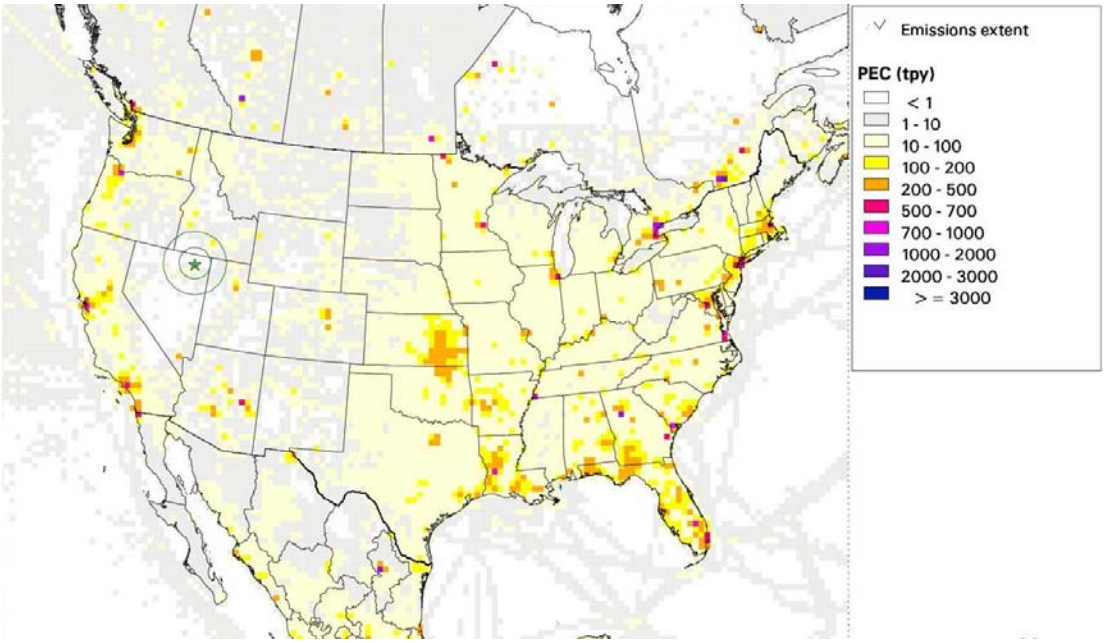
FIGURE 3-21

REGIONAL MAPS OF EC EMISSIONS FOR 2002 AND 2018

2002



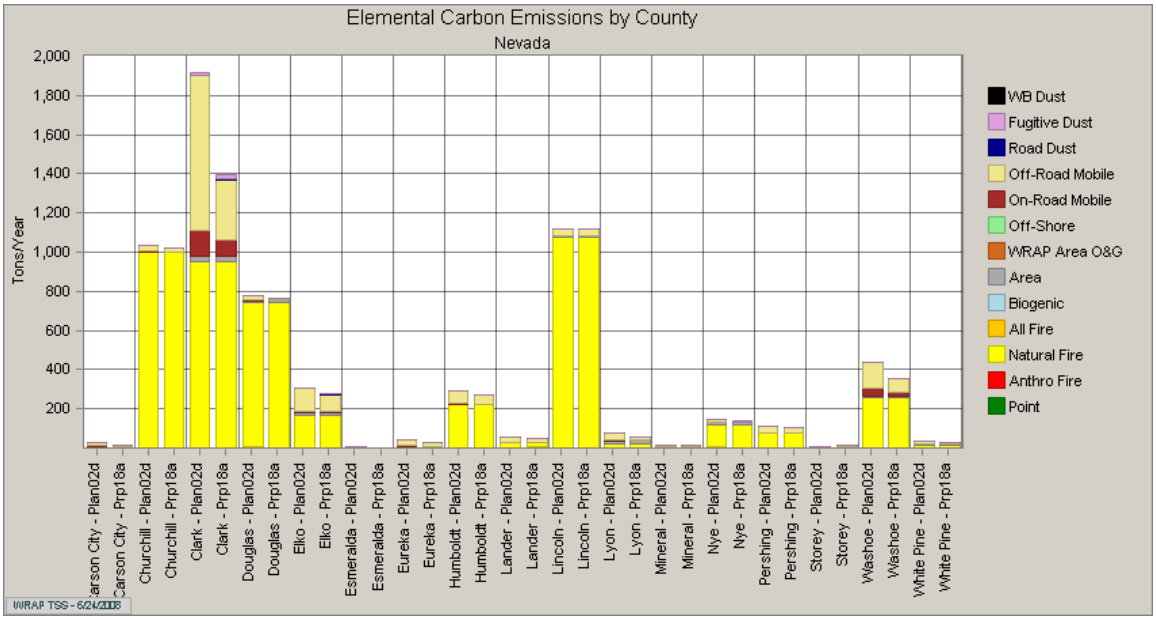
2018



In Figure 3-21, note the decrease in emissions for Nevada. Overall the EC emissions for Nevada are among the lowest in the U.S. 2018 projections show most of the state with EC emissions at less than 10 tons per year. Figure 3-22 shows that natural fire is the dominant source category for EC primarily for Lincoln, Churchill, Clark and Douglas counties. Significant off-road mobile source reductions for 2018 are seen for Clark and Washoe counties.

