Air[1]

Introduction

Air provides many ecosystem services on which life depends. Air provides *supporting* ecosystem services by supplying (1) oxygen for respiration by plants and animals, (2) carbon dioxide for photosynthesis, and (3) nitrogen for plant nutrition. Air also provides *regulating* ecosystem services, as it is key to global redistribution of biological and physical byproducts. Air contributes to *provisioning* ecosystem services by enabling transportation (wind for sails, lift for airplanes) and providing energy (wind turbines). Especially important to humans are the *cultural* ecosystem services that air provides to society (delivery of aesthetically pleasing aromas).

Air quality has long been recognized as an important resource to protect on national forests. Not only does the public value the fresh air and sweeping views that national forests can provide, but the impacts from air pollution on forest health, water quality, and impacts to fisheries are also highly valued and are just a few that can be affected by poor air quality.

The 2012 Planning Rule requires national forests and grasslands to consider air quality when developing plan components. The purpose of the air quality assessment is to evaluate available information about air quality. This section assesses air quality on, and affecting, the Carson National Forest. This assessment will describe the current conditions and trends regarding air quality in the plan area. This information will be used to anticipate future conditions and to determine if trends in air quality pose risks to system integrity at the forest level. Additionally, this assessment will identify information gaps regarding air quality and any uncertainty with the data. The information contained in this assessment will be used to inform agency officials, whether current direction needs adjustment to protect air resources and the systems that rely on air quality on the forest.

Including in this assessment, the following components are identified, as specified by Forest Service Handbook, Chapter 10 Section 12.21 (FSH 1909.12):

- Airsheds relevant to the plan area
- Location and extent of known sensitive air quality areas, such as Class I areas, non-attainment areas, and air quality maintenance areas
- Emission inventories, conditions, and trends relevant to the plan area
- Federal, state, and tribal governmental agency implementation plans for regional haze, non-attainment, or maintenance areas (including assessing whether Forest Service emission estimates have been included in the appropriate agency implementation plans)
- Critical loads
- Conditions and trends of relevant airsheds assuming existing plan direction remains in place

Based on the above information, the assessment characterizes and evaluates the status of airsheds and air quality relevant to the plan area, assuming management is consistent with current plan direction.

Identification of Airsheds

[1]For this assessment, the best available science was used that is relevant, accurate, and reliable. Uncertainty in the assessment has been appropriately documented where relevant. Government data that has met strict protocols for data collection was used to assess the current conditions and trends with regards to ambient air quality, visibility, emissions inventories, and deposition. The critical load information was based on multi-agency government research, analysis, and following Forest Service protocols.

Airsheds are similar to watersheds, in that they are defined geographic areas that because of topography, meteorology, or climate, they are frequently affected by the same air mass. The difference with airsheds is that air masses and air pollutants move between airsheds mostly based upon larger meteorological patterns, rather than primarily by topography, as with water flowing through a watershed. As with watersheds, airsheds can be defined at multiple scales. For this assessment, airsheds were defined according to the classification used by the New Mexico Environment Department as well as looking at a larger scale including northern New Mexico and Southern Colorado.

The Carson is spread out across 4 counties in New Mexico and numerous airsheds. Figure 1 identifies the airsheds as classified by the New Mexico Environment Department. The Carson is primarily contained within Rio Arriba and Taos counties, with smaller ownership within Mora and Colfax counties. The Carson lies primarily within the Upper Rio Grande airshed but portions are also included in the San Juan and Canadian airsheds.

For the purpose of this assessment, the air quality and emissions will be limited to those counties and airsheds identified in Figure 1 as well as emissions from southern Colorado, which may affect air resources on the Carson.

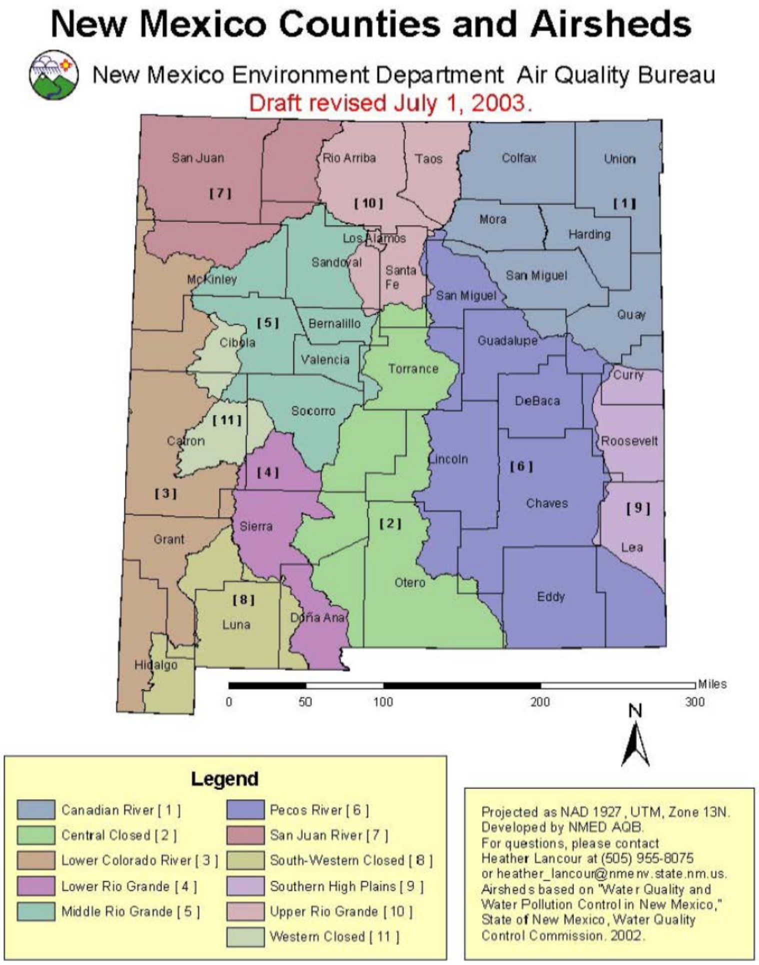


Figure 1. New Mexico Counties and Airsheds.

Identification of sensitive air quality areas

The basic framework for controlling air pollutants in the United States is mandated by the Clean Air Act (CAA), originally adopted in 1963, and amended in 1970, 1977, and 1990. The CAA was designed to "protect and enhance" air quality. Section 160 of the CAA requires measures "to preserve, protect, and enhance the air quality in national parks, national wilderness areas, national monuments, national seashores, and other areas of special national or regional natural, recreation, scenic, or historic value."

Congress classified 158 areas as Class I areas, including national parks larger than 6,000 acres and national wilderness areas larger than 5,000 acres, in existence on August 7, 1977 (42 U.S.C. 7472) (CAA Section 162). Class I areas have been designated within the Clean Air Act as deserving the highest level of air-quality protection. These "mandatory" Class I areas may not be re-classified to a less protective classification. The Carson manages Wheeler Peak Wilderness a Class 1 area. In addition, there are several nearby Class 1 areas that could be affected by projects and sources on or near the Carson (Figure 2). They include the San Pedro Parks Wilderness, Bandelier National Monument, and the Pecos Wilderness to the south of the forest. To the north are the ID those C1As in CO & update map.

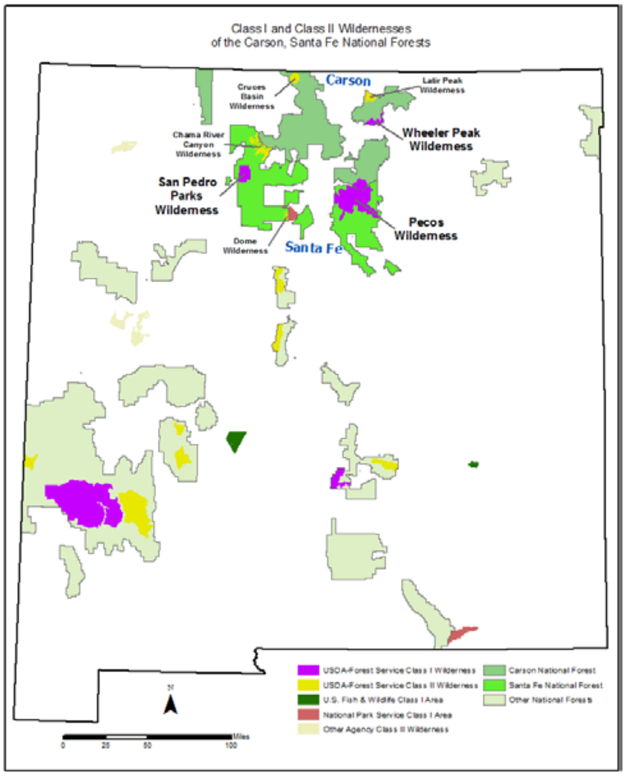


Figure 2. Class I and Sensitive Class II Areas in New Mexico.

The purpose of the CAA is to protect and enhance air quality, while at the same time ensuring the protection of public health and welfare. The Act established National Ambient Air Quality Standards (NAAQS), which represent maximum air pollutant concentrations which would protect public health and welfare. The pollutants regulated by an NAAQS are called criteria air pollutants and include carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), sulfur dioxide (SO_2), lead (Pb), and particulate matter (PM_{10} and $PM_{2.5}$).

The US Environmental Protection Agency (EPA) established NAAQS for specific pollutants considered harmful to public health and the environment. The Clean Air Act identifies two types of NAAQS:

1. The primary standards represent the maximum allowable atmospheric concentrations that may occur and still protect public health and welfare, and include a reasonable margin of safety to protect the more sensitive individuals in the population.

2. Secondary standards provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings.

State agencies are given primary responsibility for air quality management as it relates to public health and welfare, and are further responsible for developing their State Implementation Plans (SIPs) to identify how NAAQS compliance will be achieved. If an area in a state has air quality worse than the NAAQS, that area becomes a non-attainment area. The state is then required to develop an SIP to improve air quality in that area. Once a non-attainment area meets the standards and that area can be designated as a maintenance area.

State standards, established by the New Mexico Environmental Improvement Board (EIB) and enforced by the New Mexico Environment Department, Air Quality Bureau (NMED-AQB), are termed the New Mexico Ambient Air Quality Standards (NMAAQS). The NMAAQS must be at least as restrictive as the National Ambient Air Quality Standards (NAAQS). NMAAQS also includes standards for total suspended particulate matter (TSP), hydrogen sulfide, and total reduced sulfur for which there are no National standards. Table 1 presents the national and state ambient air quality standards.

Table 1. National and New Mexico ambient air quality standards.

Pollutant	Averaging Time	New Mexico Standards	National Standards[a]	
			Primary[b,c]	Secondary[b,d]
Ozone	8-hour	—	0.075 ppm	Same as primary
Carbon monoxide	8-hour	8.7 ppm	9 ppm	—
	1-hour	13.1 ppm	35 ppm	—
Nitrogen dioxide	Annual	0.05 ppm	0.053 ppm	Same as primary
	24-hour	0.10 ppm	—	—
	1-hour		0.1 ppm	—
Sulfur dioxide	Annual	0.02 ppm	0.03 ppm	—
	24-hour	0.10 ppm	0.14 ppm	—
	3-hour	—	—	0.5 ppm
	1-hour		0.75 ppm	—
Hydrogen sulfide	1-hour	0.010 ppm	—	—
Total Reduced Sulfur	½-hour	0.003 ppm	—	—
PM_{10}	24-hour	Same as Federal	150 μg/m^3	Same as primary
$PM_{2.5}$	Annual (arithmetic mean)	Same as Federal	12 μg/m^3	Same as primary
	24-hour	Same as Federal	35 μg/m^3	Same as primary
Total Suspended Particulates (TSP)	Annual (geometric mean)	60 μg/m^3	—	—
	30-day Average	90 μg/m^3	—	—

Pollutant	Averaging Time	New Mexico Standards	National Standards[a] Primary[b,c]	Secondary[b,d]
	7-day	110 µg/m^3	—	—
	24-hour	150 µg/m^3	—	—
Lead	Quarterly Average	—	1.5 µg/m^3	Same as primary

Notes:
(a) Standards other than the 1-hour ozone, 24-hour PM_{10}, and those based on annual averages are not to be exceeded more than once a year.

(b) To attain the 8 hour ozone standard the 3 year average of the fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.075 ppm.

(c) Concentrations are expressed in units in which they were promulgated. µg/m^3 = micrograms per cubic meter and ppm = parts per million. Units shown as µg/m^3 are based upon a reference temperature of 25^{o}C and a reference pressure of 760 mm of mercury.

(d) Primary Standards: The levels of air quality necessary, with an adequate margin of safety to protect the public health.

(e) Secondary Standards: The levels of air quality necessary to protect the public welfare from any known or anticipated adverse effects of a pollutant.

µg/m^3 = micrograms per cubic meter; ppm = parts per million

The New Mexico Environment Department – Air Quality Bureau (NMED-AQB) enforces air pollution regulations and sets guidelines to attain and maintain the national and state ambient air quality standards within the state of New Mexico, except for tribal lands and Bernalillo County which maintain separate jurisdictions.

At the present time, the plan area attains all national and New Mexico ambient air quality standards. Dona Ana County is the only area in New Mexico that is currently in non-attainment for PM_{10}.

Emissions Inventories, including current conditions and trends

This section presents current and historical data related to air quality in or near the Carson. This data and any relevant trends in the data provide an understanding of the air quality conditions that could affect resources on the forest sensitive to air pollution. Included are a general description of baseline emissions inventories, ambient air quality measurements, visibility, and deposition measurements for sulfur, nitrogen, and mercury that define current air quality conditions of the plan area. Data are presented for the following parameters:

- Emission Inventory
- Ambient Air Quality
- Visibility
- Atmospheric Deposition (Acid Deposition and Mercury Deposition)

For emissions, the information presented in this section represents statewide totals for New Mexico. County-level emissions inventories were analyzed and can be found on the Western Regional Air Partnership (WRAP) website, using the Technical Support System tool (WRAP TSS 2012). Emissions inventories are useful tools for understanding regional sources of pollution that could affect the forest. Emissions inventories are created by quantifying the amount of pollution that comes from point sources (power plants, factories) and area sources (emissions from automobiles in a city or oil and gas development). Emissions can also originate from natural events like a wildfire.

