6.0 STATE AND CLASS I AREA SUMMARIES

As described in Section 2.0, each state is required to submit progress reports at interim points between submittals of Regional Haze Rule (RHR) State Implementation Plans (SIPs), which assess progress towards visibility improvement goals in each state's mandatory Federal Class I areas (CIAs). Data summaries for each CIA in each Western Regional Air Partnership (WRAP) state, which address Regional Haze Rule (RHR) requirements for visibility measurements and emissions inventories are provided in this section. These summaries are intended to provide individual states with the technical information they need to determine if current RHR implementation plan elements and strategies are sufficient to meet all established reasonable progress goals, as defined in their respective initial RHR implementation plans.

6.4 COLORADO

The goal of the RHR is to ensure that visibility on the 20% most impaired, or worst, days continues to improve at each Federal Class I area (CIA), and that visibility on the 20% least impaired, or best, days does not get worse, as measured at representative Interagency Monitoring of Protected Visual Environments (IMPROVE) monitoring sites. Colorado has 12 mandatory Federal CIAs, which are depicted in Figure 6.4-1 and listed in Table 6.4-1, along with the associated IMPROVE monitor locations.

This section addresses differences between the 2000-2004 baseline and 2005-2009 period, for both monitored data and emission inventory estimates. Monitored data are presented for the 20% most impaired, or worst, days and for the 20% least impaired, or best, days, as per Regional Haze Rule (RHR) requirements. Annual average trend statistics for the 2000-2009 10-year period are also presented here to support assessments of changes in each monitored species that contributes to visibility impairment. Some of the highlights regarding these comparisons are listed below, and more detailed state specific information is provided in monitoring and emissions sub-sections that follow.

- For both the best and worst days, the 5-year average deciview metric decreased at all Colorado Federal CIA IMPROVE sites.
- All sites measured either decreases or no change in 5-year average ammonium nitrate, particulate organic mass, elemental carbon and coarse mass.
- Increases in 5-year average ammonium sulfate were measured at the GRSA1, MOZI1, WEMI1, and WHRI1 sites, but annual average trends for ammonium sulfate were either insignificant or decreasing. Many regional sites, including sites in Arizona, Colorado, and New Mexico were affected by anomalously higher than average ammonium sulfate measurements in 2005. Increases were also not consistent with emissions inventory comparisons, where state-wide emissions totals and annual tracking of EGU emissions showed decreases in SO_2, due mostly to decreases in point, area and mobile sources.
- Increases in 5-year average soil were measured at the MOZI1, ROMO1, WEMI1, and WHRI1 sites, but no increasing annual trends were measured. Emissions inventory comparisons showed net increases in, with largest increases reported for windblown dust and point sources, although reported windblown dust increases are likely due to updated inventory methodology rather than actual increases.

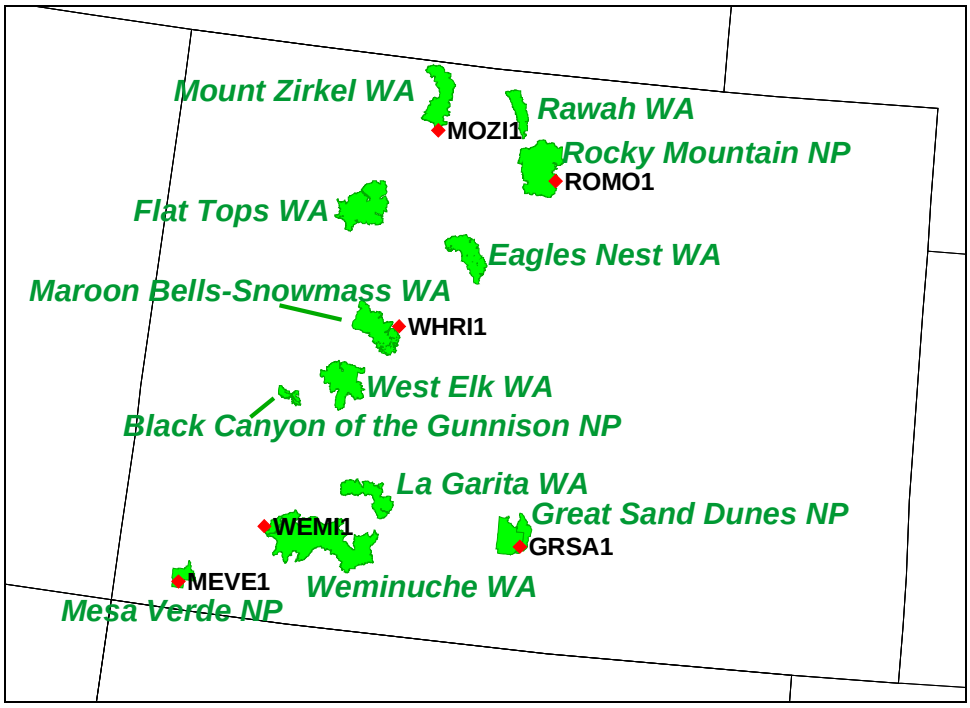

Figure 6.4-1. Map Depicting Federal CIAs and Representative IMPROVE Monitors in Colorado.

Table 6.4-1
Colorado CIAs and Representative IMPROVE Monitors

Class I Area	Representative IMPROVE Site	Latitude	Longitude	Elevation (m)
Great Sand Dunes NP	GRSA1	37.72	-105.52	2498
Mesa Verde NP	MEVE1	37.20	-108.49	2172
Mount Zirkel WA Rawah WA	MOZI1	40.54	-106.68	3243
Rocky Mountain NP	ROMO1	40.28	-105.55	2760
Weminuche WA La Garita WA Black Canyon of the Gunnison NP	WEMI1	37.66	-107.80	2750
Eagles Nest WA Flat Tops WA Maroon Bells-Snowmass WA West Elk WA	WHRI1	39.15	-106.82	3413

6.4.1 Monitoring Data

This section addresses RHR regulatory requirements for monitored data as measured by IMPROVE monitors representing Federal CIAs in Colorado. These summaries are supported by regional data presented in Section 4.0 and by more detailed site specific tables and charts in Appendix D.

As described in Section 3.1, regional haze progress in Federal CIAs is tracked using calculations based on speciated aerosol mass as collected by IMPROVE monitors. The RHR calls for tracking haze in units of deciviews (dv), where the deciview metric was designed to be linearly associated with human perception of visibility. In a pristine atmosphere, the deciview metric is near zero, and a one deciview change is approximately equivalent to a 10% change in cumulative species extinction. To better understand visibility conditions, summaries here include both the deciview metric, and the apportionment of haze into extinction due to the various measured species in units of inverse megameters (Mm^{-1}).

6.4.1.1 Current Conditions

This section addresses the regulatory question, ***what are the current visibility conditions for the most impaired and least impaired days (40 CFR 51.308 (g)(3)(i))?*** RHR guidance specifies that 5-year averages be calculated over successive 5-year periods, i.e. 2000-2004, 2005-2009, 2010-2014, etc.[1] Current visibility conditions are represented here as the most recent successive 5-year average period available, or the 2005-2009 period average, although the most recent IMPROVE monitoring data currently available includes 2010 data.

Tables 6.4-2 and 6.4-3 present the calculated deciview values for current conditions at each site, along with the percent contribution to extinction from each aerosol species for the 20% most impaired, or worst, and 20% least impaired, or best, days for each of the Federal CIA IMPROVE monitors in Colorado. Figure 6.4-2 presents 5-year average extinction for the current progress period for both the 20% most impaired and 20% least impaired days. Note that the percentages in the tables consider only the aerosol species which contribute to extinction, while the charts also show Rayleigh, or scattering due to background gases in the atmosphere.

Specific observations for the current visibility conditions on the 20% most impaired days are as follows:

- The largest contributors to aerosol extinction at Colorado sites were particulate organic mass, ammonium sulfate and coarse mass.
- The highest aerosol extinction (12.8 dv) was measured at the ROMO1 site, where particulate organic mass was the largest contributor to aerosol extinction, followed by ammonium sulfate and ammonium nitrate. The lowest aerosol extinction (8.9 dv) was measured at the WHRI1 site.

[1] EPA's September 2003 *Guidance for Tracking Progress Under the Regional Haze Rule* specifies that progress is tracked against the 2000-2004 baseline period using corresponding averages over successive 5-year periods, i.e. 2005-2009, 2010-2014, etc. (See page 4-2 in the Guidance document.)