FIGURE 3-22

ELEMENTAL CARBON EMISSIONS BY COUNTY (Plan02d) AND (PRP18a)



3.8.6 Nevada PM Fine Emission Inventory for 2002 and 2018

PM fine emissions are comprised of fine particulates under 2.5 microns that are generated mostly from area sources, road dust and fugitive dust. PM fine emissions are largely related to agricultural and mining activities, windblown dust from construction areas, and emissions from unpaved and paved roads. A particle of fine dust has a relative impact on visibility one-tenth as great as a particle of elemental carbon. For any given visibility event where poor visual air quality is present in a scene, the impact of dust can vary widely. Overall, on the 20 percent worst days, PM fine has about the same impact as nitrate particles. Agricultural activities, dust from unpaved roads and construction are prevalent in this source category and changes in emissions are tied to population and vehicle miles traveled. Since PM fine emissions are not directly from the tailpipe of the vehicle, the mobile source categories do not show any fine particulates emissions; all vehicle-related emissions from paved and unpaved roads show up in the fugitive dust category. Fine particulate matter can remain suspended in the atmosphere for long periods of time and travel long distances. Fine particulates can efficiently scatter the transmission of light that contributes to visibility reduction on a regional scale at Class I areas. For 2018 projected emissions windblown dust was held constant.

In Figure 3-23 and Table 3-12, the projected statewide PM fine emission net increase is 15

percent. Most of the anticipated increase is associated with fugitive dust from 24 percent in the Plan02d inventory to 30 percent in the PRP18a inventory.