The Western Regional Air Partnership is a voluntary partnership of states, tribes, federal land managers and the EPA. It tracks emissions data from states, tribes, and local air agencies, as well as emissions from wildland fire, in coordination with the EPA's National Emission Inventory (NEI). In addition, WRAP supports states by analyzing this data and models what future emissions maybe based on future trends, as part of the Regional Haze Rule. The Regional Haze Rule sets a 60-year timeline for states to improve visibility within mandatory federal Class I areas from baseline (2000-04) levels to natural conditions by 2064. States are required to show that reasonable progress is expected to be made toward this goal over the course of intermediary planning periods.

A summary of baseline emissions and projected emissions for 2018 for the state of New Mexico and Colorado and the counties within 200 km of the Carson were analyzed (WRAP TSS 2012). The following pollutants were included in the summary: carbon monoxide, nitrogen oxides, sulfur oxides, volatile organic compounds (VOCs), coarse particulate matter (surrogate for PM_{10}), and fine particulate matter (surrogate for $PM_{2.5}$). Nitrogen oxides and VOCs were included since they are precursors to the formation of ozone, which has both effects to human health but also has been shown to impact forested systems.

Emissions information is important, as adverse air quality impacts on the Carson can usually be traced to air emissions. Knowing the magnitude of emissions and recognizing trends in emissions over time is important because emissions are usually correlated to the type and severity of air quality impacts. Often, adverse air quality impacts to air quality related values can be mitigated through programs that reduce associated air emissions. However, the Forest Service typically lacks direct authority to control air emissions that impact a particular ranger district.

While emissions play an important role in determining overall air quality for a given area, air quality evaluations are also based, in part, on ambient concentrations of pollutants in the air. The EPA is primarily concerned with air pollutants that result in adverse health effects. The Forest Service also uses these ambient concentrations to determine how pollutants such as ozone (O_3), particulate matter (PM), nitrogen dioxide (NO_2) and sulfur dioxide (SO_2) impact forest resources. Because ambient air quality measurements provide quantitative information, they can also be meaningfully incorporated into air quality models. Ambient air quality data are presented in this section for a number of state, and federal monitoring stations in and around the air quality monitoring plan area.

Visibility data are presented for stations operated as part of the Interagency Monitoring of Protected Visual Environments (IMPROVE) monitoring program sponsored by the EPA and other government agencies. Visibility generally relates to the quality of visitors' visual experience on the forest and has been recognized as an important air quality related value in Class I wilderness areas dating back to the 1977 Clean Air Act Amendments. Generally, the presence of air pollution degrades the visual quality of a particular scene. In the Clean Air Act, a national visibility goal was established to return visibility to "natural background" conditions no later than 2064. IMPROVE monitoring data tracks the quality of visibility conditions and trends in visibility data and are specific to the wilderness areas of interest.

Deposition data are presented from the National Atmospheric Deposition Program (NADP). Deposition generally arises from the transformation in the atmosphere of air pollution to acidic chemical compounds (e.g., sulfuric acid, nitric acid), a portion of which are deposited into forested ecosystems. Excessive deposition may lead to adverse effects on ecosystems and on other resources (e.g., cultural). Acid deposition can lead to changes in the pH of stream runoff and adverse effects on aquatic species. Also, acidic depositions can accumulate in the wintertime snowpack. Research has demonstrated that when portions of the snowpack with high acid concentrations melt during spring thaw, the acids are often released as an acute pulse. The sudden influx of acid can alter the pH of high altitude lakes and streams for short periods, with dramatic consequences for respective aquatic communities.

Lastly, excessive nitrogen deposition can "over-fertilize" sensitive ecosystems, thereby promoting unnatural eruptions of native and nonnative plant species, invasions by noxious species and altering long-term patterns of nutrient cycling. National Atmospheric Deposition Program monitoring data collected in the plan area were chosen to best characterize these conditions in the wilderness areas of interest.

Where available, data on mercury deposition are also presented. Mercury is a neurotoxin which accumulates in plant and animal tissue, especially within the aquatic food chain. As birds, mammals, and humans consume fish and other aquatic organisms, the accumulated mercury is passed on to those species as well. Within human populations, mercury exposure is of particular concerns to pregnant women, as mercury can pass through the placenta to developing fetuses. Low-level mercury exposure is also linked to learning disabilities in children and interferes with the reproductive cycle in mammals that consume fish.

Emissions Inventory

Air quality effects on national forests are generally traceable back to the original source of emissions; therefore, air emissions information provides an overview of the magnitude of air pollution and is important in understanding air quality on the forest. Also, trends in precursor emissions would be expected to track with trends on the forest, e.g., visibility, acid deposition, etc. For example, improving visibility conditions in Class I areas would generally be associated with corresponding decreases in emissions for visibility precursor pollutants.

Emissions information is generally tracked for pollutants that have health-based air quality standards such as carbon monoxide (CO), nitrogen oxides (NOx), sulfur dioxide (SO_2), volatile organic compounds (VOCs), and particulate matter (PM). Volatile organic compounds emissions do not have a health-based standard, but are involved in the atmospheric chemical reactions that lead to ozone (O_3), which does. Ozone pollution is of added concern, because it can stress sensitive ecological systems. Particulate matter emissions are generally broken into two categories based on the size of the PM emissions: Fine PM (FPM) represents the particulate matter emissions sized at or below 2.5 microns in diameter. Coarse PM (CPM) represents the particulate matter emissions sized at or below 10 microns, but above 2.5 microns, in diameter. Smaller sized particles have greater health-related impacts because the smaller particles are more easily inhaled into the lungs.

Figure 3–Figure 8 show air emissions for the state of New Mexico and Colorado for the criteria air pollutants of interest: CO, NOx, SO_2, VOC, CPM, and FPM.[2] Fine particulate matter (FPM) is analogous to $PM_{2.5}$ and course PM represents the PM_{10} emissions that are not $PM_{2.5}$. Each figure also depicts the relative magnitude of emissions from various source categories, such as mobile sources (vehicle exhaust), point sources (industrial and commercial operations), fire, biogenic sources etc. These figures represent statewide emissions for the baseline period (2000-2004) along with projected emissions for the 2018 time frame, based on information at the end of 2005. Since that time, additional regulations have been passed which should continue to reduce emissions. All of the emissions information in these figures has been taken from the WRAP Technical Support System (WRAP TSS 2012).

[2] Products obtained from WRAP TSS Emissions Review Tool http://vista.cira.colostate.edu/TSS/Results/HazePlanning.aspx Plan02d data represent the 5-year baseline average period. PRP18b data represent WRAP's Preliminary Reasonable Progress Inventory. Blank entries represent instances where data categories are not applicable or data are not available.

For CO, and NOxthe trend shows a projected decrease in statewide emissions through 2018 for both New Mexico and Colorado. Most of the emissions reductions for CO and NOx emissions come from fewer mobile source emissions and are associated with the introduction of lower emitting vehicles over time, cleaner transportation fuels, and improvements in vehicle gas mileage.

SO_2 emissions are expected to generally decrease in both states except for area emissions in New Mexico, which are expected to increase significantly. The general improvement over time is largely from reductions in stationary source emissions, such as coal-fired power plants, which are expected, in the near term, to install emission controls defined as Best Available Retrofit Technology (BART) under the regional haze regulations. Some of the decrease in SO_2 emissions occurs from mobile sources and is associated with cleaner transportation fuels, such as the introduction of low sulfur diesel fuel.

The expected increase in oil and gas industry activity through 2018 increases emissions of NOx and SO_2, which offsets some of the emissions decreases described above, particularly in the Four Corners Area including increases in emissions in both New Mexico and Colorado.

The VOC emissions in New Mexico and Colorado are dominated by biogenic emission sources, (i.e., trees, agricultural crops, and microbial activity in soils). Overall VOC emissions are projected to remain fairly stable through 2018, with some increases projected from oil and gas industrial activity.

Particulate emissions, both CPM and FPM, are expected to increase across New Mexico through 2018, consistent with the projected population growth in the state. Higher population translates to more vehicular traffic and the projected particulate emission increases generally occur in the “fugitive dust” and “road dust” categories. Relatively small increases in CPM are expected in Colorado, while relatively small decreases are expected in FPM in Colorado, both resulting in relative changes in wind blow dust.

Data analyzed using the WRAP TSS Emissions Review Tool shows similar emissions information for the pollutants of interest on a county-by-county basis (WRAP TSS 2012). The analysis consisted of review of counties in northern New Mexico and sourthern Colorado. County-by-county distribution of emissions mostly follows the distribution of population across the counties of interest.

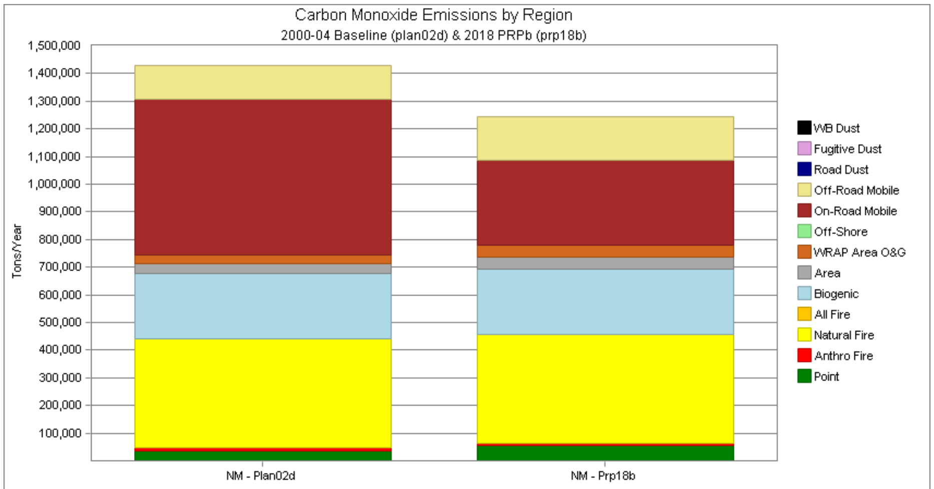
Particulate matter (PM) and VOCs are all expected to increase or stay stable at state and county levels through 2018 in New Mexico and Colorado. The primary source of PM, both coarse and fine, is from windblown dust across the land and from fugitive dust from anthropogenic sources. Higher temperatures and persistent drought could exacerbate this trend (Prospero 2003). At the state level, VOCs are expected to increase primarily from oil and gas development in the Four Corners area. Biogenic sources of VOCs are a major source relative to the overall emissions in both New Mexico and Colorado and in the counties where the Carson is located.

San Juan County shows significant contributions to the NOx and SO2 emissions inventories from point source emissions. These data reflect the large coal-fired electric generating stations in that county (San Juan Generation Station and Four Corners Generating Station).

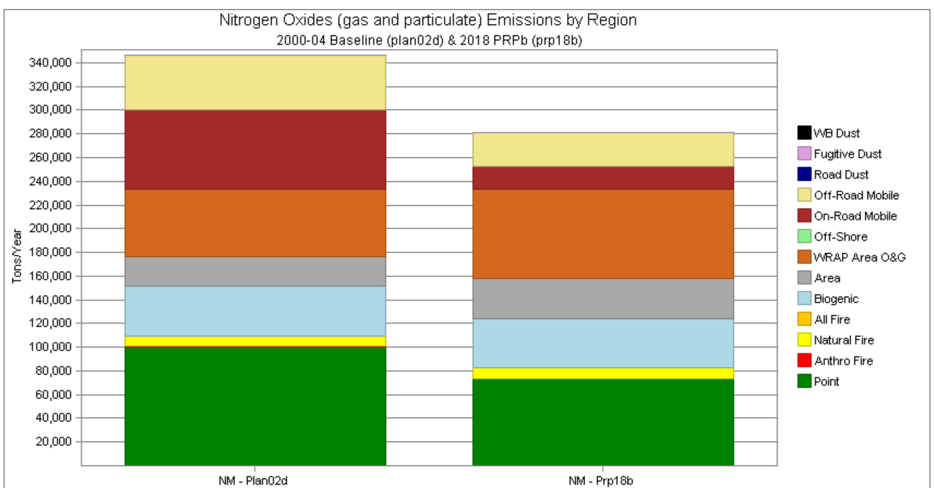
Also Rio Arriba County and San Juan County, in New Mexico and Montezuma County and La Plata County in Colorado also show significant emissions from oil and gas development in that particular region of the state. The oil and gas industry emissions are important for SO2, NOx and VOCs and to a lesser extent, CO emissions. In the absence of oil and gas industry sources, biogenic emissions make up most of the VOC inventory in each county. Fire was also shown as a significant contributor to the CO emissions inventory in Rio Arriba County and San Juan County.

Except where the industrial emissions noted above dominate, the county-by-county distribution of emissions mostly follows the distribution of population across the counties of interest.

The county-by-county emissions trends through 2018 generally share the patterns described above for the statewide inventory trends. However, in those counties where oil and gas industry sources are significant, the downward trend of emissions noted in the state The county-by-county emissions trends through 2018 generally share the patterns described above for the statewide inventory trends. However, in those counties where oil and gas industry sources are significant, the downward trend of emissions noted in the statewide data is offset somewhat by the increased level of local oil and gas development and associated emissions.