Specific observations for the current visibility conditions on the 20% least impaired days are as follows:

- The aerosol contribution to total extinction on the best days was less than Rayleigh, or the background scattering that would occur in clear air. Average extinction (including Rayleigh) ranged from 0.2 dv (WHRI1) to 3.6 dv (GRSA1).
- For all sites, ammonium sulfate was the largest contributor to the non-Rayleigh aerosol portion of extinction

Table 6.4-2
Colorado Class I Area IMPROVE Sites
Current Visibility Conditions
2005-2009 Progress Period, 20% Most Impaired Days

Site	Deciviews (dv)	Percent Contribution to Aerosol Extinction by Species (Excludes Rayleigh) (% of Mm^{-1}) and Rank						
		Ammonium Sulfate	Ammonium Nitrate	Particulate Organic Mass	Elemental Carbon	Soil	Coarse Mass	Sea Salt
GRSA1	11.4	**29% (1)**	7% (6)	26% (2)	7% (5)	8% (4)	22% (3)	0% (7)
MEVE1	11.3	27% (2)	9% (4)	**28% (1)**	7% (6)	9% (5)	20% (3)	0% (7)
MOZI1	9.7	28% (2)	7% (5)	**36% (1)**	8% (4)	6% (6)	15% (3)	0% (7)
ROMO1	12.6	26% (2)	15% (3)	**32% (1)**	8% (5)	5% (6)	14% (4)	0% (7)
WEMI1	10.0	27% (2)	5% (6)	**36% (1)**	10% (4)	7% (5)	15% (3)	0% (7)
WHRI1	8.9	30% (2)	8% (5)	**33% (1)**	8% (4)	7% (6)	13% (3)	0% (7)

*Highest aerosol species contribution per site is highlighted in bold.

Table 6.4-3
Colorado Class I Area IMPROVE Sites
Current Visibility Conditions
2005-2009 Progress Period, 20% Least Impaired Days

Site	Deciviews (dv)	Percent Contribution to Aerosol Extinction by Species (Excludes Rayleigh) (% of Mm^{-1}) and Rank						
		Ammonium Sulfate	Ammonium Nitrate	Particulate Organic Mass	Elemental Carbon	Soil	Coarse Mass	Sea Salt
GRSA1	3.6	**36% (1)**	9% (5)	26% (2)	10% (4)	5% (6)	13% (3)	0% (7)
MEVE1	3.1	**44% (1)**	12% (3)	21% (2)	9% (5)	5% (6)	9% (4)	0% (7)
MOZI1	0.7	**44% (1)**	16% (3)	20% (2)	8% (5)	3% (6)	9% (4)	0% (7)
ROMO1	2.0	**37% (1)**	8% (4)	25% (2)	8% (5)	5% (6)	17% (3)	0% (7)
WEMI1	2.4	**36% (1)**	6% (5)	23% (2)	15% (4)	4% (6)	15% (3)	1% (7)
WHRI1	0.2	**46% (1)**	10% (5)	14% (3)	15% (2)	5% (6)	11% (4)	0% (7)

*Highest aerosol species contribution per site is highlighted in bold.

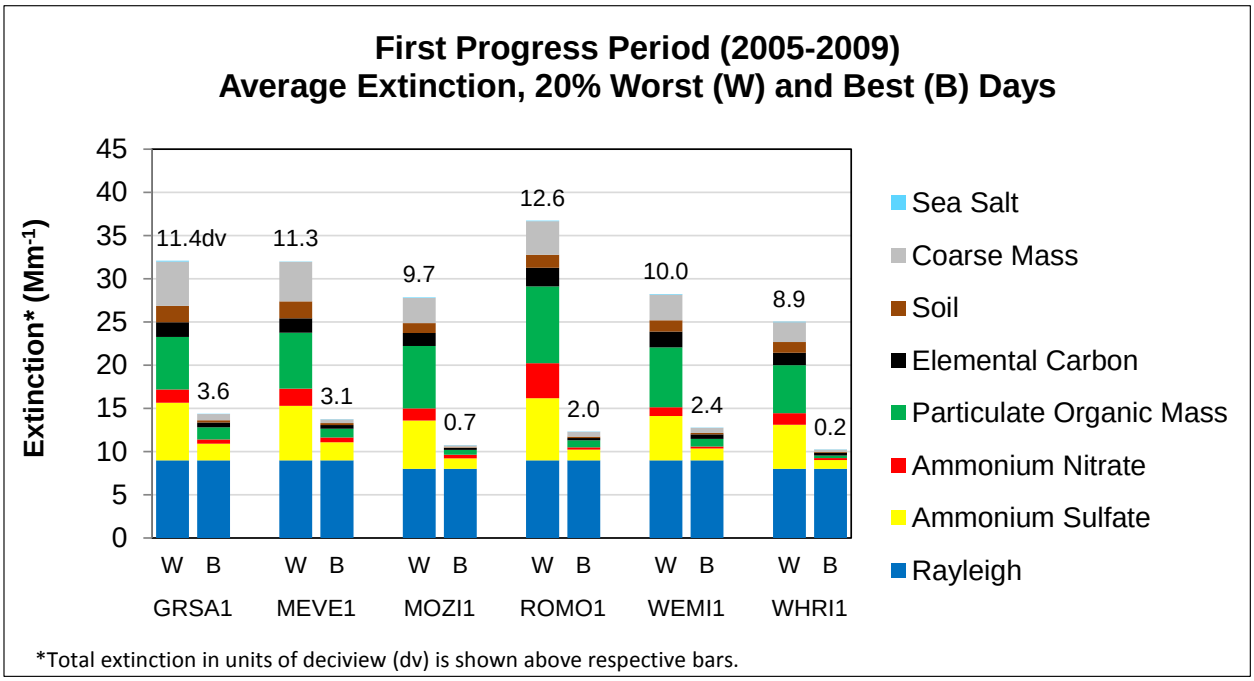

Figure 6.4-2. Average Extinction for Current Progress Period (2005-2009) for the Worst (Most Impaired) and Best (Least Impaired) Days Measured at Colorado Class I Area IMPROVE Sites.

6.4.1.2 Differences Between Current and Baseline Conditions

This section addresses the regulatory question, ***what is the difference between current visibility conditions for the most impaired and least impaired days and baseline visibility conditions (40 CFR 51.308 (g)(3)(ii))?*** Included here are comparisons between the 5-year average baseline conditions (2000-2004) and current progress period extinction (2005-2009).

Table 6.4-4 presents the differences between the 2000-2004 baseline period average extinction and the 2005-2009 progress period average for each site in Colorado for the 20% most impaired days, and Table 6.4-5 presents similar data for the least impaired days. Averages that increased are depicted in red text and averages that decreased in blue.

Figure 6.4-3 presents the 5-year average extinction for the baseline and current progress period averages for the worst days and Figure 6.4-4 presents the differences in averages by aerosol species, with increases represented above the zero line and decreases below the zero line. Figures 6.4-5 and 6.4-6 present similar plots for the best days.

For the 20% most impaired days, the 5-year average deciview metric decreased at all Colorado sites. Notable differences for individual species averages were as follows:

- Largest charges in concentration were seen in particulate organic mass. Decreases for both particulate organic mass and elemental carbon were observed at all sites, with the largest decreases at the MEVE1 site.

- All sites measured either slight decreases or no change in ammonium nitrate, elemental carbon and coarse mass.
- Increases in ammonium sulfate were measured at the GRSA1, MOZI1, WEMI1 and WHRI1 sites, and decreases were measured at the MEVE1 and ROMO1 sites.

For the 20% least impaired days, the 5-year average deciview metric decreased at all sites. Notable differences for individual species averages on the 20% least impaired days were as follows:

- All sites measured either slight decreases or no change in all species. The largest decreases were recorded in particulate organic mass.

Table 6.4-4
Colorado Class I Area IMPROVE Sites
Difference in Aerosol Extinction by Species
2000-2004 Baseline Period to 2005-2009 Progress Period
20% Most Impaired Days

Site	Deciview (dv)			Change in Extinction by Species (Mm^{-1})*						
	2000-04 Baseline Period	2005-09 Progress Period	Change in dv*	Amm. Sulfate	Amm. Nitrate	POM	EC	Soil	CM	Sea Salt
GRSA1	12.8	11.4	-1.4	+0.7	-0.4	-2.4	-0.1	-0.9	-2.1	0.0
MEVE1	13.0	11.3	-1.7	-0.2	-0.3	-5.8	-0.7	-0.5	-2.0	0.0
MOZI1	10.5	9.7	-0.8	+0.3	-0.7	-2.7	-0.3	+0.1	-0.2	0.0
ROMO1	13.8	12.6	-1.2	-0.7	-1.2	-1.6	-0.4	+0.1	-1.0	0.0
WEMI1	10.3	10.0	-0.3	+0.1	-0.2	-1.4	-0.2	+0.1	0.0	-0.1
WHRI1	9.6	8.9	-0.7	+0.3	0.0	-2.3	-0.3	+0.1	-0.5	0.0

*Change is calculated as progress period average minus baseline period average. Values in red indicate increases in extinction and values in blue indicate decreases.