FIGURE 3-23

NEVADA SOIL (PM FINE) EMISSION INVENTORY – 2002 AND 2018

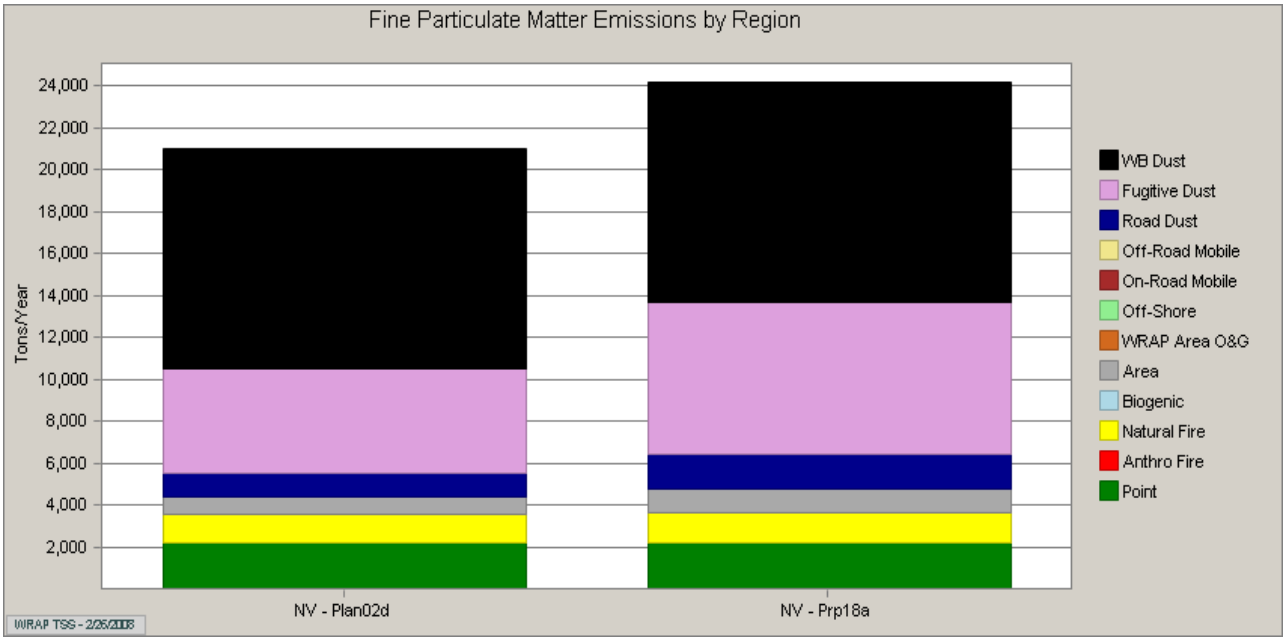


TABLE 3-12

NEVADA PM FINE EMISSIONS BY SOURCE CATEGORY FOR 2002 AND 2018

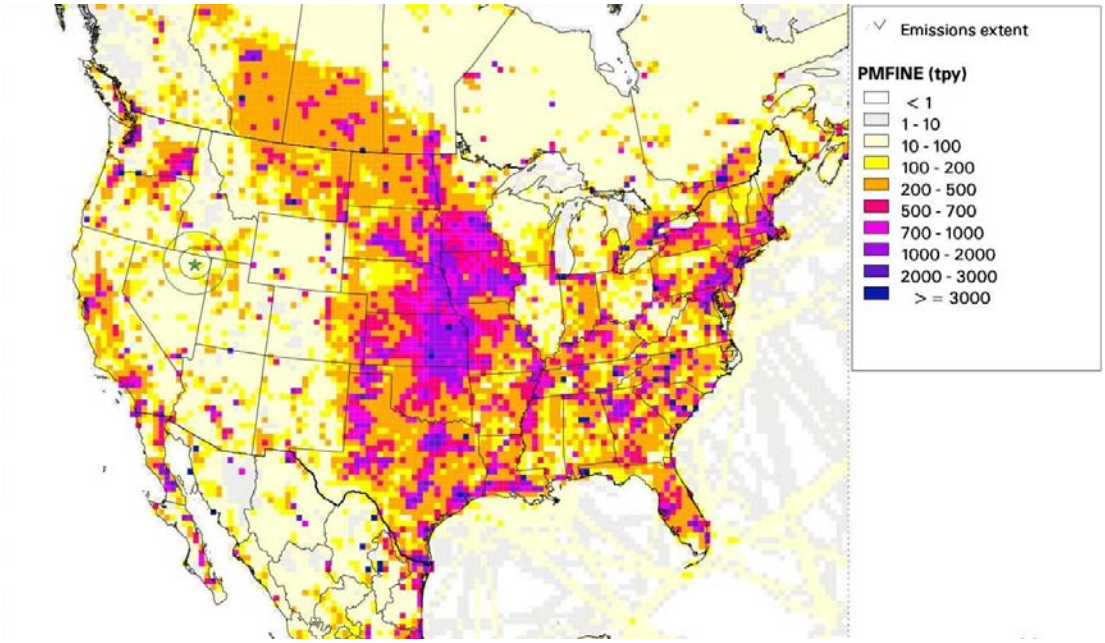
Nevada Planning and Baseline Emission Inventories			
Source Category	Statewide PM fine		
	Plan 02d (tpy)	PRP 18a (tpy)	Net Change
Point	2,158	2,211	2%
Area	830	1,150	39%
On-Road Mobile	0	0	0%
Off-Road Mobile	0	0	0%
Oil and Gas	0	0	0%
Road Dust	1,091	1,672	53%
Fugitive Dust	5,038	7,251	44%