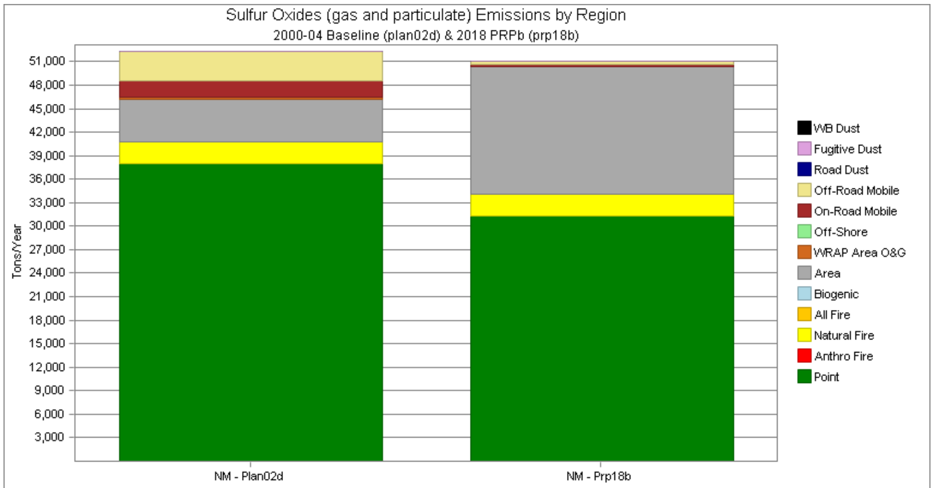


Scenario	Year	Point	Anthro Fire	Natural Fire	All Fire	Biogenic	Area	WRAP Area O&G	Off-Shore	On-Road Mobile	Off-Road Mobile	Road Dust	Fugitive Dust	WB Dust
Plan02d	2,002	36,589	9,937	393,865		238,478	34,426	31,628		561,611	124,063			
Prp18a	2,018	57,376	6,349	393,855		238,478	41,942	44,011		308,010	153,865			

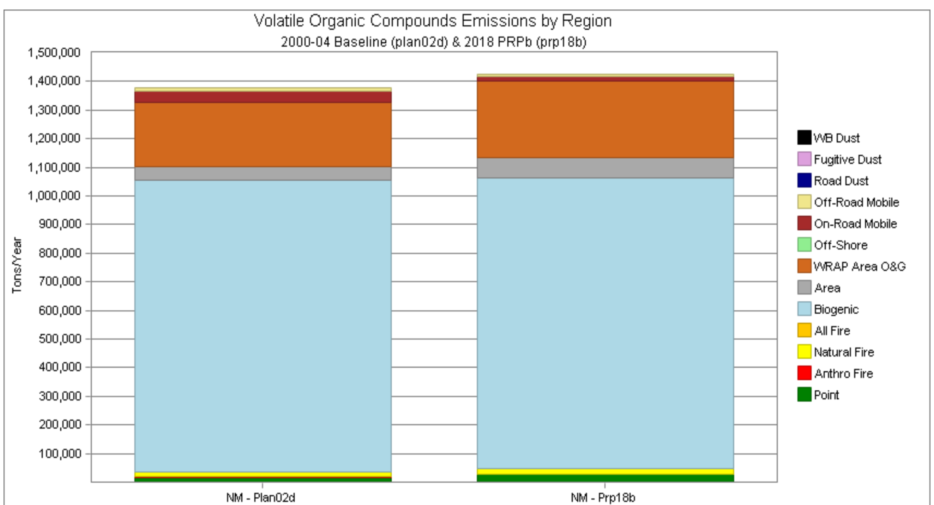


Scenario	Year	Point	Anthro Fire	Natural Fire	All Fire	Biogenic	Area	WRAP Area O&G	Off-Shore	On-Road Mobile	Off-Road Mobile	Road Dust	Fugitive Dust	WB Dust
Plan02d	2,002	100,387	394	8,570		42,139	25,130	56,210		67,835	45,311			
Prp18a	2,018	74,600	262	8,570		42,139	33,768	74,648		19,746	33,175			

Figure 3. New Mexico 2002 baseline and projected 2018 emission summaries, carbon monoxide (top) and nitrogen oxides (bottom).

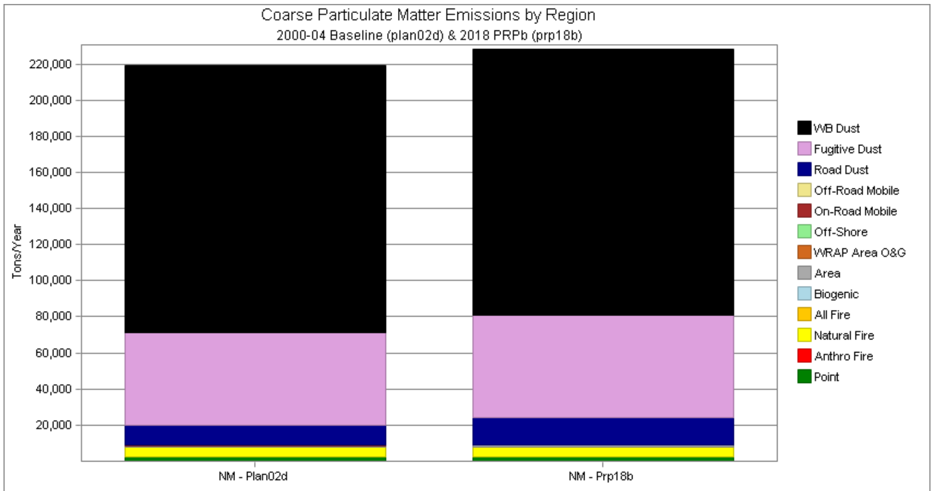


Scenario	Year	Point	Anthro Fire	Natural Fire	All Fire	Biogenic	Area	WRAP Area O&G	Off-Shore	On-Road Mobile	Off-Road Mobile	Road Dust	Fugitive Dust	WB Dust
Plan02d	2,002	37,918	94	2,729			5,433	250		2,066	3,846	4	6	
Prp18a	2,018	32,634	72	2,729			16,255	12		334	356	6	7	

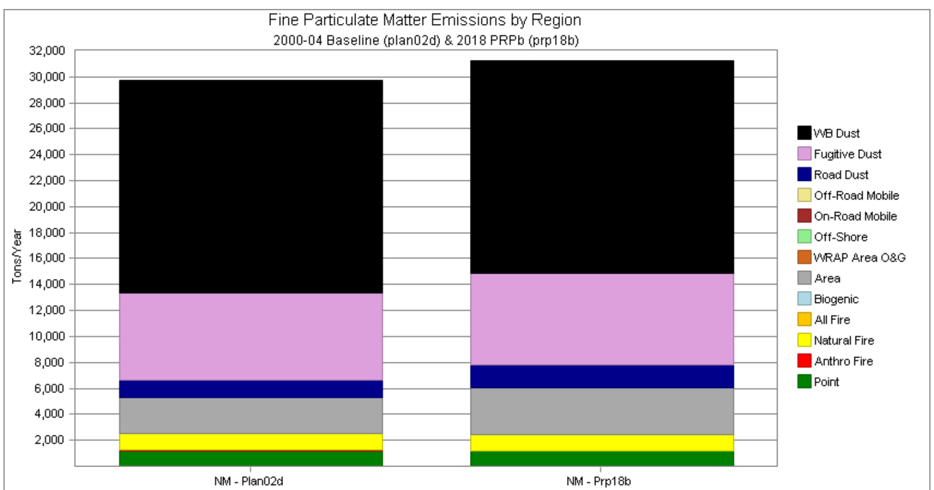


Scenario	Year	Point	Anthro Fire	Natural Fire	All Fire	Biogenic	Area	WRAP Area O&G	Off-Shore	On-Road Mobile	Off-Road Mobile	Road Dust	Fugitive Dust	WB Dust
Plan02d	2,002	17,574	608	18,846		1,016,487	49,010	224,268		38,768	13,850			
Prp18a	2,018	26,187	388	18,846		1,016,487	70,556	267,846		15,554	9,463			

Figure 1. New Mexico 2002 baseline and projected 2018 emission summaries, sulfur oxides (top) and volatile organic compounds (bottom).

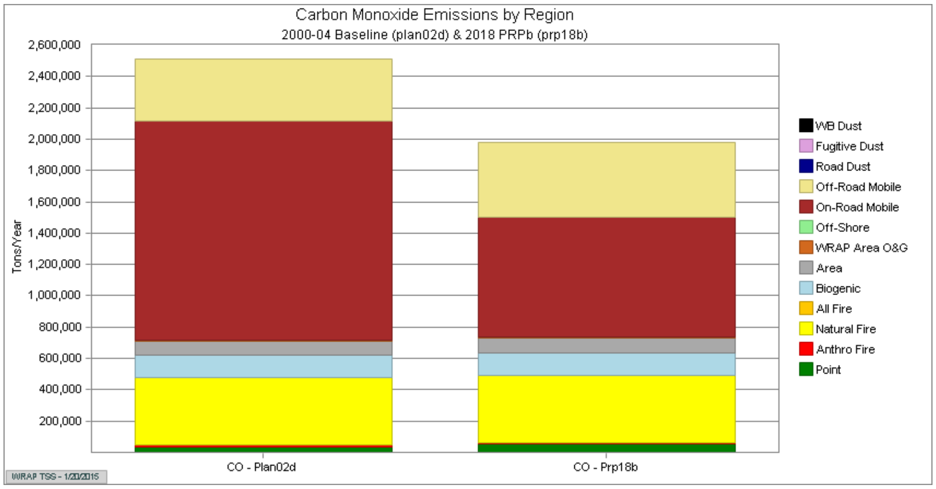


Scenario	Year	Point	Anthro Fire	Natural Fire	All Fire	Biogenic	Area	WRAP Area O&G	Off-Shore	On-Road Mobile	Off-Road Mobile	Road Dust	Fugitive Dust	WB Dust
Plan02d	2,002	2,286	105	5,400			695			403		11,074	51,533	147,589
Prp18a	2,018	1,944	63	5,400			1,231			464		14,857	56,533	147,589

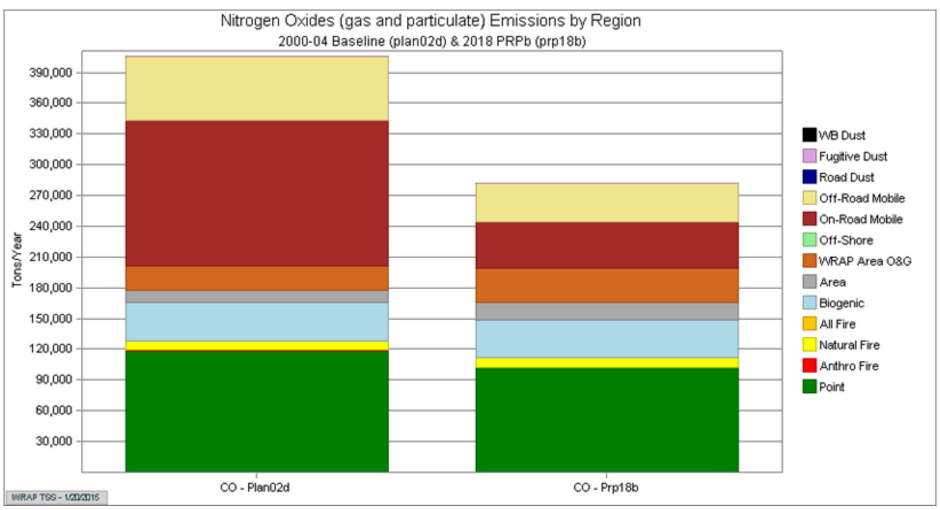


Scenario	Year	Point	Anthro Fire	Natural Fire	All Fire	Biogenic	Area	WRAP Area O&G	Off-Shore	On-Road Mobile	Off-Road Mobile	Road Dust	Fugitive Dust	WB Dust
Plan02d	2,002	1,180	87	1,223			2,821					1,305	6,751	16,399
Prp18a	2,018	1,144	44	1,223			3,644					1,751	7,026	16,399

Figure 5. New Mexico 2002 baseline and projected 2018 emission summaries, coarse particulate mass (top) and fine particulate mass (bottom).

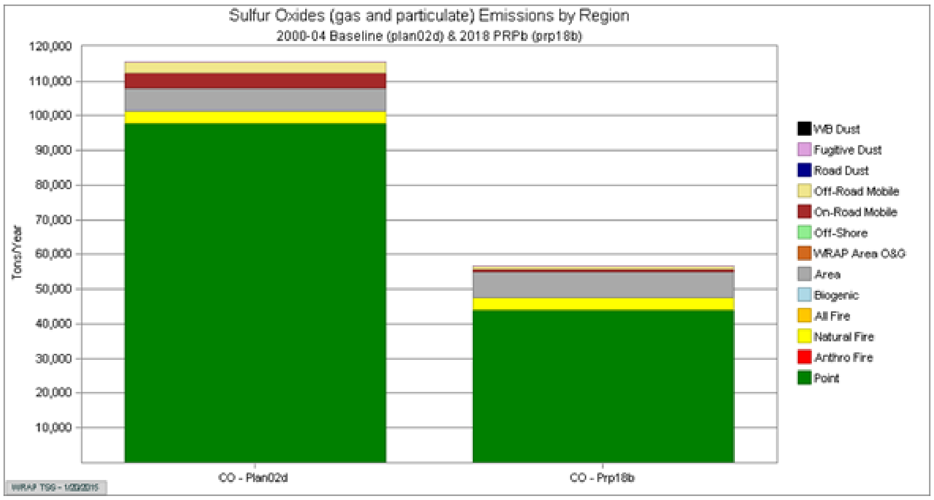


Scenario	Year	Point	Anthro Fire	Natural Fire	All Fire	Biogenic	Area	WRAP Area O&G	Off-Shore	On-Road Mobile	Off-Road Mobile	Road Dust	Fugitive Dust	WB Dust
Plan02d	2002	35,951	9,419	432,263		146,587	84,243	6,847		1,401,328	391,982			
Prp18b	2018	51,985	6,910	432,264		146,587	89,606	9,661		762,667	479,921			——

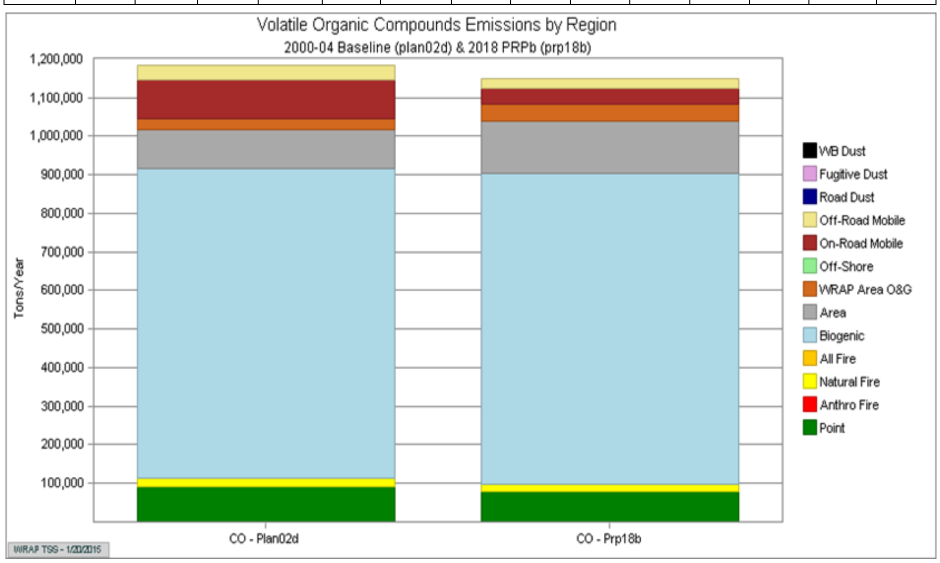


Scenario	Year	Point	Anthro Fire	Natural Fire	All Fire	Biogenic	Area	WRAP Area O&G	Off-Shore	On-Road Mobile	Off-Road Mobile	Road Dust	Fugitive Dust	WB Dust
Plan02d	2002	118,667	520	9,377		37,349	11,729	23,518		141,883	62,448	1	16	
Prp18b	2018	101,818	408	9,377		37,349	16,360	33,517		45,249	37,916	1	14	——

Figure 6. Colorado 2002 baseline and projected 2018 emission summaries, carbon monoxide (top) and nitrogen oxides (bottom).