Table 6.4-5
Colorado Class I Area IMPROVE Sites
Difference in Aerosol Extinction by Species
2000-2004 Baseline Period to 2005-2009 Progress Period
20% Least Impaired Days

Site	Deciview (dv)			Change in Extinction by Species (Mm^{-1})*						
	2000-04 Baseline Period	2005-09 Progress Period	Change in dv*	Amm. Sulfate	Amm. Nitrate	POM	EC	Soil	CM	Sea Salt
GRSA1	4.5	3.6	-0.9	-0.2	-0.2	-0.4	-0.1	-0.1	-0.4	0.0
MEVE1	4.3	3.1	-1.2	-0.3	-0.3	-0.5	-0.2	-0.2	-0.3	0.0
MOZI1	1.6	0.7	-0.9	-0.3	-0.1	-0.3	-0.1	0.0	-0.3	0.0
ROMO1	2.3	2.0	-0.3	-0.1	-0.1	-0.1	-0.1	0.0	-0.1	0.0
WEMI1	3.1	2.4	-0.7	-0.1	-0.1	-0.4	-0.2	0.0	-0.1	0.0
WHRI1	0.7	0.2	-0.5	0.0	-0.1	-0.3	-0.1	0.0	0.0	0.0

*Change is calculated as progress period average minus baseline period average. Values in red indicate increases in extinction and values in blue indicate decreases.

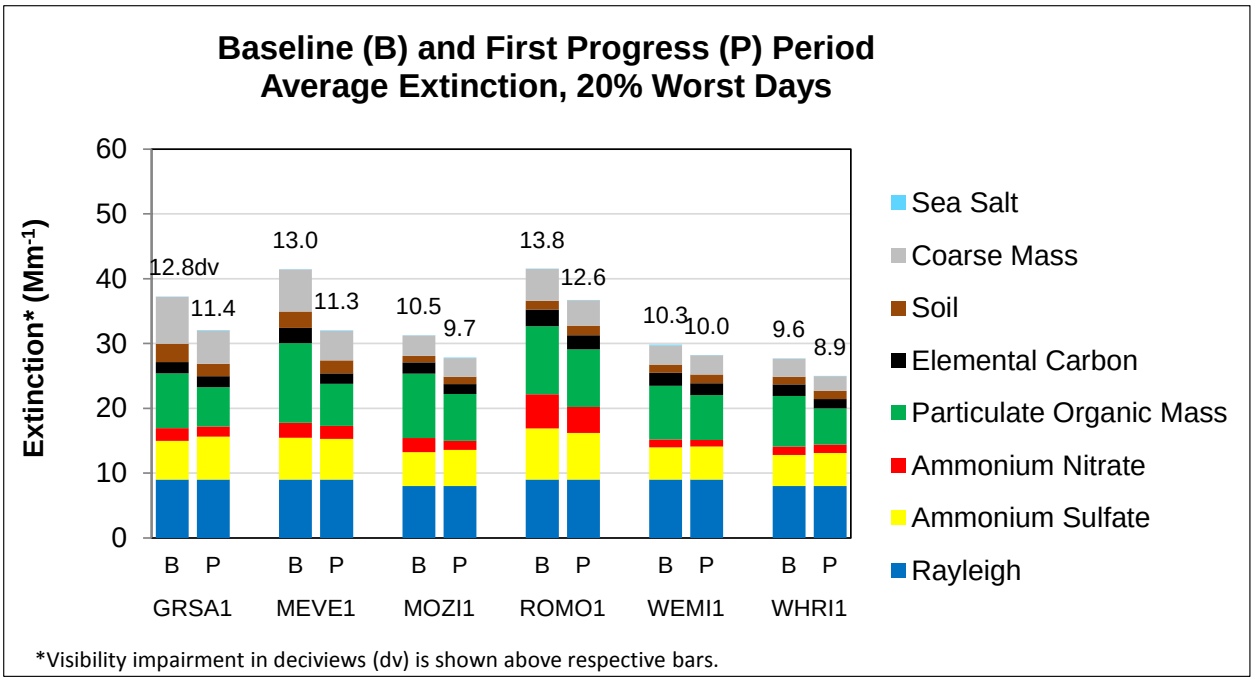

Figure 6.4-3. Average Extinction for Baseline and Progress Period Extinction for Worst (Most Impaired) Days Measured at Colorado Class I Area IMPROVE Sites.

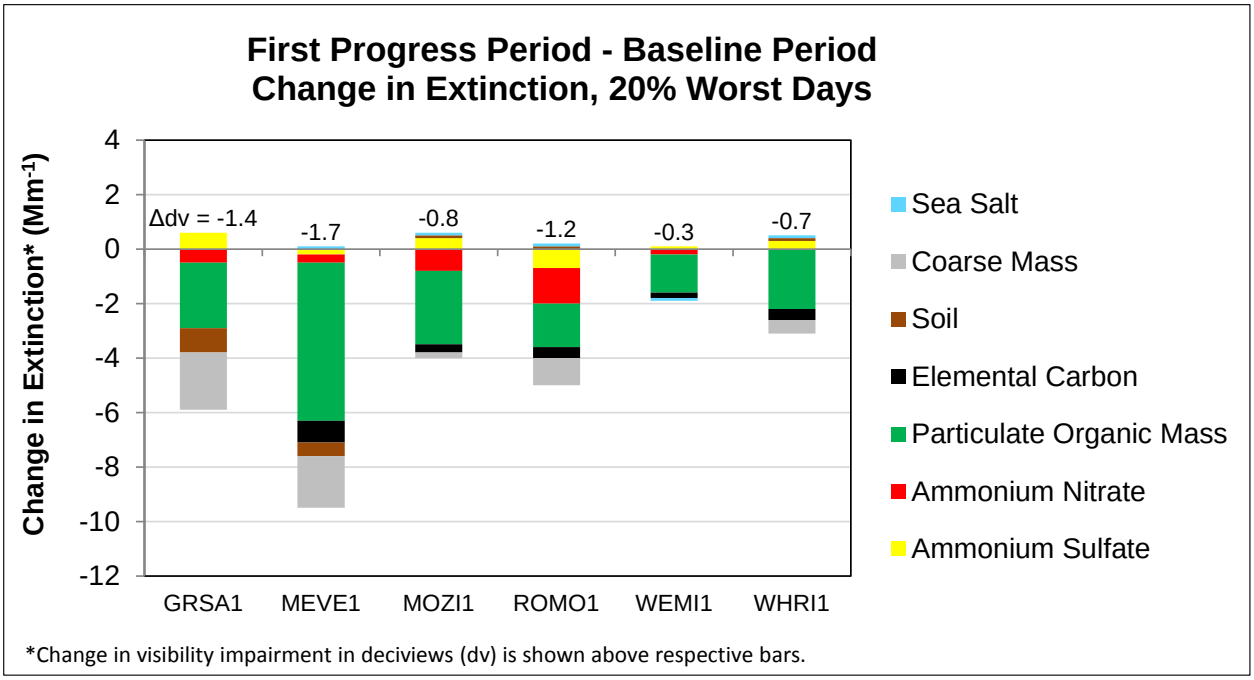

Figure 6.4-4. Difference between Average Extinction for Current Progress Period (2005-2009) and Baseline Period (2000-2004) for the Worst (Most Impaired) Days Measured at Colorado Class I Area IMPROVE Sites.

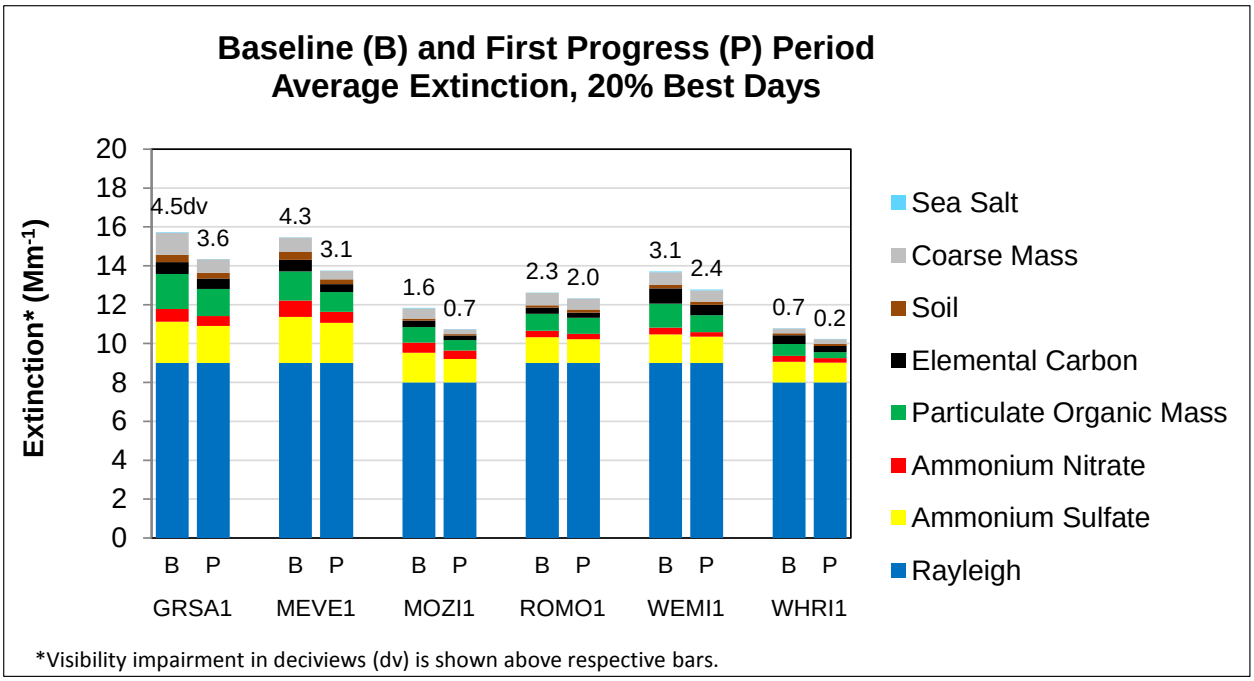

Figure 6.4-5. Average Extinction for Baseline and Progress Period Extinction for Best (Least Impaired) Days Measured at Colorado Class I Area IMPROVE Sites.