Windblown Dust	10,438	10,438	0%
Anthro Fire	9	5	-48%
Natural Fire	1,406	1,406	0%
Biogenic	ND	ND	ND
Total:	20,969	24,134	15%

Figure 3-24, provides the Plan02d and PRP18a regional PM fine emission maps with the location of the JARB1 IMPROVE monitor identified with a green star surrounded by 100 km and 200 km radius concentric circles.

FIGURE 3-24

REGIONAL MAPS OF PM FINE EMISSIONS FOR 2002 AND 2018

2002



2018

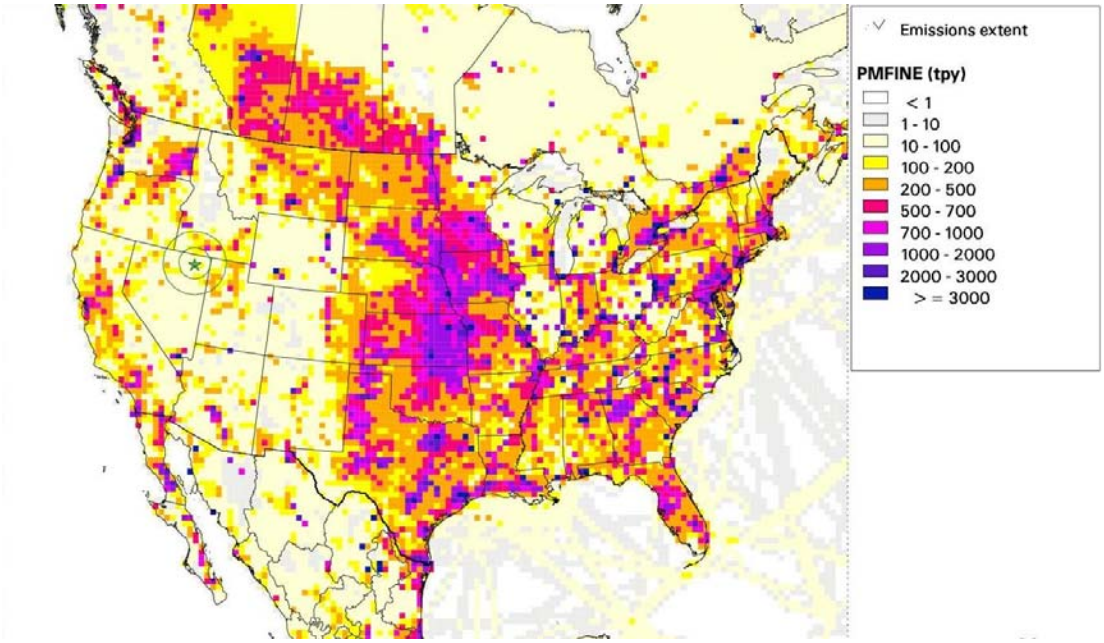
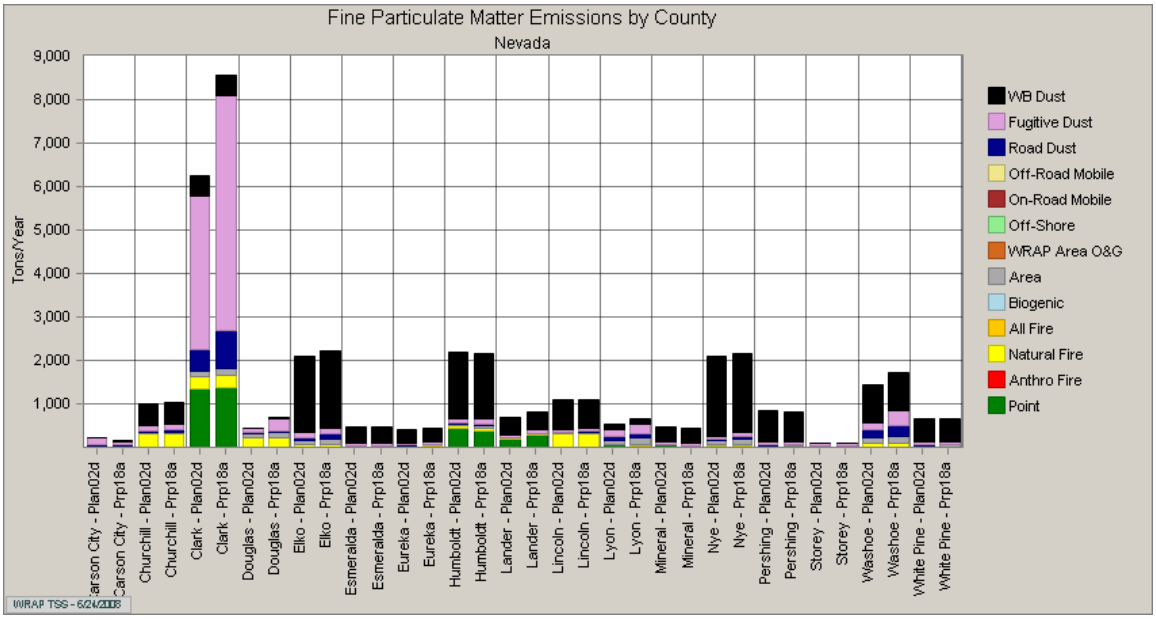