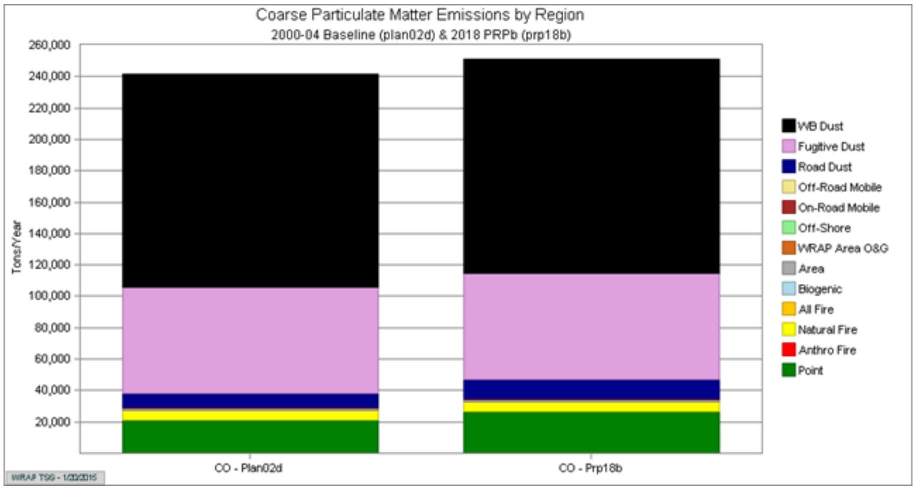


Scenario	Year	Point	Anthro Fire	Natural Fire	All Fire	Biogenic	Area	WRAP Area O&G	Off-Shore	On-Road Mobile	Off-Road Mobile	Road Dust	Fugitive Dust	WB Dust
Plan02d	2002	97,984	108	3,335			6,533	118		4,389	3,015	4	6	
Prp18b	2018	44,062	91	3,335			7,644	11		677	754	6	5	—

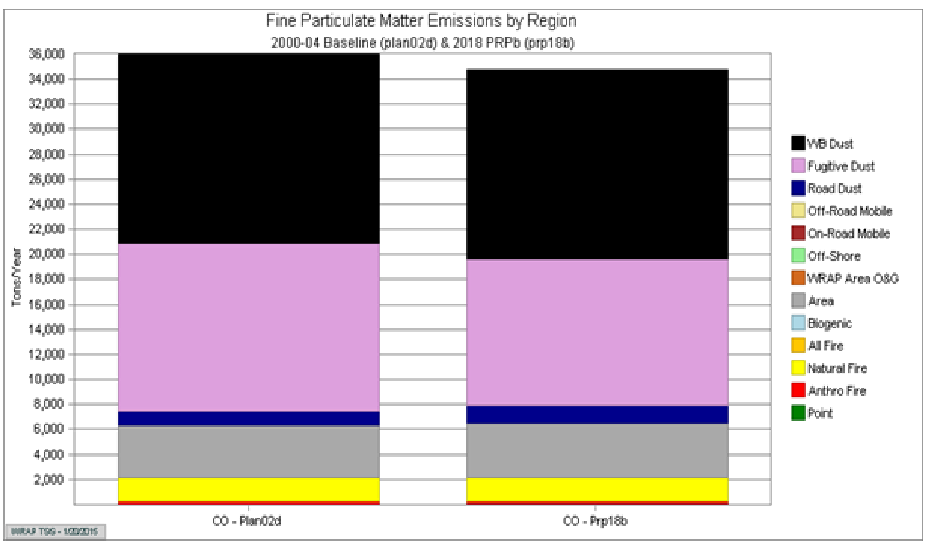


Scenario	Year	Point	Anthro Fire	Natural Fire	All Fire	Biogenic	Area	WRAP Area O&G	Off-Shore	On-Road Mobile	Off-Road Mobile	Road Dust	Fugitive Dust	WB Dust
Plan02d	2002	91,750	915	20,404		804,777	99,191	27,259		100,860	38,401			
Prp18b	2018	77,312	666	20,404		804,777	136,032	43,639		41,489	24,684			

Figure 7. Colorado 2002 baseline and projected 2018 emission summaries, sulfur oxides (top) and volatile organic compounds (bottom).



Scenario	Year	Point	Anthro Fire	Natural Fire	All Fire	Biogenic	Area	WRAP Area O&G	Off-Shore	On-Road Mobile	Off-Road Mobile	Road Dust	Fugitive Dust	WB Dust
Plan02d	2002	21,096	51	5,973			1,363			794		8,930	67,642	135,945
Prp18b	2018	26,828	32	5,973			1,388			917		11,826	67,910	135,945



Scenario	Year	Point	Anthro Fire	Natural Fire	All Fire	Biogenic	Area	WRAP Area O&G	Off-Shore	On-Road Mobile	Off-Road Mobile	Road Dust	Fugitive Dust	WB Dust
Plan02d	2002	6	253	1,948			4,170					1,082	13,401	15,105
Prp18b	2018	85	169	1,948			4,311					1,435	11,679	15,105

Figure 8. Colorado 2002 baseline and projected 2018 emission summaries, coarse particulate mass (top) and fine particulate mass (bottom).

Ambient Air Quality Measurements

This section summarizes the ambient air quality measurements collected between the years 2000 and 2010 at New Mexico monitoring sites in and near the Carson. These monitoring data depict concentrations of air pollutants which have the potential to cause adverse health effects in the general population and/or adverse ecological effects. Additional discussion about the health and ecological effects of individual pollutants is provided below.

Figure 9 shows the location of the air quality monitoring sites that are relevant to the plan area. There are a variety of air monitoring stations throughout New Mexico that are operated by the state, Bernalillo County, the Navajo Nation, and by federal land management agencies that can be used to gauge ambient air quality, visibility, and deposition of pollutants. A summary of the pollutants monitored and available period of record for each site is provided in Table 2. The visibility monitoring data are described in next section.

For the Carson, most of the nearby ambient air quality monitoring stations are located in the greater Albuquerque metropolitan area. Although air quality levels in an urban area are not likely to be totally representative of the Carson, these data do provide for a reasonable upper bound on air quality concentrations within the plan area. Lacking other data collected in more remote settings, the reported data are the best available information to characterize exiting air quality conditions for the wilderness areas of concern.

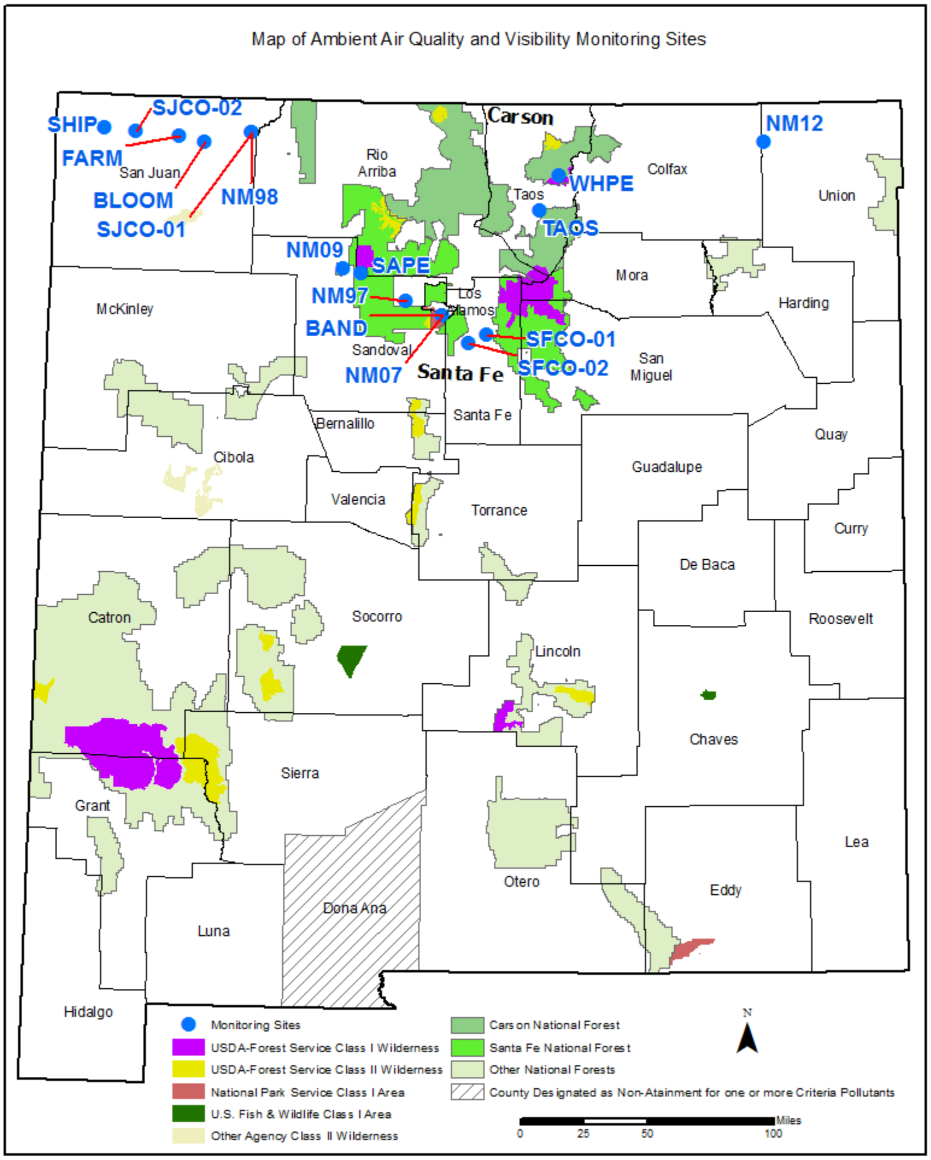


Figure 9. Map of air quality monitoring sites in the plan area.

Table 2. Air quality monitoring sites for the Carson.

Monitoring Site	Site Label	Pollutants Monitored (review period)*
Bandelier	NM07	NADP/NTN (2000-2010)
Bandelier National Monument	BAND	IMPROVE Aerosol, dv (2000-2010)
Bloomfield – Highway Yard	BLOOM	O_3 (2000-2010), NO_2 (2000-2010), SO_2 (2000-2010)
Capulin Volcano	NM12	NADP/NTN (2000-2010)
Cuba	NM09	NADP/NTN (2000)
Farmington	FARM	$PM_{2.5}$ (2008-2010), PM_{10} (2008-2010)
Navajo Lake	NM98	MDN (2009-2010)
San Juan County #1	SJCO-01	O_3 (2006-2010), NO_2 (2005-2010)
San Juan County #2	SJCO-02	O_3 (2000-2010), NO_2 (2000-2010), SO_2 (2000-2010)
San Pedro Parks	SAPE	IMPROVE Aerosol, dv (2001-2010)
Santa Fe County #1	SFCO-01	$PM_{2.5}$ (2000-2010), PM_{10} (2000-2010)
Santa Fe County #2	SFCO-01	O_3 (2007-2010)
Shiprock	SHIP	O_3 (2010), NO_2 (2010), SO_2 (2010), PM_{10} (2007-2010)
Taos County	TAOS	PM_{10} (2000-2010)
Valles Caldera National Preserve	NM97	MDN (2009-2010)
Wheeler Peak	WHPE	IMPROVE Aerosol, dv (2001-2010)

*For the purposes of this assessment, only measurements collected between 2000 and forward were reviewed (dv=deciview).

Table 2 lists the current primary National Ambient Air Quality Standards (NAAQS), which represent ambient concentrations of air pollutants determined by the EPA to result in adverse health effects to the most sensitive population groups, such as: children, the elderly, and persons with breathing difficulties. The health effects of air pollution are discussed further in the subsequent sections that describe specifics of monitoring data for each pollutant.

Carbon Monoxide (CO) Concentrations

Carbon monoxide (CO) data has not been collected in the airsheds containing the Carson National Forest. Generally, CO emissions are caused by exhaust from fuel combustion in mobile sources (cars, trucks, etc.) and as such are generally monitored only in large urban settings, like Albuquerque. CO is not expected to be an issue in areas containing or near the Carson.