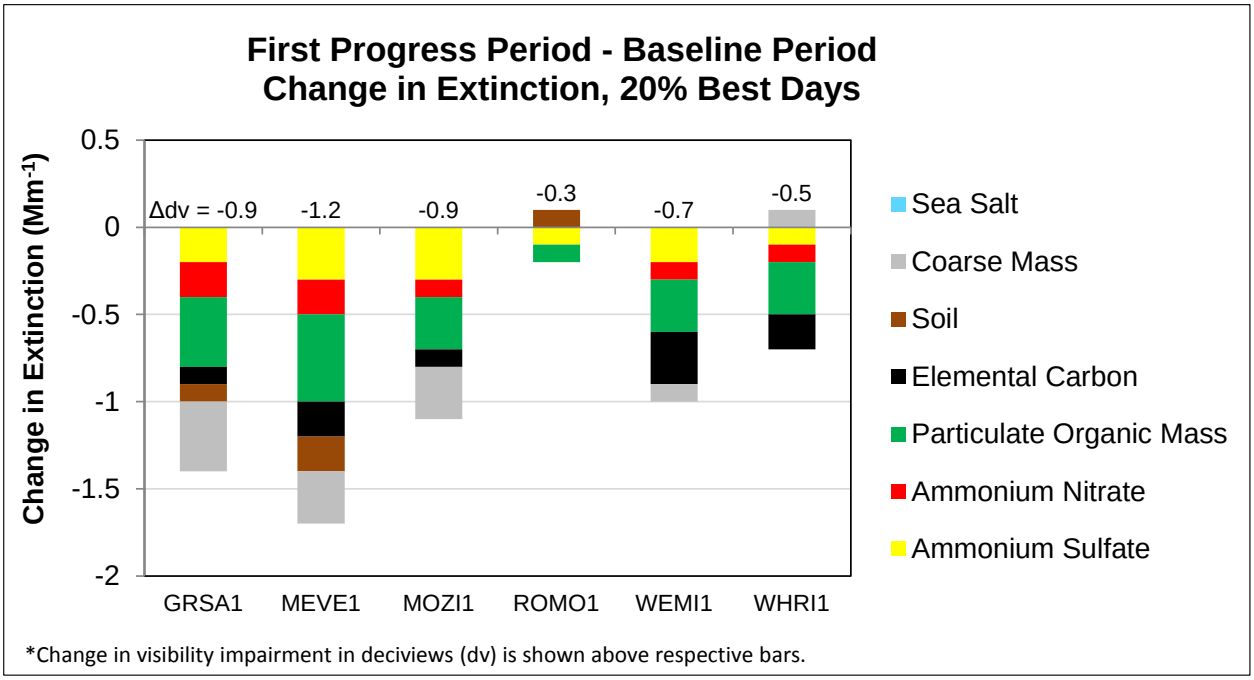

Figure 6.4-6. Difference between Average Extinction for Current Progress Period (2005-2009) and Baseline Period (2000-2004) for the Best (Least Impaired) Days Measured at Colorado Class I Area IMPROVE Sites.

6.4.1.3 Changes in Visibility Impairment

This section addresses the regulatory question, ***what is the change in visibility impairment for the most impaired and least impaired days over the past 5 years (40 CFR 51.308 (g)(3)(iii))?*** Included here are changes in visibility impairment as characterized by annual average trend statistics, and some general observations regarding local and regional events and outliers on a daily and annual basis that affected the current 5-year progress period. The regulatory requirement asks for a description of changes over the past 5-year period, but trend analysis is better suited to longer periods of time, so trends for the entire 10-year planning period are presented here.

Trend statistics for the years 2000-2009 for each species at each site in Colorado are summarized in Table 6.4-6, and regional trends were presented earlier in Section 4.1.1.[2] Only trends for aerosol species trends with p-value statistics less than 0.15 (85% confidence level) are presented in the table here, with increasing slopes in red and decreasing slopes in blue.[3] In some cases, trends may show decreasing tendencies while the difference between the 5-year averages do not (or vice versa), as discussed in Section 3.1.2.2. In these cases, the 5-year average for the best and worst days is the important metric for RHR regulatory purposes, but trend statistics may be of value to understand and address visibility impairment issues for planning purposes.

For each site, a more comprehensive list of all trends for all species, including the associated p-values, is provided in Appendix D. Additionally, this appendix includes plots depicting 5-year, annual, monthly, and daily average extinction for each site. These plots are intended to provide a fairly comprehensive compilation of reference information for individual states to investigate local and regional events and outliers that may have influenced changes in visibility impairment as tracked using the 5-year deciview metrics. Note that similar summary products are also available from the WRAP TSS website (http://vista.cira.colostate.edu/tss/). Some general observations regarding changes in visibility impairment at sites in Colorado are as follows:

- Particulate organic mass was the largest contributor to aerosol extinction for the worst days at all sites except GRSA1, and the second largest contributor at GRSA1. The largest measurements generally occurred between June and August, consistent with wildfire activity. The 5-year average of particulate organic mass decreased at all sites. Also, elemental carbon, a relatively minor contributor to haze which is often related to wildfire activity, decreased at all sites.

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[2] Annual trends were calculated for the years 2000-2009, with a trend defined as the slope derived using Theil statistics. Trends derived from Theil statistics are useful in analyzing changes in air quality data because these statistics can show the overall tendency of measurements over long periods of time, while minimizing the effects of year-to-year fluctuations which are common in air quality data. Theil statistics are also used in EPA's National Air EPA's National Air Quality Trends Reports (http://www.epa.gov/airtrends/) and the IMPROVE program trend reports (http://vista.cira.colostate.edu/improve/Publications/improve_reports.htm)

[3] The significance of the trend is represented with p-values calculated using Mann-Kendall trend statistics. Determining a significance level helps to distinguish random variability in data from a real tendency to increase or decrease over time, where lower p-values indicate higher confidence levels in the computed slopes.

- Ammonium sulfate was the largest contributor to aerosol extinction at GRSA1, and the second largest contributor to aerosol extinction at all other sites in Colorado. The 5-year averages showed very little change for the worst days, and improvement at all sites for the best days. Annual average trends showed extinction due to ammonium sulfate decreasing on an annual basis at the GRSA1, MEVE1 and ROMO1 sites.
- The largest concentrations of ammonium nitrate were measured at the ROMO1 site. The 5-year average metrics showed ammonium nitrate decreasing or staying the same at all sites for the worst days, and decreasing at all sites for the best days. Annual average trends show extinction due to ammonium nitrate decreasing at the ROMO1 site at a rate of approximately 0.1 Mm^{-1} per year for all measured days.

Table 6.4-6
Colorado Class I Area IMPROVE Sites
Change in Aerosol Extinction by Species
2000-2009 Annual Average Trends

Site	Group	Annual Trend* (Mm^{-1}/year)						
		Ammonium Sulfate	**Ammonium Nitrate**	**Particulate Organic Mass**	**Elemental Carbon**	**Soil**	**Coarse Mass**	**Sea Salt**
GRSA1	20% Best	0.0	--	0.0	0.0	0.0	**-0.1**	--
	20% Worst	--	--	**-0.6**	**-0.1**	**-0.1**	**-0.4**	0.0
	All Days	**-0.1**	--	**-0.1**	--	0.0	**-0.2**	--
MEVE1	20% Best	**-0.1**	0.0	**-0.1**	0.0	0.0	0.0	--
	20% Worst	--	--	--	**-0.2**	--	--	0.0
	All Days	**-0.1**	--	**-0.3**	**-0.1**	--	--	0.0
MOZI1	20% Best	0.0	--	0.0	0.0	--	0.0	0.0
	20% Worst	--	**-0.2**	--	--	--	--	0.0
	All Days	--	0.0	--	0.0	--	--	0.0
ROMO1	20% Best	0.0	0.0	--	0.0	0.0	--	--
	20% Worst	**-0.2**	--	--	**-0.1**	--	--	0.0
	All Days	**-0.1**	**-0.1**	--	0.0	0.0	**-0.1**	--
WEMI1	20% Best	**-0.1**	0.0	**-0.1**	**-0.1**	--	--	--
	20% Worst	--	--	--	0.0	--	--	--
	All Days	--	0.0	--	**-0.1**	--	--	--
WHRI1	20% Best	--	0.0	**-0.1**	0.0	--	--	--
	20% Worst	--	--	--	**-0.1**	--	--	0.0
	All Days	--	--	**-0.1**	0.0	--	--	0.0

*(--) Indicates statistically insignificant trend (<85% confidence level). Annual averages and complete trend statistics for all significance levels are included for each site in Appendix D.