Figure 3-25 shows that Clark County has the greatest amount of PM fine emissions on a statewide basis, dominated by fugitive dust and point sources. Most of the counties in Nevada have significant windblown dust emissions.

FIGURE 3-25

PM FINE EMISSIONS BY COUNTY (Plan02d) AND (PRP18a)



3.8.7 Nevada PM Coarse Emission Inventory for 2002 and 2018

PM coarse emissions are closely related to the same sources as PM fine emissions but other activities like rock crushing and processing, material transfer, open pit mining and unpaved road emissions can be prominent sources. PM coarse emissions travel shorter distances in the atmosphere than other smaller particles but can remain in the atmosphere sufficiently long enough to play a role in regional haze. PM coarse emissions have the smallest direct impact on regional haze on a particle-by-particle basis where one particle of coarse mass has a relative visibility weight of 0.6 compared to a carbon particle having a weight of 10. Nevertheless, they are commonly present at all monitoring sites and are a greater contributor to regional haze than the PM fine component.

Figure 3-26 and Table 3-13 show the overall net increase in PM coarse emissions of 17 percent. A substantial increase in PM coarse emissions is seen in the road dust (53 percent) and fugitive dust (45 percent) categories. This is due to the fact that construction activities and emissions from paved and unpaved roads are linked to population, vehicle miles traveled and employment data. Growth in these factors results in projected emission increases from 2002 to 2018. Although PM coarse emissions from windblown dust decrease from 58 percent to 50 percent by 2018, windblown dust is still the primary source category for these emissions. Fugitive dust is also projected to be a major contributor to PM coarse emissions in 2018 at 36 percent.