Ozone (O_3) Concentrations

Ozone (O_3) data have been collected at five sites near the Carson. However, some of the monitoring has only recently commenced. The Shiprock site has O3 data only for 2010, the Santa Fe #2 site has O3 data starting in 2007, and the San Juan #2 site has O3 data starting in 2006 (USEPA 2012).Ozone (O_3) is one of the major constituents of photochemical smog. It is not emitted directly into the atmosphere, but instead is formed by the reaction between nitrogen oxide (NOx) emissions and volatile organic compounds (VOCs) emissions in the presence of sunlight. The highest concentrations of O_3 typically occur in the summer months.

Excessive O_3 concentrations can have a detrimental impact on human health and the environment. Elevated O_3 levels can cause breathing problems, trigger asthma, reduce lung function, and lead to increased occurrence of lung disease. Ozone (O_3) also has potentially harmful effects on vegetation, which is usually the principal threat to forested ecosystems. It can enter plants through leaf stomata and oxidize tissue, causing the plant to expend energy to detoxify and repair itself at the expense of added growth. Damage to plant tissue can be more pronounced where the detoxification and repair does not keep up with the O_3 exposure. The mesophyll cells under the upper epidermis of leaves are particularly sensitive to O_3. Ozone (O_3) damage can generate a visible lesion on the upper side of a leaf, termed "oxidant stipple." Other symptoms of elevated O_3 exposure may include chlorosis, premature senescence, and reduced growth. These symptoms are not unique to ozone damage and may also occur from other stresses on plant communities such as disease and/or insect damage.

Data representing the 4^{th} highest 8-hour average O_3 concentrations for calendar years 2000–2010 for the Bloomfield, San Juan #1, San Juan #2, Shiprock, and Santa Fe #2 monitoring stations were analyzed (WRAP 2012). The applicable 8-hour National Ambient Air Quality Standards (NAAQS) is based on the annual fourth-highest daily maximum O_3 concentration averaged over three years. At some New Mexico monitoring sites, the annual 4^{th} highest concentration is at or near the NAAQS level (75 ppb). However, in the last three years, the 75 ppb level has not been exceeded based on the 4^{th} highest 8-hour average O_3 concentration. Note that given the form of the O_3 NAAQS, data analyzed does not allow for a strict comparison to the NAAQS as the data have not been averaged over three years as required for comparison to the NAAQS. However, it would appear that O_3 concentrations are below the applicable NAAQS although the margin of compliance is small. It should also be noted that the EPA has proposed lowering the standard to between 65 and 70 ppb O_3, with an expected decision in early 2015.

Comment [UFS1]: Add reference

Particulate Matter - $PM_{2.5}$/PM_{10}

$PM_{2.5}$ data are currently available from two monitoring sites near the forest areas of interest (Farmington and Santa Fe #1). The Farmington site has $PM_{2.5}$ data going back to 2000 while Farmington has $PM_{2.5}$ data only for 2008-10. For PM_{10}, data are available for up to four sites over the reporting period (2000-2010). How PM2.5 data are currently available from two monitoring sites near the forest areas of interest (Farmington and Santa Fe #1). The Farmington site has $PM_{2.5}$ data going back to 2000 while Farmington has PM2.5 data only for 2008-10. For PM_{10}, data are available for up to four sites over the reporting period (2000-2010). However, only two PM_{10} monitoring sites were active for 2006 and earlier years. The Shiprock PM_{10} site was added in 2007 and the Farmington PM_{10} site was added in 2008 (USEPA 2012).

As shown by the emissions inventory data documented in the prior section, most PM emissions in New Mexico are associated with fugitive dust and other sources of dust (e.g., wind erosion and re-entrained dust from traffic on streets and roadways). Chronic exposure to elevated $PM_{2.5}$ and PM_{10} concentrations leads to an increased risk of developing cardiovascular and respiratory diseases (including lung cancer) where the PM emissions contain toxic constituents such as heavy metals (WHO, 2011).

The annual average $PM_{2.5}$ concentration was in the range of 4-5 micrograms per cubic meter at both of the monitoring sites, compared to the NAAQS of 12 micrograms per cubic meter. On December 14, 2012, the EPA reduced the primary $PM_{2.5}$ NAAQS from 15 micrograms per cubic meter to 12 micrograms per cubic meter (annual mean, averaged over three years). The 15 micrograms per cubic meter standard was retained as the annual mean secondary $PM_{2.5}$ NAAQS.

The 98th percentile 24-hour average $PM_{2.5}$ concentrations measured 10 micrograms per cubic meter at the Santa Fe #1 site, with a peak measurement of 15 micrograms per cubic meter in 2002. At the Farmington site, the 98th percentile 24-hour average $PM_{2.5}$ concentration was around 18 micrograms per cubic meter in 2010. The 24-hour NAAQS for $PM_{2.5}$ is 35 micrograms per cubic meter, based on the 98th percentile concentration averaged over three years.

The PM_{10} data were charted for the annual mean and the maximum 24-hour average concentration. The PM_{10} NAAQS exists only for the 24-hour average (150 micrograms per cubic meter). Except for a few readings at the Shiprock monitor in 2007 and 2008, the highest measured 24-hour average PM_{10} concentration generally ranged between 50-75 micrograms per cubic meter. Shiprock measured PM_{10} levels near 150 micrograms per cubic meter in 2007 and near 125 micrograms per cubic meter in 2008.

Over the period of record, the annual mean PM_{10} at the various monitoring sites averaged 10-20 micrograms per cubic meter, with Shiprock showing somewhat highest PM_{10} concentrations (about 25 micrograms per cubic meter). There is no obvious trend in the annual PM_{10} measurements. An applicable annual mean NAAQS no longer exists for PM_{10} concentrations, although PM_{10} is still regulated by an NAAQS for the 24 hour average as noted above.

Available PM_{10} and $PM_{2.5}$ monitoring data show that concentrations within the plan area comply with the applicable NAAQS, although the PM_{10} levels approach the NAAQS at Shiprock.

Nitrogen Dioxide (NO_2) and Sulfur Dioxide (SO_2)

Nitrogen oxides (NOx) and SO_2 emissions occur as a result of fuel combustion, either in industrial or commercial emission sources such as power generation facilities or in mobile sources (e.g., cars, trucks, busses, aircraft etc.). Sulfur dioxide (SO_2) emissions are linked to the quantity of sulfur in fuels that are combusted. These emissions may also result from smelting and refining of copper ores, due to the liberation of sulfur compounds contained in the ore body.

Nitrogen oxides (NOx) and SO_2 emissions are also linked to the formation of nitrate and sulfate aerosols, which have potential adverse effects on visibility. Also, NOx and SO_2 emissions are linked to increases in acid precipitation and acid deposition.

Nitrogen dioxide (NO_2) is the regulated form of NOx emissions. NO_2 monitoring data are currently available for four sites, although the Shiprock site only has data for 2010. NO_2 data at the San Juan #1 site are available since 2005 (USEPA 2012).

Health effects from exposure to elevated concentrations of NO_2 include inflammation of the airways for acute exposures and increases in the occurrence of bronchitis for children and other sensitive individuals chronically exposed to elevated NO_2 levels (WHO 2011).

For sites with ambient NO_2 data, the 98th percentile 1-hour NO2 concentration was generally around 40 ppb in most years and the annual mean NO_2 concentration was generally around 10-20 ppb. These levels are substantially below the applicable 1-hour and annual NAAQS (100 and 53 ppb respectively) and demonstrate that ambient NO_2 concentrations comply with the NAAQS in the area of interest. The Bloomfield monitoring site shows higher concentrations for NO2 (annual average), while the differences between sites for the 98th percentile 1-hour average NO_2 concentrations were relatively minor.

SO_2 monitoring data are available for two sites in the area of interest from 2000-2010, with a third site (Shiprock) being added during 2010 (USEPA 2012). In particular, the San Juan #2 site is located near the San Juan Generating Station and as such, these SO_2 measurements are probably not broadly representative of current ambient conditions in most areas on the Carson. Away from the local impacts of the power plant emissions, ambient SO_2 concentrations are expected to be much less however is a potential issue with regards to atmospheric deposition.

Health effects from SO_2 exposures include changes in pulmonary function and increases in respiratory symptoms along with irritation of the eyes. Inflammation of the respiratory tract may result in coughing, mucus secretions, and aggravation of asthma and chronic bronchitis. Persons exposed to elevated SO_2 levels are also more prone to infections of the respiratory tract (WHO 2011).

The measurements at San Juan #2 have shown a significant decline in ambient SO2 levels since the Year 2000, and the 2010 levels are well below the NAAQS. Over this time period, emission reductions strategies have been implemented for SO_2 control at San Juan and the nearby Four corners Generating Station.

The 2010 Shiprock SO_2 data show elevated concentrations for the 99th percentile 1-hour average daily maximum concentration. However, NAAQS compliance for the Shiprock SO_2 monitoring station cannot be determined because the NAAQS is based on the concentrations averaged over a three year period.

Visibility

Visibility has been recognized as an important value going back to the 1977 Clean Air Act (CAA) Amendments, which designated it as an important value for most wilderness areas that are designated as "Class I." Visibility refers to the conditions that allow the appreciation of the inherent beauty of landscape features. This perspective takes into account the form, contrast, detail, and color of near and distant landscapes. Air pollutants (particles and gasses) may interfere with the observer's ability to see and distinguish landscape features.

The Interagency Monitoring of Protected Visual Environments (IMPROVE) program has been monitoring visibility conditions in Class I wilderness areas in New Mexico and nationwide since the late 1980s. The following three IMPROVE monitoring sites (mapped in Figure 9) are relevant to the Carson:

1. Bandelier National Monument (BAND1)
2. San Pedro Parks (SAPE1)
3. Wheeler Peak (WHPE)

IMPROVE monitors concentrations of atmospheric aerosols (sulfates, nitrates, etc.) and uses these data to assess light "extinction," or the degree to which light is absorbed and/or scattered by air pollution. Visibility is normally expressed in terms of "extinction" or by using the "deciview" index, which is calculated from the measured extinction value. The "deciview" index represents a measure of change in visibility conditions which is typically perceptible to the human eye. A deciview change in the range of 0.5 to 1.0 dv is generally accepted as being the limit of human perceptibility. Figure 10 illustrates the relationships among extinction, deciviews, and visual range.

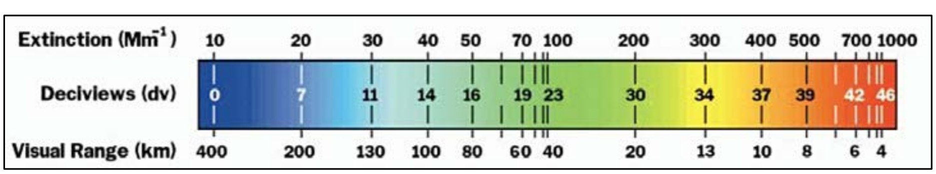


Figure 10. Relationship among extinction, deciview Index, and visual range.

Measurements of annual mean visibility (as extinction) across the United States are shown in Figure 11 as taken from IMPROVE (Hand et al. 2011). These data show lower values of extinction (better overall visibility) across the western United States and high values of extinction in the eastern United States. Western areas in and around urban centers (e.g., Phoenix, Denver, Las Vegas, etc.) also show more degraded visibility.

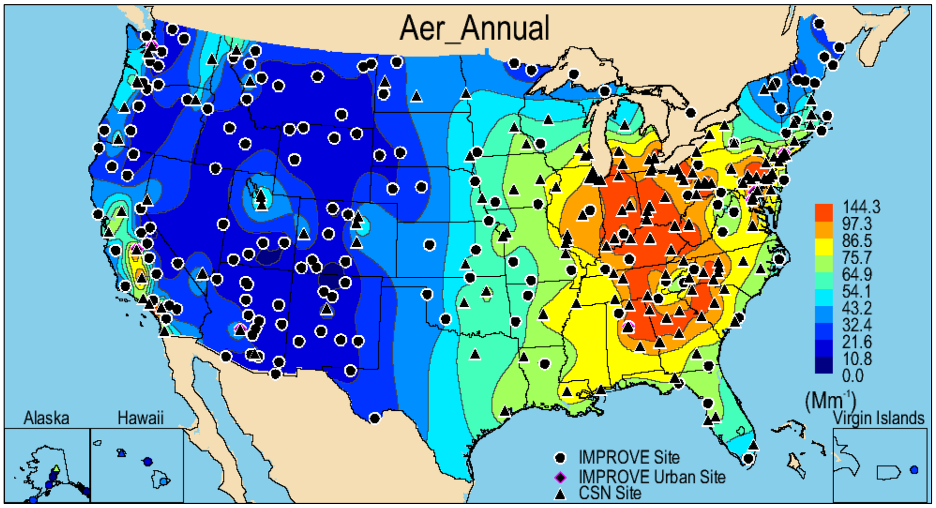


Figure 11. Reconstructed annual mean aerosol extinction from IMPROVE and other aerosol data (Hand et al. 2011).

Under the Clean Air Act (CAA), the national visibility goal is to return visibility in Class I areas to the "natural background condition" no later than 2064. To meet this goal, the CAA has instituted measures for emissions control at large stationary sources that contribute to visibility impairment.

Interagency Monitoring of Protected Visual Environments (IMPROVE) reconstructed extinction data for the Carson were calculated from the IMPROVE aerosol measurements for the period 2000–2010 and are summarized in Table 3 for the 20 percent worst-case days (IMPROVE 2012). The IMPROVE measurements were sorted to provide the representative visibility conditions for the "worst 20%" visibility and the "average" visibility days, which are standard techniques for reviewing and assessing IMPROVE aerosol monitoring data. The visibility condition representing the 2064 goal for achieving "natural background" is also shown in Table 3. These data provide a measure of how much visibility improvement is required at each Class I area in order to achieve the 2064 National Visibility Goal (NMED 2011).

The data in Table 3 are reported using the deciview metric described earlier. Higher values of deciview represent more degraded visibility conditions. Data are shown using the "baseline period" (2000–2004) along with the "progress period" (2005–2009) corresponding to the New Mexico regional haze SIP and the 2064 National Visibility Goal (natural background).