6.4.2 Emissions Data

Included here are summaries depicting differences between two emission inventory years that are used to represent the 5-year baseline and current progress periods. The baseline period is represented using a 2002 inventory developed by the WRAP for use in the initial WRAP state SIPs, and the progress period is represented by a 2008 inventory which leverages recent WRAP inventory work for modeling efforts, as referenced in Section 3.2.1. For reference, Table 6.4-7 lists the major emitted pollutants inventoried, the related aerosol species, some of the major sources for each pollutant, and some notes regarding implications of these pollutants. Differences between these baseline and progress period inventories, and a separate summary of annual emissions from electrical generating units (EGUs), are presented in this section.

Table 6.4-7
Colorado
Pollutants, Aerosol Species, and Major Sources

Emitted Pollutant	Related Aerosol	Major Sources	Notes
Sulfur Dioxide (SO_2)	Ammonium Sulfate	Point Sources; On- and Off-Road Mobile Sources	SO_2 emissions are generally associated with anthropogenic sources such as coal-burning power plants, other industrial sources such and refineries and cement plants, and both on- and off-road diesel engines.
Oxides of Nitrogen (NO_X)	Ammonium Nitrate	On- and Off-Road Mobile Sources; Point Sources; Area Sources	NO_X emissions are generally associated with anthropogenic sources. Common sources include virtually all combustion activities, especially those involving cars, trucks, power plants, and other industrial processes.
Ammonia (NH_3)	Ammonium Sulfate and Ammonium Nitrate	Area Sources; On-Road Mobile Sources	Gaseous NH_3 has implications in particle formation because it can form particulate ammonium. Ammonium is not directly measured by the IMPROVE program, but affects formation potential of ammonium sulfate and ammonium nitrate. All measured nitrate and sulfate is assumed to be associated with ammonium for IMPROVE reporting purposes.
Volatile Organic Compounds (VOCs)	Particulate Organic Mass (POM)	Biogenic Emissions; Vehicle Emissions; Area Sources	VOCs are gaseous emissions of carbon compounds, which are often converted to POM through chemical reactions in the atmosphere. Estimates for biogenic emissions of VOCs have undergone significant updates since 2002, so changes reported here are more reflective of methodology changes than actual changes in emissions (see Section 3.2.1).
Primary Organic Aerosol (POA)	POM	Wildfires; Area Sources	POA represents organic aerosols that are emitted directly as particles, as opposed to gases. Wildfires in the west generally dominate POA emissions, and large wildfire events are generally sporadic and highly variable from year-to-year.
Elemental Carbon (EC)	EC	Wildfires; On- and Off-Road Mobile Sources	Large EC events are often associated with large POM events during wildfires. Other sources include both on- and off-road diesel engines.
Fine soil	Soil	Windblown Dust; Fugitive Dust; Road Dust; Area Sources	Fine soil is reported here as the crustal or soil components of $PM_{2.5}$.
Coarse Mass (PMC)	Coarse Mass	Windblown Dust; Fugitive Dust	Coarse mass is reported by the IMPROVE Network as the difference between PM_{10} and $PM_{2.5}$ mass measurements. Coarse mass is not separated by species in the same way that $PM_{2.5}$ is speciated, but these measurements are generally associated with crustal components. Similar to crustal $PM_{2.5}$, natural windblown dust is often the largest contributor to PMC.

6.4.2.1 Changes in Emissions

This section addresses the regulatory question, ***what is the change over the past 5 years in emissions of pollutants contributing to visibility impairment from all sources and activities within the State (40 CFR 51.308 (g)(4))?*** For these summaries, emissions during the baseline years are represented using a 2002 inventory, which was developed with support from the WRAP for use in the original RHR SIP strategy development (termed plan02d). Differences between inventories are represented as the difference between the 2002 inventory, and a 2008 inventory which leverages recent inventory development work performed by the WRAP for the WestJumpAQMS and DEASCO$_3$ modeling projects (termed WestJump2008). Note that the comparisons of differences between inventories does not necessarily reflect a change in emissions, as a number of methodology changes and enhancements have occurred between development of the individual inventories, as referenced in Section 3.2.1. Inventories for all major visibility impairing pollutants are presented for major source categories, and categorized as either anthropogenic or natural emissions. State-wide inventories totals and differences are presented here, and inventory totals on a county level basis are available on the WRAP Technical Support System website (http://vista.cira.colostate.edu/tss/).

Table 6.4-8 and Figure 6.4-7 present the differences between the 2002 and 2008 sulfur dioxide (SO_2) inventories by source category. Tables 6.4-9 and Figure 6.4-8 present data for oxides of nitrogen (NO_X), and subsequent tables and figures (Tables 6.4-10 through 6.4-15 and Figures 6.4-9 through 6.4-14) present data for ammonia (NH_3), volatile organic compounds (VOCs), primary organic aerosol (POA), elemental carbon (EC), fine soil and coarse mass. General observations regarding emissions inventory comparisons are listed below.

- Largest differences for point source inventories were decreases in SO_2, NO_X and coarse mass Note that this is consistent with the decline in annual SO_2 and NO_X EGU emissions, as shown in Section 6.4.2.2.
- Area source inventories showed decreases in SO_2 and VOCs, but increases in NO_X NH_3, and POA. These changes may be due to a combination of population changes and differences in methodologies used to estimate these emissions, as referenced in Section 3.2.1. One methodology change was the reclassification of some off-road mobile sources (such as some types of marine vessels and locomotives) into the area source category in 2008, which may have contributed to increases in area source inventory totals, but decreases in off-road mobile totals.
- On-road mobile source inventory comparisons showed decreases in most parameters, especially SO_2, NO_X and VOCs, with slight increases in POA, EC and coarse mass. Reductions in NO_X and VOC are likely influenced by federal and state emissions standards that have already been implemented. The increases in POA, EC and coarse mass occurred in all of the WRAP states for on-road mobile inventories, regardless of reductions in NO_2 and VOCs, indicating that these increases were likely due to use of different on-road models, as referenced in Section 3.2.1.
- Off-road mobile source inventories showed decreases in NO_X, SO_2, and VOCs, and increases in fine soil and coarse mass, which was consistent with most contiguous WRAP states. These differences were likely due to a combination of actual changes

in source contributions and methodology differences, as referenced in Section 3.2.1. As noted previously, one major methodology difference was the reclassification of some off-road mobile sources (such as some types of marine vessels and locomotives) into the area source category in 2008, which may have contributed to decreases in the off-road inventory totals, but increases in area source totals.

- Inventory comparison results for area oil and gas showed increases for most parameters, but note that inventory methodologies for these sources may have evolved substantially between the baseline and 2008 inventories as referenced in Section 3.2.1.
- For most parameters, especially POAs, VOCs, and EC, natural fire emission inventory estimates decreased. Note that these differences are not necessarily reflective of changes in monitored data, as the baseline period is represented by an average of 2000-2004 fire emissions, and the progress period is represented only by the fires that occurred in 2008, as referenced in Section 3.2.1.
- Comparisons between VOC inventories showed large decreases in biogenic emissions, which was consistent with other contiguous WRAP states. Estimates for biogenic emissions of VOCs have undergone significant updates since 2002, so changes reported here are more reflective of methodology changes than actual changes in emissions, as referenced in Section 3.2.1.
- Fine soil and coarse mass decreased in the windblown dust inventory comparisons and increased in the combined fugitive/road dust inventories. Large variability in changes in windblown dust was observed for the contiguous WRAP states, which was likely due in large part to enhancements in dust inventory methodology, as referenced in Section 3.2.1, rather than changes in actual emissions.