FIGURE 3-26

NEVADA COARSE MASS (PM COARSE) EMISSION INVENTORY – 2002 AND 2018

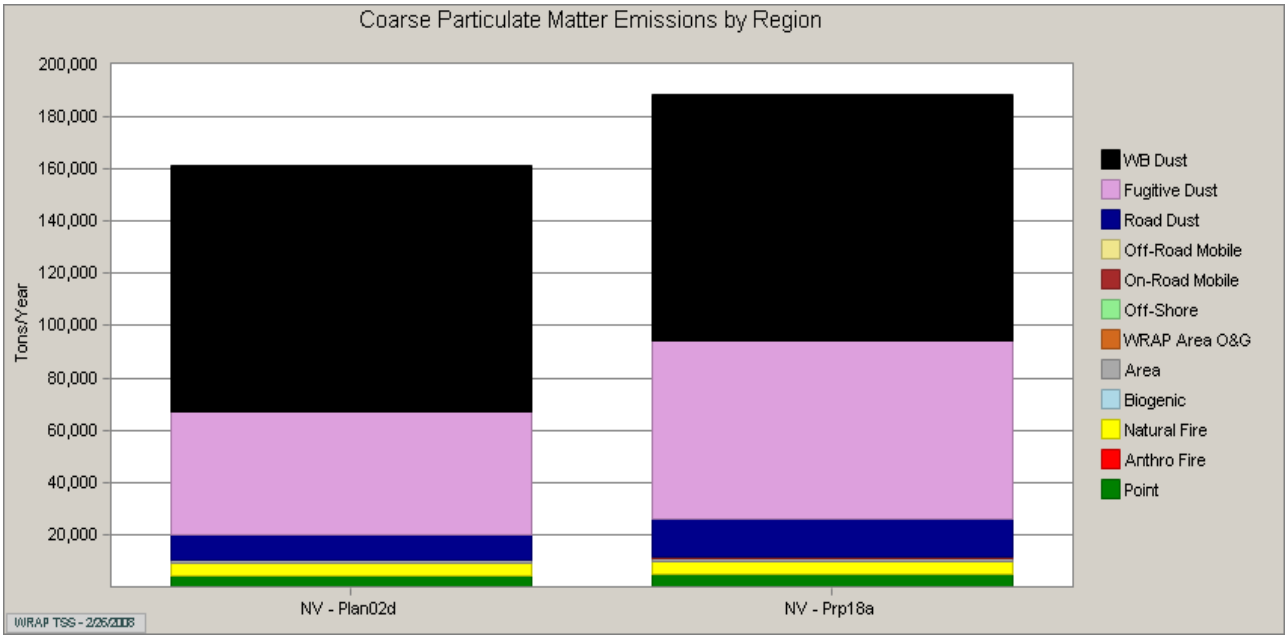


TABLE 3-13

NEVADA PM COARSE EMISSIONS BY SOURCE CATEGORY FOR 2002 AND 2018

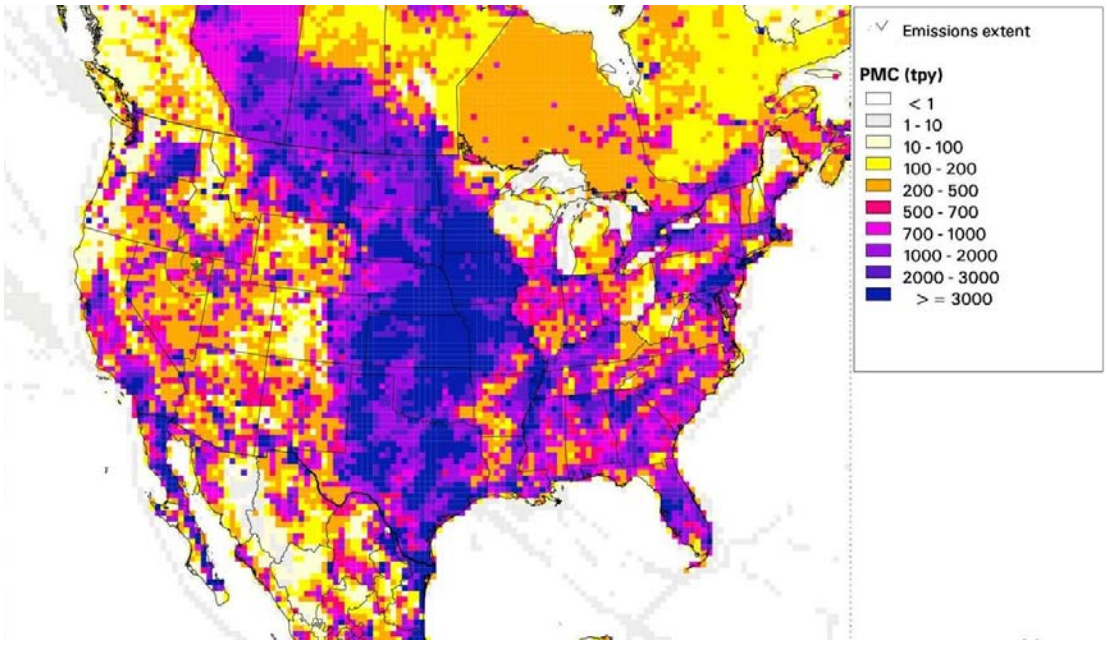
Nevada Planning and Baseline Emission Inventories			
Source Category	Statewide PM coarse		
	Plan 02d (tpy)	PRP 18a (tpy)	Net Change
Point	4,093	4,717	15%
Area	897	1,012	13%
On-Road Mobile	245	360	47%
Off-Road Mobile	0	0	0%
Oil and Gas	0	0	0%
Road Dust	9,413	14,439	53%
Fugitive Dust	47,366	68,634	45%
Windblown Dust	93,946	93,946	0%
Anthro Fire	7	3	-48%
Natural Fire	5,176	5,176	0%
Biogenic	ND	ND	ND
Total:	161,142	188,287	17%

Figure 3-27, provides the Plan02d and PRP18a regional PM coarse emission maps with the location of the JARB1 IMPROVE monitor identified with a green star surrounded by 100 km and 200 km radius concentric circles.