Table 3. Summary of IMPROVE visibility monitoring data, 20% worst-case days (dv).

Wilderness	IMPROVE Monitor	2000-04 Baseline Period		2005-09 Progress Period		2064 Goal Natural Background
		Average	Range	Average	Range	

Wilderness	IMPROVE Monitor	2000-04 Baseline Period		2005-09 Progress Period		2064 Goal Natural Background
		Average	Range	Average	Range	
Bandelier	BAND1	12.2	10.5–14.6	11.8	11.0–12.8	6.26
San Pedro Parks	SAPE1	10.2	9.3–11.6	9.9	8.2–10.8	5.72
Wheeler Peak	WHPE	10.4	8.4-11.4	9.1	8.6-10.1	6.08

These data show that based on the 20 percent worst days during the 2005–2009 "progress period," Bandelier has the most degraded visibility and San Pedro Parks and Wheeler Peak have the least degraded visibility. Also, the general trend in visibility (based on the change in the worst 20 percent days between the baseline period and progress period) has been toward moderately improving visibility conditions. Table 3 also shows that the level of visibility improvement through the 2005–2009 "progress period," has been relatively modest compared to the visibility improvements needed by 2064 to achieve the goal of natural background conditions.

Interagency Monitoring of Protected Visual Environments (IMPROVE) measurements at each of the nearby Class I areas of interest can be found at http://views.cira.colostate.edu/fed/ (IMPROVE 2012). Data from this site show the reconstructed extinction at each IMPROVE monitoring site for each year (2000–2010 where data are available for the entire period of record). This site also produces pie charts showing the percent contribution to the reconstructed extinction for the different aerosol species. The percent contribution charts represent the 2000–2004 "baseline" and the 2005–2009 "reasonable further progress" periods described above. For these particular charts, the visibility is reported using units of inverse megameters, which is a direct measure of atmospheric light extinction. Again, higher values of extinction represent more degraded visibility.

- **Bandelier National Monument** (BAND1): The reconstructed extinction for the most impaired 20 percent days showed levels generally in the 30–40 Mm-1 range, except during 2000, when the extinction measured around 70 Mm-1. The conditions in Year 2000 at BAND1 appear somewhat anomalous, with very high extinction budgets for organics, strongly suggesting the presence of nearby wildfires. These conditions are not apparent in any other data year. Excluding the potential bias introduced by the Year 2000 measurements, the extinction budgets at Bandelier are roughly 25 percent Rayleigh scattering, 25–30 percent sulfate and nitrate (indicative of industrial source emissions), 20–25 percent organics, and 10–15 percent coarse mass and soils. There has been a steady improvement in the visibility conditions represented by the 20 percent most impaired days since about 2007, which is mostly reflected by reductions in sulfate and may be a result of emissions control technology improvements at coal-fired electric generating stations.
- **San Pedro Parks & Wheeler Peak**: As mentioned above, the San Pedro Parks and Wheeler Peak have similar trends in their data. They have the least degraded visibility, and this is also evident in the extinction data. For the 20 percent most impaired days, the reconstructed extinction ranges between 25–35 Mm-1. Because they have the least impaired visibility, the Rayleigh contribution in the extinction budget is 30 percent, slightly larger than other IMPROVE sites. The sulfate and nitrate contribution is about 25–30 percent, the organics contribution is about 25 percent, and the coarse mass and soil contribution is about 15 percent. Similar to some of the other sites, the extinction data show some improvements in visibility conditions since 2007, generally reflecting less impact from sulfate, which might be indicative of regional SO_2 emission reductions.

Atmospheric Deposition Information

Sulfur and Nitrogen Deposition

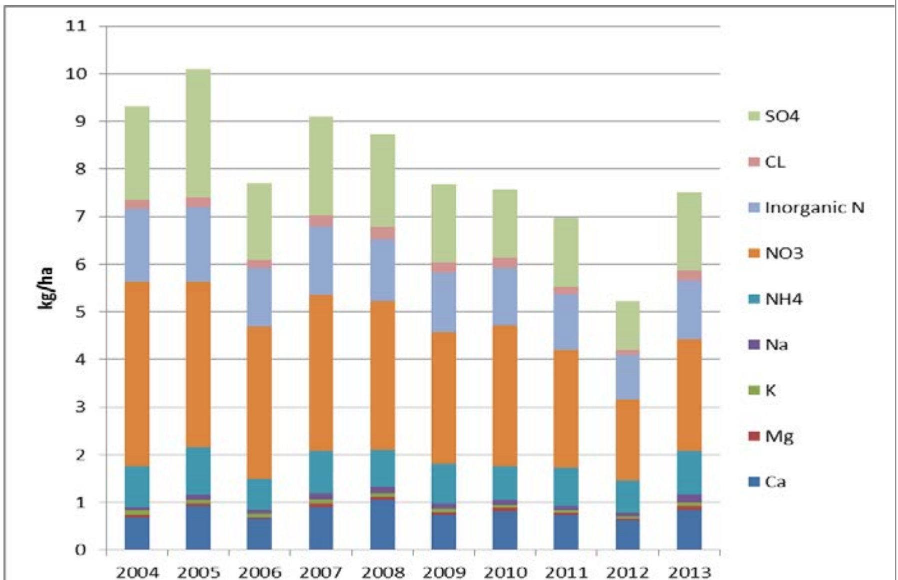
Air emissions of nitrogen oxides (NOx) and sulfur dioxide (SO_2) can lead to atmospheric transformation of these pollutants to acidic compounds (e.g., nitric acid and sulfuric acid) and the resultant deposition onto land and water surfaces in forested ecosystems. Documented effects of nitrogen and sulfur deposition include acidification of lakes, streams and soils, leaching of nutrients from soils, injury to high-elevation forests, changes in terrestrial and aquatic species composition and abundance, changes in nutrient cycling, unnatural fertilization of terrestrial ecosystems, and eutrophication of aquatic ecosystems.

Deposition impacts are generally described in terms of the "critical load," defined as "the quantitative estimate of an exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment are not expected to occur based on present knowledge" (NADP 2009). In other words, the "critical load" determines the tipping point at which harmful effects attributable to deposition in a particular ecosystem start to occur. Critical loads have been established at some, but not all wilderness areas. For the New Mexico wilderness areas of interest, critical loads for nitrogen and acid deposition have been established based on a national assessment, although they lack some site-specific data for a more robust assessment (Pardo et al. 2011). This general approach has been applied to determine critical loads for nitrogen and sulfur deposition, for some sensitive receptors on the forest.

Figure 12 shows the sulfur and nitrogen deposition measurements collected at the Bandelier National Monument station operated for the National Trends Network (NTN) over the period 2004–2014 (CASTNET 2013). Totals are shown for wet deposition and dry deposition for both sulfur and nitrogen, along with other chemical species. Units of measurement are kilograms per hectare (kg/ha).

Deposition has remained relatively constant over the period of record, although some year-to-year variability is noted. Generally, the observed deposition at Bandelier ranges between 5.0-10.0 kg/ha-yr. Nitrogen deposition makes up the bulk of the deposition and typically constitutes about 3 kg/ha-yr, while sulfur deposition is typically closer to 2 kg/ha-yr.

The Carson also supports the United States Geological Society (USGS) Snowpack Chemistry Monitoring Study which includes two locations on the forest (USGS, 2014 http://co.water.usgs.gov/projects/RM_snowpack/index.html). One site is located near the Taos Ski area and the second is near Hopewell Lake. Generally, nitrate deposition at the two sites has decreased over the last 14 years, consistent with overall emissions and the expected trend in emissions. Sulfate emissions have been more variable, with levels increasing at the Taos site and decreasing at the Hopewell site. While the expected trend is expected to decrease in sulfur emissions over time, many of the regulatory actions driving this trend have yet to take effect.



	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
SO4	1.98	2.71	1.6	2.08	1.95	1.64	1.45	1.46	1.03	1.64
CL	0.17	0.19	0.19	0.23	0.25	0.2	0.21	0.15	0.11	0.2
Inorganic N	1.53	1.56	1.22	1.44	1.3	1.27	1.21	1.17	0.91	1.24
NO3	3.88	3.49	3.2	3.26	3.12	2.76	2.94	2.48	1.72	2.34
NH4	0.84	1	0.64	0.9	0.76	0.83	0.71	0.79	0.66	0.91
Na	0.086	0.101	0.092	0.13	0.156	0.104	0.108	0.095	0.071	0.182
K	0.075	0.073	0.062	0.081	0.067	0.064	0.06	0.049	0.053	0.068
Mg	0.053	0.059	0.048	0.067	0.078	0.057	0.067	0.046	0.045	0.08
Ca	0.7	0.92	0.65	0.91	1.04	0.75	0.82	0.74	0.62	0.84

Figure 12. Chemical deposition (Bandelier Station, 2004–2014).
(Data obtained from http://nadp.sws.uiuc.edu/sites/siteinfo.asp?id=NM07&net=NTN)

Mercury Deposition

Mercury is a persistent bioaccumulative toxin which can stay in the environment for long periods of time, cycling between air, water and soil. Mercury deposits on the earth's surface through wet or dry deposition, which can accumulate in the food chain and bodies of water. Toxic air contaminants like mercury, are emitted primarily by coal-fired utilities, and may be carried thousands of miles before entering lakes and streams as mercury deposition. Mercury can bioaccumulate and greatly biomagnify through the food chain in fish, humans, and other animals. Mercury is converted to methylmercury by sulfur reducing bacteria in aquatic sediments, and it is this form that is present in fish. Methylmercury is a potent neurotoxin, and has been shown to have detrimental health effects in human populations as well as behavioral and reproductive impacts to wildlife. Eating fish is the main way that people are exposed to methylmercury. However, each person's exposure depends on the amount of methylmercury in the fish they eat, how much they eat, and how often. Typically, larger fish that are higher up the food chain (eat lots of little fish rather than algae) will have a greater amount of methylmercury in them.

Almost every state (including New Mexico) has consumption advisories for certain lakes and streams warning of mercury-contaminated fish and shellfish. Many of the lakes on or near the Carson have fish consumption advisories for mercury for some species of fish (NMED 2011).

The Mercury Deposition Network collects and provides a long-term record of mercury concentrations and deposition in precipitation. As a result of coal-fired utilities in the Southwest, and the limited levels of mercury pollution controls at those sites, the total concentration of mercury in the air is fairly high relative to elsewhere in the United States (Figure13) (MDN, 2013). However, due to the relatively low precipitation rates (except at higher elevations), the mercury from wet deposition is comparatively low (Figure 14) (MDN 2013).

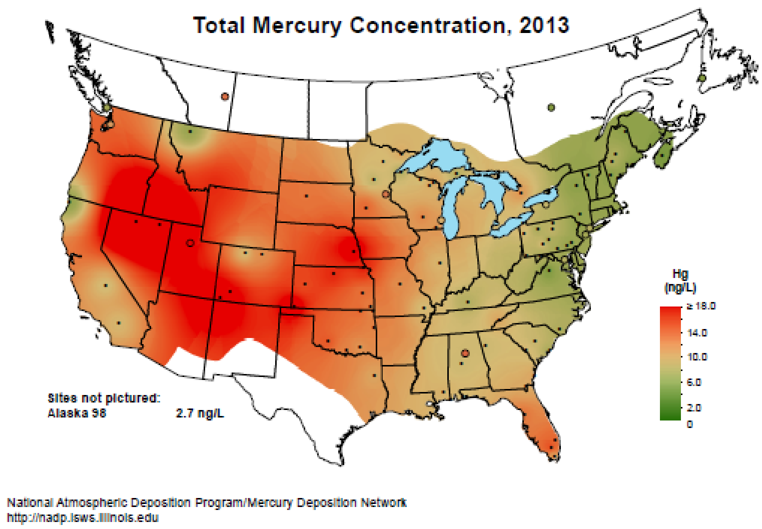


Figure13. Total mercury concentration, 2013.
(Data obtained from: http://nadp.sws.uiuc.edu/maplib/pdf/mdn/hg_Conc_2013.pdf)

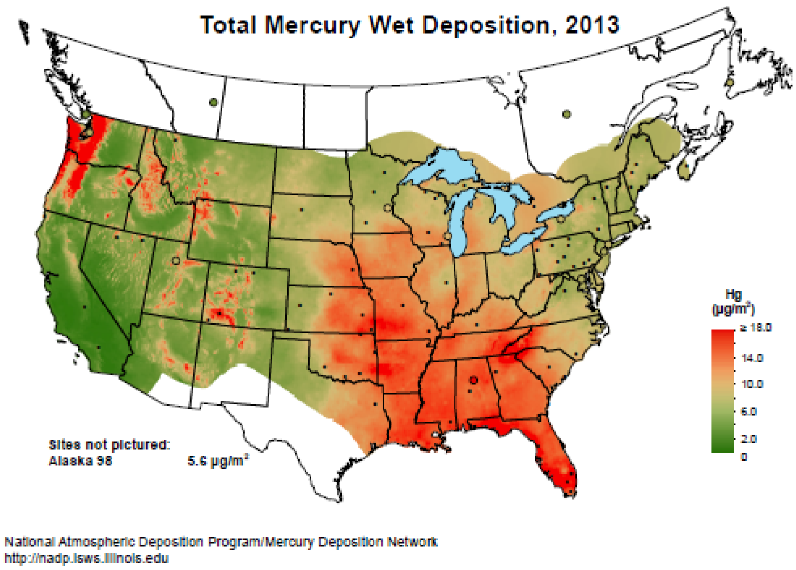


Figure 14. Total wet mercury deposition, 2013.

(Data obtained from: http://nadp.sws.uiuc.edu/maplib/pdf/mdn/hg_dep_2013.pdf)

Some sites also are now collecting total deposition, both wet and dry. One site is located on the Valles Caldera National Preserve. Although it is not on the Carson, it can provide some indication of the conditions on the Carson. While it has only been operating for two years, initial results suggest that dry deposition adds significantly to the total deposition (Sather 2013).