Table 6.4-8
Colorado
Sulfur Dioxide Emissions by Category

Source Category	Sulfur Dioxide Emissions (tons/year)		
	2002 (Plan02d)	2008 (WestJump2008)	Difference (Percent Change)
Anthropogenic Sources			
Point	97,978	64,516	-33,463
Area	6,299	493	-5,807
On-Road Mobile	4,147	959	-3,188
Off-Road Mobile	2,469	609	-1,860
Area Oil and Gas	118	555	437
Fugitive and Road Dust	0	0	0
Anthropogenic Fire	92	32	-60
Total Anthropogenic	**111,103**	**67,163**	**-43,940 (-40%)**
Natural Sources			
Natural Fire	2,542	132	-2,410
Biogenic	0	0	0
Wind Blown Dust	0	0	0
Total Natural	**2,542**	**132**	**-2,410 (-95%)**
All Sources			
Total Emissions	**113,645**	**67,295**	**-46,350 (-41%)**

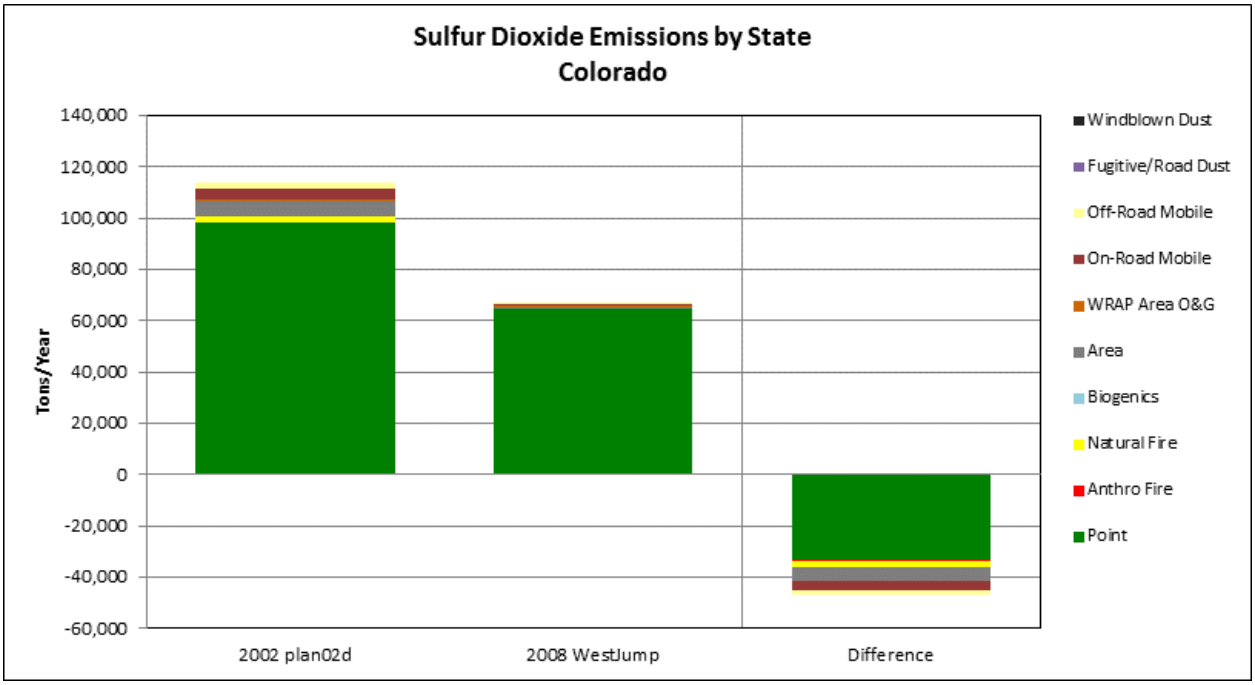

Figure 6.4-7. 2002 and 2008 Emission and Difference between Emissions Inventory Totals, for Sulfur Dioxide by Source Category for Colorado.

Table 6.4-9
Colorado
Oxides of Nitrogen Emissions by Category

Source Category	Oxides of Nitrogen Emissions (tons/year)		
	2002 (Plan02d)	2008 (WestJump2008)	Difference (Percent Change)
Anthropogenic Sources			
Point	118,666	108,088	-10,578
Area	11,700	22,852	11,152
On-Road Mobile	141,883	129,591	-12,292
Off-Road Mobile	62,448	31,360	-31,088
Area Oil and Gas	23,518	27,048	3,530
Fugitive and Road Dust	0	0	0
Anthropogenic Fire	517	234	-282
Total Anthropogenic	**358,732**	**319,173**	**-39,558 (-11%)**
Natural Sources			
Natural Fire	9,297	932	-8,366
Biogenic	37,349	9,542	-27,807
Wind Blown Dust			
Total Natural	**46,646**	**10,473**	**-36,173 (-78%)**
All Sources			
Total Emissions	**405,378**	**329,647**	**-75,731 (-19%)**

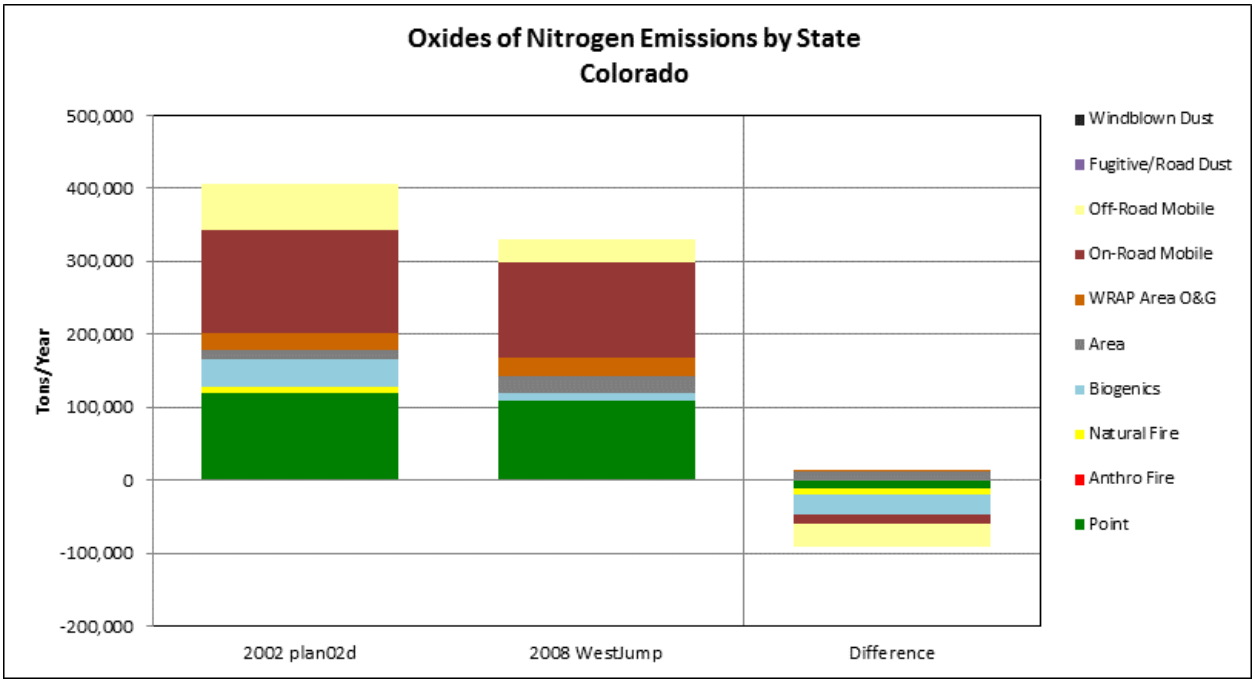

Figure 6.4-8. 2002 and 2008 Emission and Difference between Emissions Inventory Totals, for Oxides of Nitrogen by Source Category for Colorado.

Table 6.4-10
Colorado
Ammonia Emissions by Category

Source Category	Ammonia Emissions (tons/year)		
	2002 (Plan02d)	2008 (WestJump2008)	Difference (Percent Change)
Anthropogenic Sources			
Point	453	469	15
Area	60,771	70,451	9,680
On-Road Mobile	4,317	2,201	-2,116
Off-Road Mobile	43	35	-8
Area Oil and Gas	0	0	0
Fugitive and Road Dust	0	0	0
Anthropogenic Fire	137	153	16
Total Anthropogenic	**65,721**	**73,310**	**7,588 (12%)**
Natural Sources			
Natural Fire	1,965	648	-1,317
Biogenic	0	0	0
Wind Blown Dust	0	0	0
Total Natural	**1,965**	**648**	**-1,317 (-67%)**
All Sources			
Total Emissions	**67,686**	**73,958**	**6,272 (9%)**