FIGURE 3-27

REGIONAL MAPS OF PM COARSE EMISSIONS FOR 2002 AND 2018

2002



2018

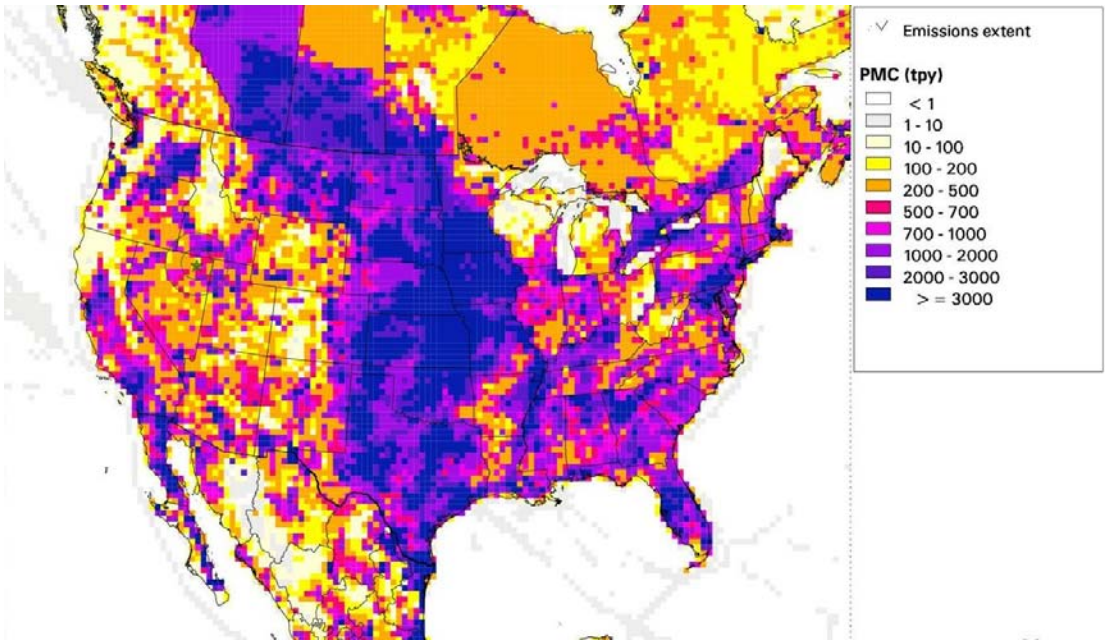
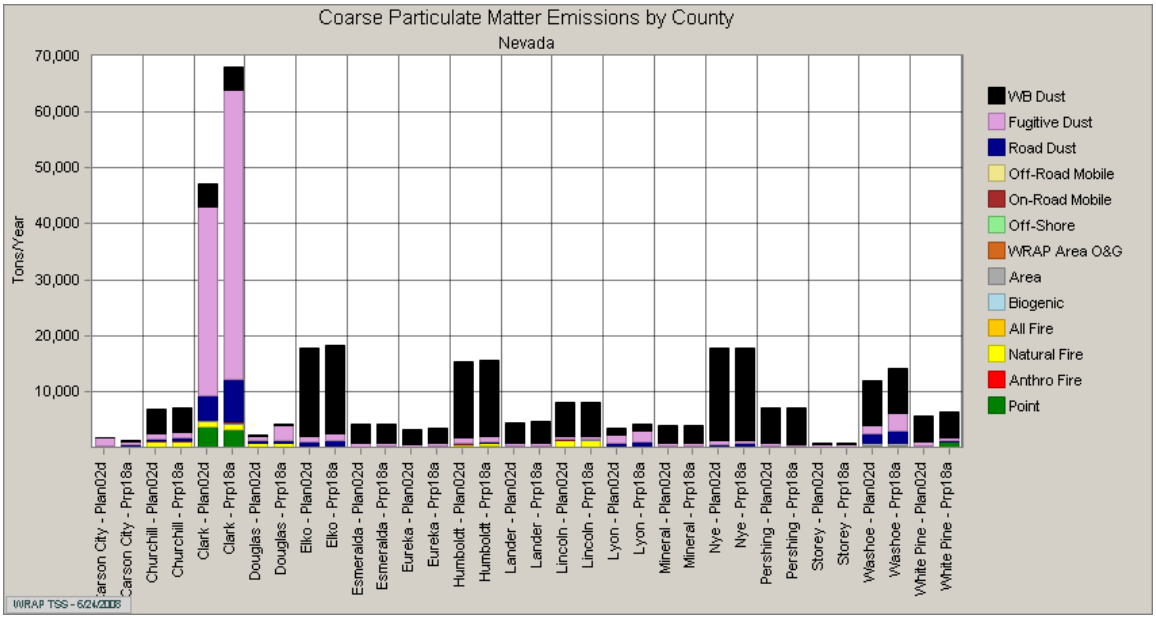


Figure 3-28 shows that Clark County has the highest PM coarse emissions in Nevada, due to

fugitive dust sources. Windblown dust is a significant source of PM coarse emissions for most counties.

FIGURE 3-28

PM COARSE EMISSIONS BY COUNTY (Plan02d) AND (PRP18a)



3.8.8 Nevada NH_3 Emission Inventory for 2002 and 2018

NH_3 emissions come from a variety of sources including wastewater treatment facilities, livestock operations, fertilizer applications and mobile sources. NH_3 is directly linked to the production of ammonium nitrate and ammonium sulfate particles in the atmosphere when SO_2 and NO_x eventually convert over to these forms of particles. Increases in NH_3 emissions from the base case year to 2018 are linked to population statistics and increased vehicular traffic.