Figure 15 shows the mercury deposition measurements collected at the Mercury Deposition Network (MDN) Valles Caldera National Preserve (Sandoval County). The Valles Caldera MDN site has data only for 2009 and 2010 and shows mercury deposition values in the range of 7,000 ng/m2.

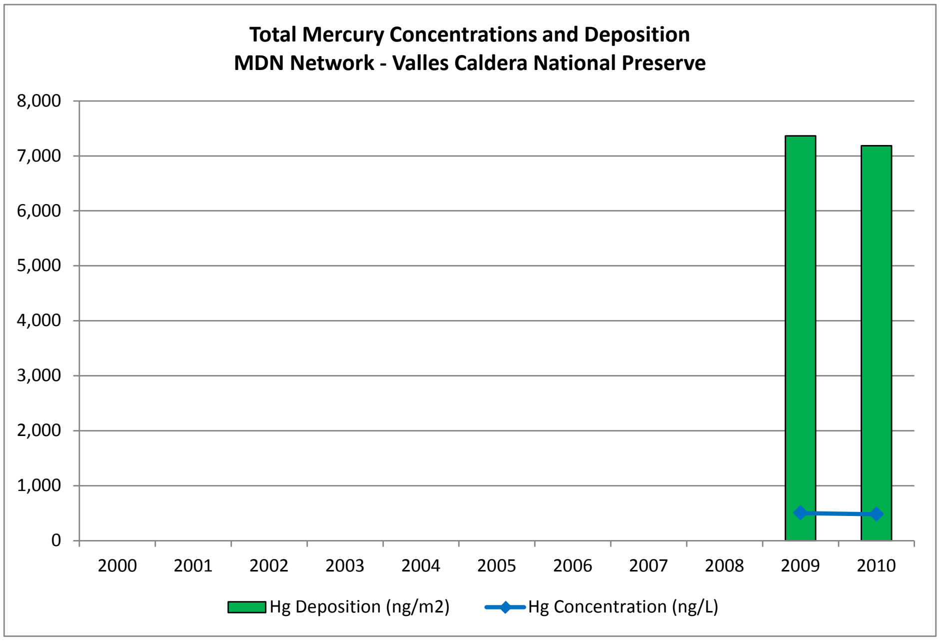


Figure 15. Total mercury concentrations and deposition, MDN Network, Valles Caldera National Preserve, 2000-2005. (Data obtained from http://nadp.sws.uiuc.edu/MDN/)

The USGS also monitors for mercury at the two snowpack chemistry monitoring sites near the Taos Ski area and near Hopewell Lake. Both sites have shown an increase in mercury deposition over the last 14 years that data has been collected.

While it is difficult to assess the current effects that mercury deposition is having on the Carson, trends in two areas suggest that overall mercury effects will decline. First, new regulatory controls at a couple regional coal fired power plants should reduce the total mercury emissions over the next several years. In addition, sulfur emissions are also expected to decline, due to new sulfur fuel standards and pollution controls at the coal fired utilities. The link between sulfur-reducing bacteria and biotic mercury concentrations has led researchers to establish that reductions in sulfur dioxide emissions and a resulting reduction in sulfate deposition will abate mercury concentrations in wildlife. As a result, as sulfates are reduced in aquatic systems, sulfur reducing bacteria will reduce less sulfur, and this will lead to less inorganic mercury being methylated.

Federal, State & Tribal State Implementation Plans

As stated previously, the federal Clean Air Act (CAA) provides the basic framework for controlling air pollution, but the states are primarily responsible for implementing and enforcing CAA requirements. Within this framework, there are a couple tools particularly relevant to protecting air quality related to national forests. Typically, air pollution that occurs off national forests is the primary concern for causing impacts on national forests. Pollution can result from either new or existing sources.

The primary tool for addressing air quality impacts from new sources is the Prevention of Significant Deterioration (PSD) program. The 1977 CAA amendments established the PSD program to preserve the clean air usually found in pristine areas, while allowing controlled economic growth. The PSD permitting program applies to new, major sources of air pollution or modifications to existing major sources which have the potential to emit certain amounts of air pollution regulated by the Environmental Protection Agency (EPA). The purpose of the PSD program is to prevent violations of NAAQS and to protect the environment including visibility and air quality is pristine areas such as Class 1 wilderness areas managed by the Forest Service. The PSD program can apply to non-criteria pollutants and can require analyses to assess the impacts of pollution on soils, vegetation, visibility and water resources managed by the Forest Service.

For existing sources of air pollution, the Federal Regional Haze Rule (RHR) requires states to develop programs to assure reasonable progress toward meeting the national goal of preventing any future, and remedying any existing, impairment of visibility in mandatory Class I federal areas. The RHR addresses requirements for SIPs, plan revisions, and periodic progress reviews to address regional haze and achieve natural haze conditions in each of the Class I areas by the year 2064.

Regional Haze Rule, 40 CFR 51.308 and 40 CFR 51.309

On July 1, 1999, the Environmental Protection Agency (EPA) issued regional haze rules to comply with requirements of the Clean Air Act. Under 40 CFR 51.308, the rule requires the state of New Mexico to develop SIPs which include visibility progress goals for each of the nine Class I areas in New Mexico, as well as provisions requiring continuing consultation between the state and Federal Land Managers (FLM) to address and coordinate implementation of visibility protection programs. Under 40 CFR 51.309, the rule also provides an optional approach to New Mexico and eight other western states to incorporate emission reduction strategies issued by the Grand Canyon Visibility Transport Commission (GCVTC) designed primarily to improve visibility in 16 Class I areas on the Colorado Plateau, including the San Pedro Parks Wilderness Area in New Mexico (NMED 2011).

New Mexico Environmental Department-State Implementation Plan

On December 31, 2003, the state of New Mexico submitted a visibility SIP to meet the requirements of 40 CFR 51.309 (309 SIP). The 2003 309 SIP and subsequent revisions to the 309 SIP, address the first phase of requirements, with an emphasis on stationary source sulfur dioxide (SO_2) emission reductions and a focus on improving visibility on the Colorado Plateau. In the 2003 submittal, New Mexico committed to addressing the next phase of visibility requirements and additional visibility improvement in New Mexico's remaining eight Class I areas by means of an SIP meeting the requirements in 309(g). The regional haze SIP describes the Class I areas where visibility protections are in place, monitors existing visibility conditions and trends, defines the cause in terms of source emissions of visibility impairment at each Class I area, projects future trends in visibility conditions based on implementation of various emission control measures, and provides a long-term strategy to meet the stated national visibility goal of reducing all man-made visibility impairment by 2064.

Since the 2003 submittal of the 309 SIP, the EPA has revised both 40 CFR 51.308 and 309 in response to numerous judicial challenges. The latest SIP petition was filed by the New Mexico Environmental Department on February 28, 2011, revised March 31, 2011 (NMED 2011). The February 2011 revision was made to satisfy New Mexico’s obligations under the “Good Neighbor” provision of the CAA at §110(a)(2)(D)(i). Included is a Best Available Retrofit Technology (BART) determination and proposed reductions for the San Juan Generating Station to achieve visibility reductions relied upon by other states in setting their visibility goals (NMED 2013). This SIP was challenged by San Juan Generating Station and the U.S. EPA, which is currently still pending appeal. On February 15, 2013, a tentative settlement was announced between the state of New Mexico, the U.S. EPA, and San Juan Generating Station. (EPA

2013). The agreement will shut down two of the plant's coal fired units and install selective non-catalytic reduction technology on the remaining two coal fired units. The two units being shut down will be replaced by less polluting natural gas-fueled units.

Grand Canyon Visibility Transport Commission – 1996 Findings and Recommendations

In 1990, amendments to the Clean Air Act under 40 CFR 51.309 established the Grand Canyon Visibility Transport Commission to advise the EPA on strategies for protecting visual air quality on the Colorado Plateau. The GCVTC released its final report in 1996 and initiated the WRAP, a partnership of state, tribal and federal land management agencies to help coordinate implementation of the Commission's recommendations (WRAP 1996). Issues addressed by the GCVTC and WRAP are summarized below:

- Air pollution prevention
- Clean air corridors
- Stationary sources
- Areas in and near parks and wilderness areas
- Mobile sources
- Road dust
- Emissions from Mexico
- Fire

Forest Service Policy and Actions

Regional Forest Service Air Resource Management (ARM) staff act as the point of contact to receive and review permit applications filed with state and local regulatory agencies by new/modified emission sources and provide comments back to the state agency. Unless a specific issue arises, individual national forests are typically not responsible for conducting reviews of new/modified sources via the state-level air quality applications process. The Forest Service regional office provides air quality analysis to determine if proposed actions are likely to cause, or significantly contribute to, an adverse impact to visibility or other air quality related values within the national forest system (USFS 2012).

Additionally, the Forest Service complies with the New Mexico State Smoke Management Programs (SMP), which is described in Section 12.7.14 of the February 2011 New Mexico Section 309(g) Regional Haze SIP (NMED 2011). New Mexico's administrative code (20.2.65 NMAC-Smoke Management) stipulates that all burners must comply with requirements of the Clean Air Act and Federal Regional Haze Rule (RHR), as well as all city and county ordinances relating to smoke management and vegetative burning practices. For prescribed fires and wildfires managed for resource benefit that exceed 10 acres, additional requirements include: registering the burn, notifying state and nearby population centers of burn date(s), visual tracking, and post-fire activity reports (NMAC 2013).

As indicated previously, the Forest Service typically lacks direct authority to control air emissions that impact a particular ranger district of the Carson. The primary role that Air Resource Management (ARM) staff can provide the New Mexico Environmental Department (NMED) staff as they prepare Prevention of Significant Deterioration (PSD) permits or develop the Federal Regional Haze Rule (RHR), is to provide information about potential impacts that could occur on national forest land, particularly in Class I areas.

The primary tool federal land managers (FLM) use is the critical load concept described in the next section on atmospheric deposition. Currently the Carson has critical loads based on a national assessment developing empirical critical loads for major ecoregions across the United States. However there are no forest specific critical loads developed for the Carson, and therefore they have not been included in the New Mexico SIP.

Critical Loads

Air pollution emitted from a variety of sources is deposited from the air into ecosystems. These pollutants may cause ecological changes, such as long-term acidification of soils or surface waters, soil nutrient imbalances affecting plant growth, and loss of biodiversity. The term critical load is used to describe the threshold of air pollution deposition below which harmful effects to sensitive resources in an ecosystem begin to occur. Critical loads are based on scientific information about expected ecosystem responses to a given level of atmospheric deposition. For ecosystems that have already been damaged by air pollution, critical loads help determine how much improvement in air quality would be needed for ecosystem recovery to occur. In areas where critical loads have not been exceeded, critical loads can identify levels of air quality needed to maintain and protect ecosystems into the future.

U.S. scientists, air regulators, and natural resource managers have developed critical loads for areas across the United States through collaboration with scientists developing critical loads in Europe and Canada. Critical loads can be used to assess ecosystem health, inform the public about natural resources at risk, evaluate the effectiveness of emission reduction strategies, and guide a wide range of management decisions.

The Forest Service is incorporating critical loads into the air quality assessments performed for forest plan revision. There are no published critical loads in the Southwest United States. For this assessment, national scale critical loads were used to determine if critical loads were exceeded for nutrient nitrogen (Pardo et al. 2011), acidity to forested ecosystems (McNulty 2007), and for acidity to surface water (Lynch 2012). In addition, mercury deposition was analyzed based on data from the mercury deposition network (MDN 2011), however no critical loads have been developed for mercury on the forest service. Ozone deposition was not assessed, due to lack of data availability and analysis in the Southwest United States. No critical loads have been developed for ozone on the Carson National Forest.

Nitrogen Saturation/Eutrophication

Nitrogen air pollution can have an acidifying effect on ecosystems as well as cause excess input of nitrogen in the ecosystem and nitrogen saturation. This excess nitrogen initially will accumulate in soil and subsequently be lost via leaching. While increased nitrogen may increase productivity in many terrestrial ecosystems (which are typically nitrogen limited) this is not necessarily desirable in protected ecosystems, where natural ecosystem function is desired. Excess nitrogen can lead to nutrient imbalances, changes in species composition (trees, understory species, nonvascular plants (lichens), or mycorrhizal fungi), and ultimately declines in forest health.

Based on research by Pardo and others (2011), national scale critical loads were developed for nitrogen deposition for lichen, herbaceous plants and shrubs, mycorrhizal fungi, forests, and nitrate leaching in soils. Summary results of this assessment are in Table 4.

Table 4. Critical load exceedance summary for nitrogen deposition on the Carson.

	% of total	Minimum Exceedance (kg-N/ha)	Maximum Exceedance (kg-N/ha)	95% Exceedance level (kg-N/ha)
Lichens				
Exceedance	89%	0.009751203	2.470469713	1.821734833
No Exceedance	2%			

	% of total	Minimum Exceedance (kg-N/ha)	Maximum Exceedance (kg-N/ha)	95% Exceedance level (kg-N/ha)
Critical Loads Not Available	9%			
Herbaceous Plants & Shrubs				
Exceedance	28%	0.00125561	2.186545077	0.944222983
No Exceedance	72%			
Critical Loads Not Available	0%			
Mycorrhizal Fungi				
Exceedance	3%	0.004093927	1.186545077	0.153771288
No Exceedance	87%			
Critical Loads Not Available	10%			
Forests				
Exceedance	28%	0.00125561	2.186545077	1.153771288
No Exceedance	62%			
Critical Loads Not Available	10%			
Nitrate Leaching				
Exceedance	28%	0.00125561	2.186545077	1.153771288
No Exceedance	62%			
Critical Loads Not Available	10%			

Lichens

Lichens, which add significantly to biodiversity of ecosystems, are some of the most sensitive species to nitrogen deposition (Pardo et al. 2011). Unlike vascular plants, lichens have no specialized tissues to mediate the entry or loss of water or gases. They rapidly hydrate and absorb gases, water and nutrients during periods of high humidity and precipitation. They dehydrate and reach an inactive state quickly, making them slow growing and vulnerable to contaminate accumulation. As such, they are an important early indicator of impacts from air pollution.