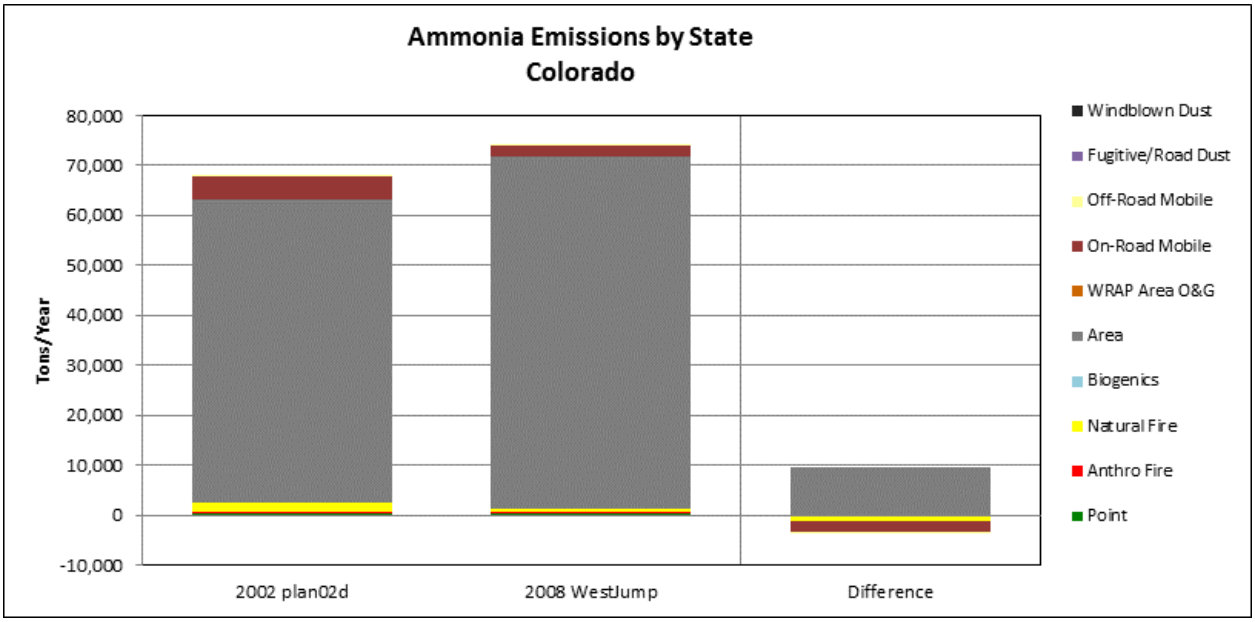

Figure 6.4-9. 2002 and 2008 Emission and Difference between Emissions Inventory Totals, for Ammonia by Source Category for Colorado.

Table 6.4-11
Colorado
Volatile Organic Compound Emissions by Category

Source Category	Volatile Organic Compound Emissions (tons/year)		
	2002 (Plan02d)	2008 (WestJump2008)	Difference (Percent Change)
Anthropogenic Sources			
Point	91,750	109,435	17,685
Area	99,191	67,133	-32,058
On-Road Mobile	100,860	55,953	-44,907
Off-Road Mobile	38,401	34,301	-4,100
Area Oil and Gas	27,259	68,895	41,636
Fugitive and Road Dust	0	0	0
Anthropogenic Fire	915	373	-542
Total Anthropogenic	**358,376**	**336,090**	**-22,286 (-6%)**
Natural Sources			
Natural Fire	20,404	900	-19,504
Biogenic	804,777	275,328	-529,449
Wind Blown Dust	0	0	0
Total Natural	**825,181**	**276,227**	**-548,953 (-67%)**
All Sources			
Total Emissions	**1,183,557**	**612,317**	**-571,240 (-48%)**

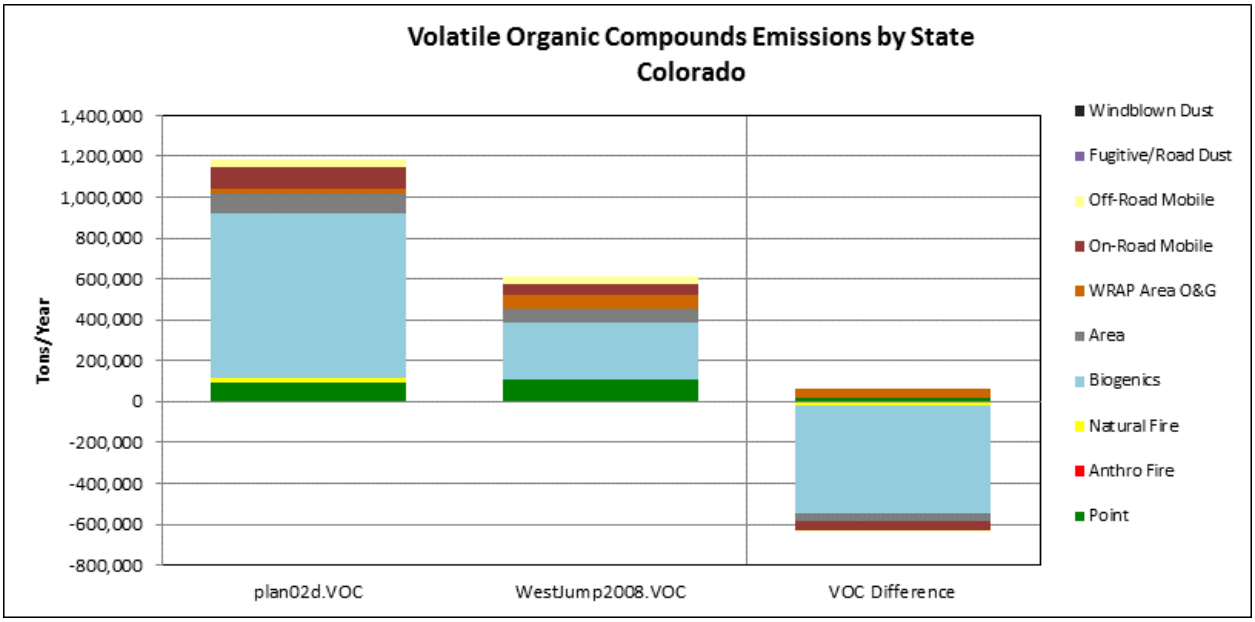

Figure 6.4-10. 2002 and 2008 Emission and Difference between Emissions Inventory Totals, for Volatile Organic Compounds by Source Category for Colorado.

Table 6.4-12
Colorado
Primary Organic Aerosol Emissions by Category

Source Category	Primary Organic Aerosol Emissions (tons/year)		
	2002 (Plan02d)	2008 (WestJump2008)	Difference (Percent Change)
Anthropogenic Sources			
Point*	17	323	306
Area	8,432	9,629	1,197
On-Road Mobile	1,280	3,279	1,999
Off-Road Mobile	1,286	1,236	-50
Area Oil and Gas	0	88	88
Fugitive and Road Dust	878	1,248	369
Anthropogenic Fire	850	458	-392
Total Anthropogenic	**12,744**	**16,262**	**3,518 (28%)**
Natural Sources			
Natural Fire	30,581	1,758	-28,822
Biogenic	0	0	0
Wind Blown Dust	0	0	0
Total Natural	**30,581**	**1,758**	**-28,822 (-94%)**
All Sources			
Total Emissions	**43,325**	**18,021**	**-25,304 (-58%)**

*Point source data includes only oil and gas and regulated CEM sources. More comprehensive point source data were not available at the time this report was prepared but will be made available through the WRAP TSS (http://vista.cira.colostate.edu/tss/).

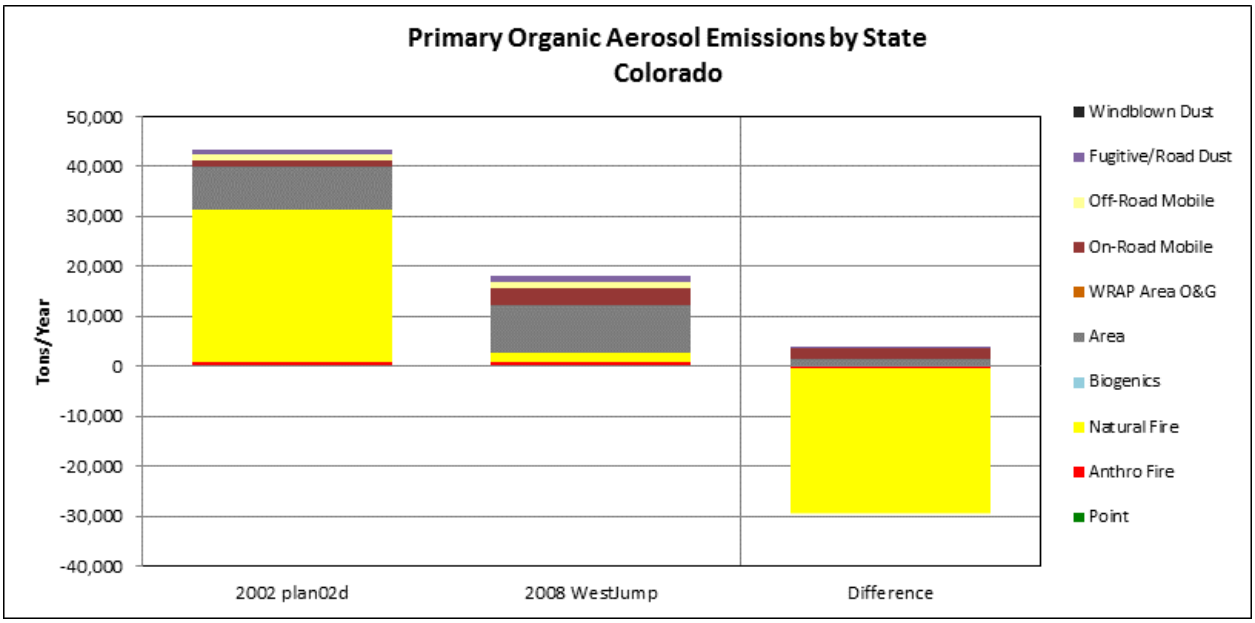

Figure 6.4-11. 2002 and 2008 Emission and Difference between Emissions Inventory Totals, for Primary Organic Aerosol by Source Category for Colorado.