An EPA report "Estimating Ammonia Emissions from Anthropogenic Non-Agricultural Sources – Draft Final Report April 2004" (http://www.epa.gov/ttn/chief/eiip/techreport/volume03/eiip_areasourcesnh3.pdf) documents that NH_3 measurements vary substantially by vehicle class in on-road mobile sources. Fleet-average NH_3 emissions are thought to be increasing as advanced catalyst-equipped vehicles make up a larger fraction of the fleet. Advanced catalysts have higher NH_3 emission rates stemming from an over-reduction of NO_x to NH_3.

Non-road mobile sources include exhaust emissions from a wide range of non-road engines. These include construction equipment, agricultural equipment, lawn and garden equipment, commercial and recreational marine vessels and locomotives. Non-road gasoline engines typically are not equipped with catalysts.

Figure 3-29 and Table 3-14, show an overall net increase of NH_3 emissions of 20 percent. Point sources show a significant net increase of 155 percent, although the percent of the projected total point NH_3 emissions for PRP18a is not significant (six percent). On-road mobile NH_3 emissions are due to projected increases in vehicular traffic.

FIGURE 3-29

NEVADA NH_3 EMISSION INVENTORY – 2002 AND 2018

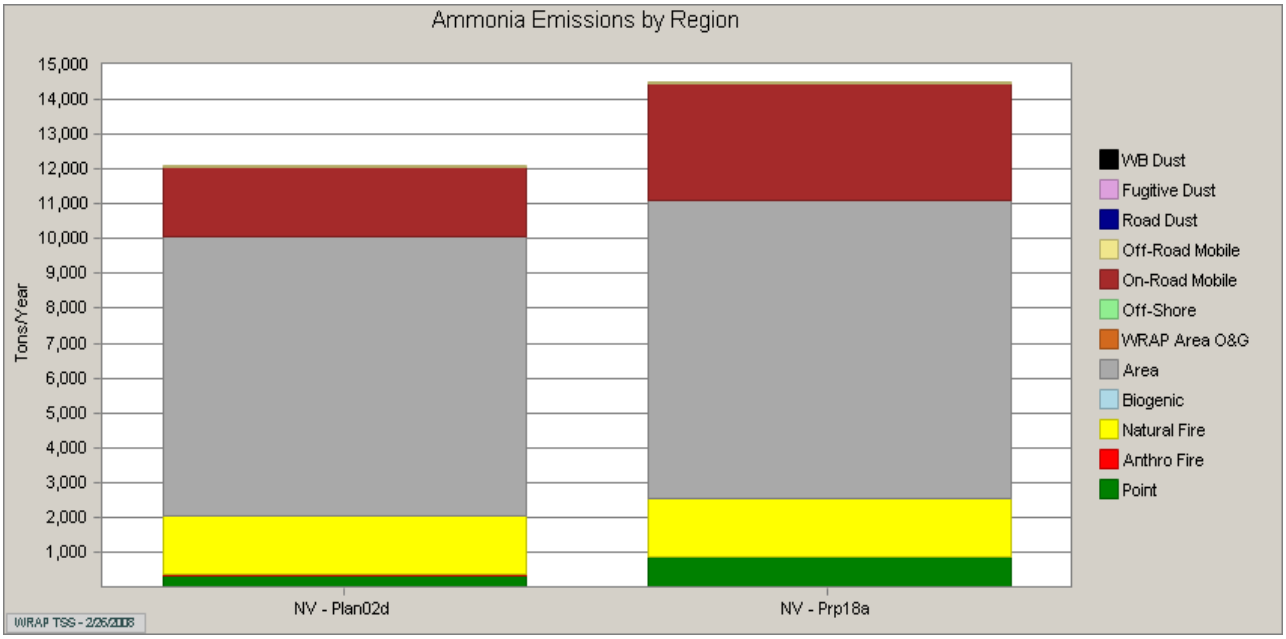


TABLE 3-14

NEVADA NH_3 EMISSIONS BY SOURCE CATEGORY FOR 2002 AND 2018

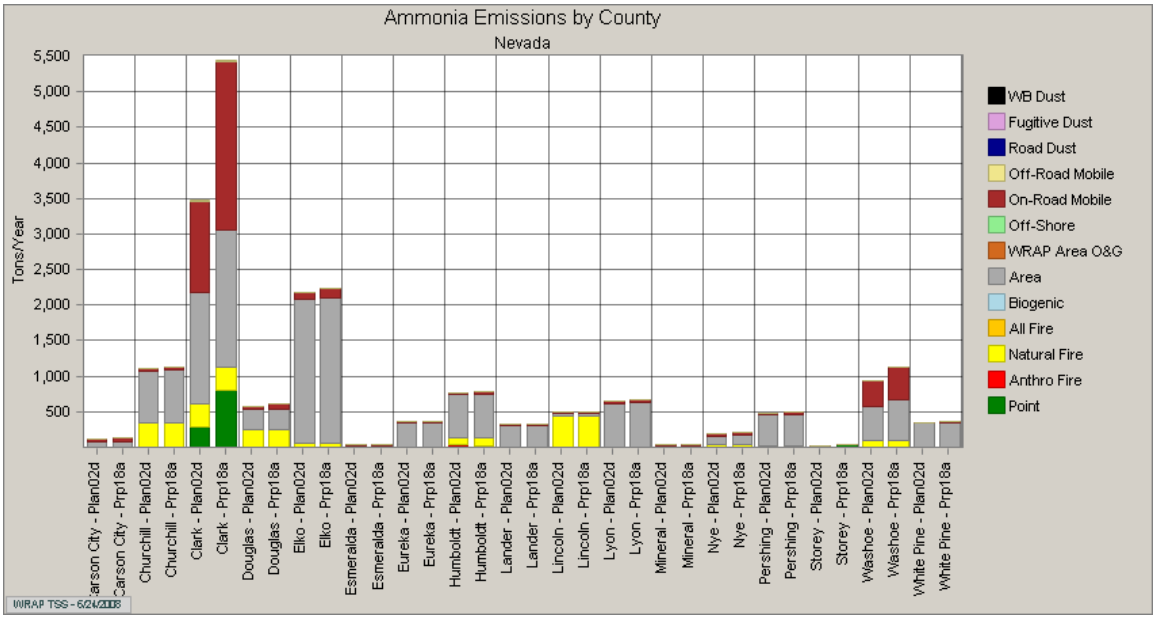
Nevada Planning and Baseline Emission Inventories			
Source Category	Statewide NH3		
	Plan 02d (tpy)	PRP 18a (tpy)	Net Change
Point	339	864	155%
Area	8,009	8,535	7%
On-Road Mobile	2,030	3,385	67%
Off-Road Mobile	22	30	37%
Oil and Gas	0	0	0%
Road Dust	ND	ND	0%
Fugitive Dust	ND	ND	0%
Windblown Dust	ND	ND	0%
Anthro Fire	8	5	-37%
Natural Fire	1,684	1,684	0%
Biogenic	ND	ND	ND
Total:	12,092	14,503	20%

There are no regional emission maps for ammonia.

Figure 3-30 shows consistently that Clark County has the greatest emissions on a county by county breakdown. Clark County's emissions are dominated by on-road and area sources. Most of the other Nevada counties are dominated by area sources.

FIGURE 3-30

AMMONIA EMISSIONS BY COUNTY (Plan02d) AND (PRP18a)



3.9 SUMMARY OF 2018 EMISSION PROJECTIONS

Analysis of the IMPROVE monitoring network data demonstrates the following pollutants, ranked according to percent contribution to annual extinction (see Table 2-2 in Chapter Two), contribute to reconstructed light extinction at JARB1 for the 20 percent worst days of the baseline period.

- OMC
- CM
- SO_4
- SOIL
- EC
- NO_3
- Sea Salt

The emissions analysis is part of the technical basis for identifying Nevada's reasonable progress goal. At the beginning of this section, Table 3-6 summarizes the contribution from natural vs. anthropogenic sources for each pollutant in 2002 and 2018. It shows that approximately three quarters (73 percent) of emissions in 2018 are expected to be from natural sources and, therefore, uncontrollable. Table 3-15 shows percent contribution from anthropogenic sources and dominant source categories for each pollutant in 2018. The "Total Emissions from All Source Categories" column includes natural emissions and puts the contribution from each pollutant into perspective with respect to other visibility impairing pollutants in Nevada.

TABLE 3-15

PREDOMINANT SOURCES OF POLLUTANTS: 2018

Pollutant	Total Emissions from All Source Categories in tpy *(percent of total)*	Percent from Anthropogenic Sources	Predominant Source and Percent from Predominant Source		Controllable
VOC	897,707 *(67)*	10	Biogenic	88	No
PM coarse	188,287 *(14)*	47	Windblown Dust	50	No
			Fugitive Dust	36	Yes
NO_x	135,496 *(10)*	83	Point	50	Yes
			Off-Road Mobile	16	Yes
			On-Road Mobile	11	Yes
			Biogenic	11	No
SO_x	46,224 *(3.5)*	94	Point	61	Yes
			Area	31	Yes
POA	24,822 *(2)*	9	Natural Fire	91	No
PM fine	24,134 *(2)*	51	Windblown Dust	43	No
			Fugitive Dust	30	Yes
NH_3	14,503 *(1)*	88	Area	59	Yes
			On-Road Mobile	23	Yes
EC	5,638 *(0.5)*	17	Natural Fire	83	No

In Nevada, anthropogenic sources are important contributors of SO_x, NO_x, and NH_3 in 2018. SO_x emissions are predominantly from point sources, 61 percent; area sources contribute 31 percent. NO_x emissions are also predominantly from point sources, approximately 50 percent, while mobile sources account for another 27 percent. VOC, POA, EC, PM fine and PM coarse emissions are dominated by natural source categories, and primarily are not controllable for those sources. NH_3 emissions are predominantly from area sources, 59 percent, with another 23 percent from on-road mobile. The total projected emissions for all pollutants in 2018 are 1,336,811 tons and of that total, only 27 percent are controllable.