Pardo and others (2011) used the major ecoregion types adapted from the Commission for Environmental Cooperation (CEC 1997), of which the Carson is within the Northwestern Forested Mountains ecoregions. The critical loads for lichens in these two ecoregions are based on research for Northwestern

Forested Mountains, with minimum levels between 2.5-7.1 kg-N/ha-yr (Pardo et al. 2011, Geiser et al. 2010). Based on these values, 89 percent of the Carson exceeds critical loads to protect lichens, where 2 percent showed no exceedance and critical loads were not available for 9 percent or the area encompassing the Carson. The minimum amount that the Carson exceeded nitrogen deposition by was 0.0098 kg-N/ha and the maximum was by 2.47 kg-N/ha.

Forests; Herbaceous Plants and Shrubs; Mycorrhizal Fungi; and Nitrate Leaching

Adding nitrogen to forests whose growth is typically limited by its availability may appear desirable, possibly increasing forest growth and timber production, but it can also have adverse effects such as increased soil acidification, biodiversity impacts, predisposition to insect infestations, and effects on beneficial root fungi called mycorrhizae. As atmospheric nitrogen deposition onto forests and other ecosystems increases, the enhanced availability of nitrogen can lead to chemical and biological changes collectively called “nitrogen saturation". As nitrogen deposition from air pollution accumulates in an ecosystem, a progression of effects can occur as levels of biologically available nitrogen increase

Herbaceous plants and shrubs comprise the majority of the vascular plants in North America (USDA, NRCS 2009). They are less sensitive to nitrogen deposition than lichens; however, they are more sensitive than trees due to rapid growth rates, shallow roots, and shorter life span (Pardo et al. 2011). Herbaceous plants are the dominant primary producers, contributing significantly to forest litter biomass and biodiversity (Gilliam 2007). The shorter lifespan of some species can result in a rapid response to nitrogen deposition and can result to rapid shifts (1–10 years) in community composition sometimes resulting in an increase in invasive species compared to native species (Pardo et al. 2011).

Based on the national scale empirical critical loads for nitrogen deposition for herbaceous plants and shrubs (Pardo et al. 2011), 28 percent of the Carson is potentially exceeding critical loads and 72 percent does not exceed. The areas exceeding critical loads for nitrogen deposition range from a slight exceedance of 0.001 kg-N/ha to 2.19 kg-N/ha. 95 percent of the grid cells exceed the critical loads for herbaceous plants and shrubs with values less than 0.94 kg-N/ha. The critical loads were based empirical data developed for the Northwestern Forested Mountains ecoregion, which noted changes in species composition and individual species responses at 4 kg-N/ha-yr Bowman, 2006).

Comment [UFS2]: Add reference

Based on the national scale empirical critical loads for nitrogen deposition for forest and nitrate leaching (Pardo et al. 2011), 28 percent of the Carson is potentially exceeding critical loads and 62 percent does not exceed, with 10 percent of the area where critical loads for these values were not available. The areas exceeding critical loads for nitrogen deposition range from a slight exceedance of 0.001 kg-N/ha to 2.19 kg-N/ha. For forested systems and nitrate leaching, 95 percent of the grid cells exceed the critical loads with values less than 1.15 kg-N/ha. The critical loads were based empirical data developed for the Northwestern Forested Mountains ecoregion, which noted changes in changes in foliar chemistry, mineralization, and nitrogen leaching in soil at levels greater than 4 kg-N/ha-yr (Rueth and Baron, 2002).

Comment [UFS3]: Add reference

Acid Deposition

The potential for impacts from acid deposition on forests has been recognized for more than 30 years in the United States. Research has shown that deposition of nitrogen and sulfur has resulted in acidifying effects, which has had negative impacts on ecosystem health, including impacts to aquatic resources, forest sustainability, and biodiversity (McNulty 2007). Acidifying effects can lead to mortality of tree species, reduced forest productivity, reduced biological diversity, and increased stream acidity (Driscoll 2001).

The following section presents critical acid load for soils and surface water on the Carson. McNulty estimated critical loads and exceedances for forested soils across the United States (McNulty 2007). The surface water critical acid loads were based on research from Lynch (Lynch 2012).

Soils

Many factors contribute to an exceedance of critical acid loads in forested ecosystems. Key factors include the composition of the soil, including how weathered it is, the amount of organic matter present, and the amount of base cations (i.e., calcium, potassium, magnesium, and sodium), which all play a role in how well the soil is buffered against acid deposition (how well the soil can neutralize the acid). For example, sandy soils are typically low in base cations, which make them more vulnerable to acid deposition. Also important are the types of tree species present due to the various rates that they uptake nitrogen, and base cations, which can either counter act the effects of acid deposition or reduce soils buffering capacity. In conifer forests, as the needles break down, the soil is naturally acidified, which can also increase the system's vulnerability to acidification. Also important is the rate at which sulfur and nitrogen compounds fall to the ground through either wet or dry deposition, which is related to what sort of emissions are occurring that are adding these compounds to the airshed. Elevation also plays a role, since more precipitation tends to occur at higher elevations increasing the rate of acid deposition.

Estimates that factor all the parameters described above show that there are no exceedances of acid critical loads on the Carson (Figure 16). This is primarily a result of low amount of acid gases in the airsheds in New Mexico and the western United States.

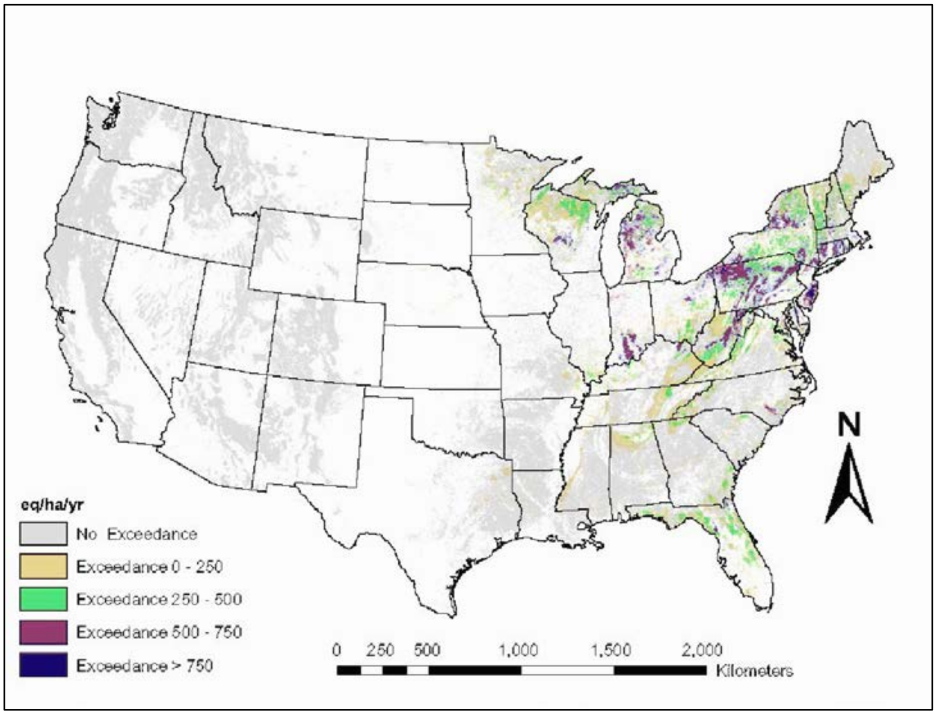


Figure 16. Average annual exceedance of the critical acid load for forest soils expressed in eq/ha-yr for the coterminous US for the years 1994–2000 at a 1-km^2 spatial resolution. (adapted from McNulty et al. 2007).

Surface Water Impacts

Stream and lake acidification can be a result of deposition of acid gases, which can reduce the pH of surface water resulting in reduced diversity and abundance of aquatic species. As described in the previous section, many of the same factors contribute to the susceptibility of aquatic ecosystems to the effects of acid deposition. Surface water acidification begins with acid deposition in adjacent terrestrial areas (Pidwirny 2006) and the system's ability to neutralize the acid before it leaches into the surface water.

There are only a few points in the national critical loads available for the Carson to assess acid deposition to surface water, however all of these points indicate that acidification of surface water on the forest does not appear to be an issue. A national analysis, by Lynch was conducted using the Steady-State Water Chemistry model (SSWC) used a mass-balance approach to assess acid critical loads for surface water (Lynch 2012). This assessment included three surface water sites on the Carson, all of which were below levels of concern. In addition, every two years the New Mexico Environment Department is required by the Clean Water Act to submit an assessment of the surface waters in New Mexico to the U.S. EPA. Based on the current list of impaired water in New Mexico, there are no impaired waters as a result of pH on the Carson (NMED 2011b).

Comment [UFS4]: Update reference

Ozone

Ground-level ozone interferes with the ability of plants to produce and store food, which makes them more susceptible to disease, insects, other pollutants, drought, and higher temperatures. Some plants have been identified as particularly sensitive to the effects of ozone and are reliable indicators of toxic levels of the pollutant on plant growth.

Ozone damages the appearance of leaves on trees and other plants. The most common visible symptom of ozone injury on broad-leaved bioindicator species is uniform interveinal leaf stippling. As a gaseous pollutant, ozone enters the stomata of plant leaves through the normal process of gas exchange, damaging the tissue. Elevated levels of ozone have not been directly measured on the Carson, nor has an assessment of the forest's vegetation been conducted in terms of looking for impacts from ozone. The effects of ozone on tree growth on the Carson are not well understood.

Uncertainty

There are many factors that contribute to the reliability and confidence of an assessment. Typically a sufficient amount of direct measurements taken over time, provide the greatest level of confidence regarding the current state and trends of forest health as it applies to air quality impacts. In the absence of direct measurements, modeled data can be used to assess relative risk of systems to the impacts for air pollution; however this creates a greater degree of uncertainty in the assessment. To understand the level of confidence in the modeled results, it is important to understand the assumptions in the models as well as how they perform in a given environment. In this case, how do they perform assessing the potential impacts that air pollution has on various indicators, such as lichens, on the Carson.

While there are direct measurements that have been taken over time, for ambient air quality and visibility, there are limited studies performed on the Carson to directly measure the impacts from air pollution on forest health, such as limited lichen surveys and snow chemistry surveys. The modeled results that are available, indicate that lichens and to a lesser degree herbaceous plants and shrubs, forests, and nitrate leaching are at risk of being impacted by nitrogen deposition. There is a fair amount of uncertainty with these estimates, however. The critical loads were developed based on a few studies in Oregon, Washington, and the Sierra Nevada's in California (Pardo et al. 2011). In addition, atmospheric nitrogen deposition estimates and critical loads are influenced by several other factors, including the difficulty of quantifying dry deposition on complex mountainous terrain in arid climates with sparse data (Pardo et al. 2011), all of which are significant factors on the Carson. At this time, there is a fair amount of uncertainty with the critical load estimates to have a high level of confidence in the assessment.

Summary of Condition, Trend, and Risk

The ecosystem services provided by air are generally stable and not at risk. Air quality on the Carson is within regulatory levels for National Ambient Air Quality Standards (NAAQS), and the trend based on projected emission inventories appears to be stable or is improving for most pollutants (Table 5). This is also true regarding visibility conditions. The main challenge could be with regards to both coarse and fine particulate matter, which can affect both the ambient air quality and visibility on the forest. Land-use both on and off the forest, as well as climate change and drought can contribute to windblown and fugitive dust. Wildfires can also be a significant source of particulate matter. Additionally, the Jicarilla District may be at risk of ozone impacts as the trend in VOCs, an ozone precursor, are increasing from oil and gas development and there is a history of high ozone levels near the district. Further significant uncertainty exists as the ozone standards is expected to be lowered soon.

Table 5. Summary of conditions, trends, and reliability of assessment.

Air Quality Measure	Current Conditions	Trend	Reliability
NAAQS*			
CO	Good	Improving	High
NO_2	Good	Improving	High
SO_2	Good	Stable	High
Pb	Good	Stable	High
O_3	Good	Stable	High
$PM_{2.5}$	Good	Stable to Declining	High
PM_{10}	Good	Stable to Declining	High
Visibility†			
Visibility	Departed	Stable to Improving	High
Critical Loads- Deposition			
Nitrogen Eutrophication			
Lichens	Potentially at risk	Improving	Moderate
Herbaceous Plants & Shrubs	Potentially at risk	Improving	Low
Mycorrhizal Fungi	Good	Improving	Low
Forests	Potentially at risk risk	Improving	Low
Nitrate Leaching	Potentially at risk risk	Improving	Low
Acid Deposition			
Soils	Good	Improving	Low
Surface Water	Good	Improving	Low
Deposition (other)			
Mercury	Potentially at risk	Improving	Moderate
Ozone	Unknown	Unknown	N/A

*Relative to NAAQS
†Relative to 2064 Regional Haze Goal

There is some indication that current levels of nitrogen deposition have exceeded critical loads and are significant enough to have resulted in impacts to lichen diversity and community structure and to a lesser degree impacts to herbaceous plants and shrubs, forest and soil nitrate leaching. However, these results were based on modeled critical loads and have not been verified on the forest. The rate of deposition of nitrogen, which can lead to impacts affecting forest health, appear to be decreasing based on projected emissions at the state level.

Modeled results also indicate that the levels of acid gases are not at levels significant enough to result in impacts to either soils or surface water. There are no direct measurements on the forest that indicate otherwise.

There is some indication that mercury deposition at higher elevations on the forest may be significant, however, atmospheric mercury, based on regional emissions, is also expected to decrease.

Key Message

Air quality and the values dependent on air quality on the Carson are generally in good condition or are improving as most pollutants are decreasing; however, visibility and ambient air quality conditions associated with particulate matter are expected to increase—likely a result of larger, more severe wildfires and increases in fugitive dust as the effects of climate change are realized. Uncertainty also exists, as the ozone standard is lowered, which could result in the area which includes the Jicarilla to be included in a non-attainment area.