Table 6.4-13
Colorado
Elemental Carbon Emissions by Category

Source Category	Elemental Carbon Emissions (tons/year)		
	2002 (Plan02d)	2008 (WestJump2008)	Difference (Percent Change)
Anthropogenic Sources			
Point*	0	64	64
Area	1,264	1,152	-112
On-Road Mobile	1,448	5,257	3,809
Off-Road Mobile	3,175	1,731	-1,444
Area Oil and Gas	0	0	0
Fugitive and Road Dust	61	28	-34
Anthropogenic Fire	92	83	-9
Total Anthropogenic	**6,041**	**8,315**	**2,275 (38%)**
Natural Sources			
Natural Fire	6,337	329	-6,008
Biogenic	0	0	0
Wind Blown Dust	0	0	0
Total Natural	**6,337**	**329**	**-6,008 (-95%)**
All Sources			
Total Emissions	**12,377**	**8,644**	**-3,734 (-30%)**

*Point source data includes only oil and gas and regulated CEM sources. More comprehensive point source data were not available at the time this report was prepared but will be made available through the WRAP TSS (http://vista.cira.colostate.edu/tss/).

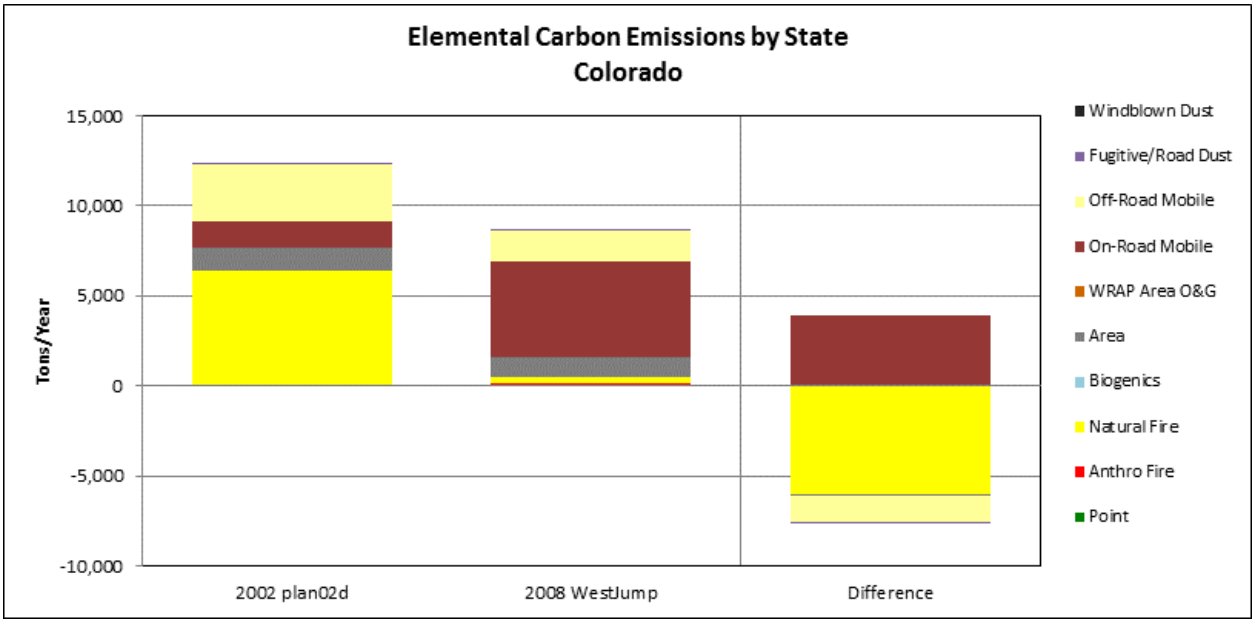

Figure 6.4-12. 2002 and 2008 Emission and Difference between Emissions Inventory Totals, for Elemental Carbon by Source Category for Colorado.

Table 6.4-14
Colorado
Fine Soil Emissions by Category

Source Category	Fine Soil Emissions (tons/year)		
	2002 (Plan02d)	2008 (WestJump2008)	Difference (Percent Change)
Anthropogenic Sources			
Point*	6	424	419
Area	4,170	4,064	-106
On-Road Mobile	812	536	-276
Off-Road Mobile	0	86	86
Area Oil and Gas	0	1,517	1,517
Fugitive and Road Dust	14,483	22,998	8,515
Anthropogenic Fire	253	173	-80
Total Anthropogenic	**19,723**	**29,799**	**10,076 (51%)**
Natural Sources			
Natural Fire	1,948	676	-1,272
Biogenic	0	0	0
Wind Blown Dust	15,105	13,138	-1,967
Total Natural	**17,053**	**13,814**	**-3,239 (-19%)**
All Sources			
Total Emissions	**36,776**	**43,613**	**6,837 (19%)**

*Point source data includes only oil and gas and regulated CEM sources. More comprehensive point source data were not available at the time this report was prepared but will be made available through the WRAP TSS (http://vista.cira.colostate.edu/tss/).

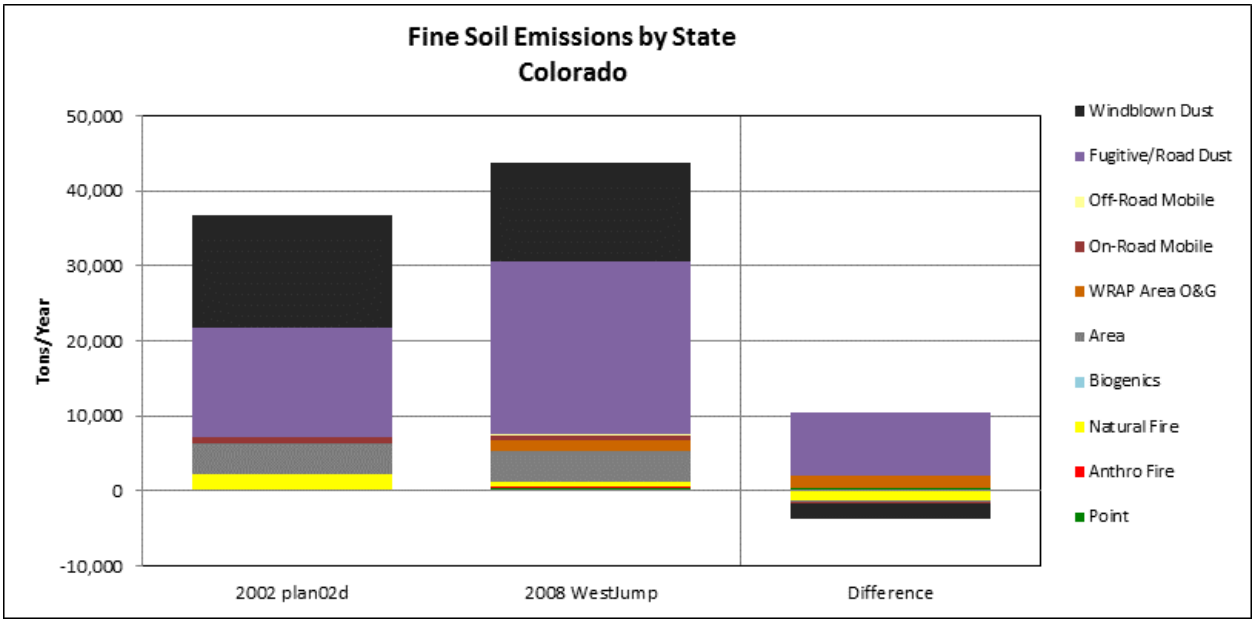

Figure 6.4-13. 2002 and 2008 Emission and Difference between Emissions Inventory Totals, for Fine Soil by Source Category for Colorado.

Table 6.4-15
Colorado
Coarse Mass Emissions by Category

Source Category	Coarse Mass Emissions (tons/year)		
	2002 (Plan02d)	2008 (WestJump2008)	Difference (Percent Change)
Anthropogenic Sources			
Point*	21,096	10,530	-10,566
Area	1,363	61	-1,302
On-Road Mobile	794	5,762	4,968
Off-Road Mobile	0	146	146
Area Oil and Gas	0	60	60
Fugitive and Road Dust	76,572	122,035	45,464
Anthropogenic Fire	51	88	37
Total Anthropogenic	**99,876**	**138,683**	**38,807 (39%)**
Natural Sources			
Natural Fire	5,973	337	-5,636
Biogenic	0	0	0
Wind Blown Dust	135,945	118,244	-17,701
Total Natural	**141,918**	**118,581**	**-23,337 (-16%)**
All Sources			
Total Emissions	**241,794**	**257,264**	**15,470 (6%)**

*Point source data includes only oil and gas and regulated CEM sources. More comprehensive point source data were not available at the time this report was prepared but will be made available through the WRAP TSS (http://vista.cira.colostate.edu/tss/).

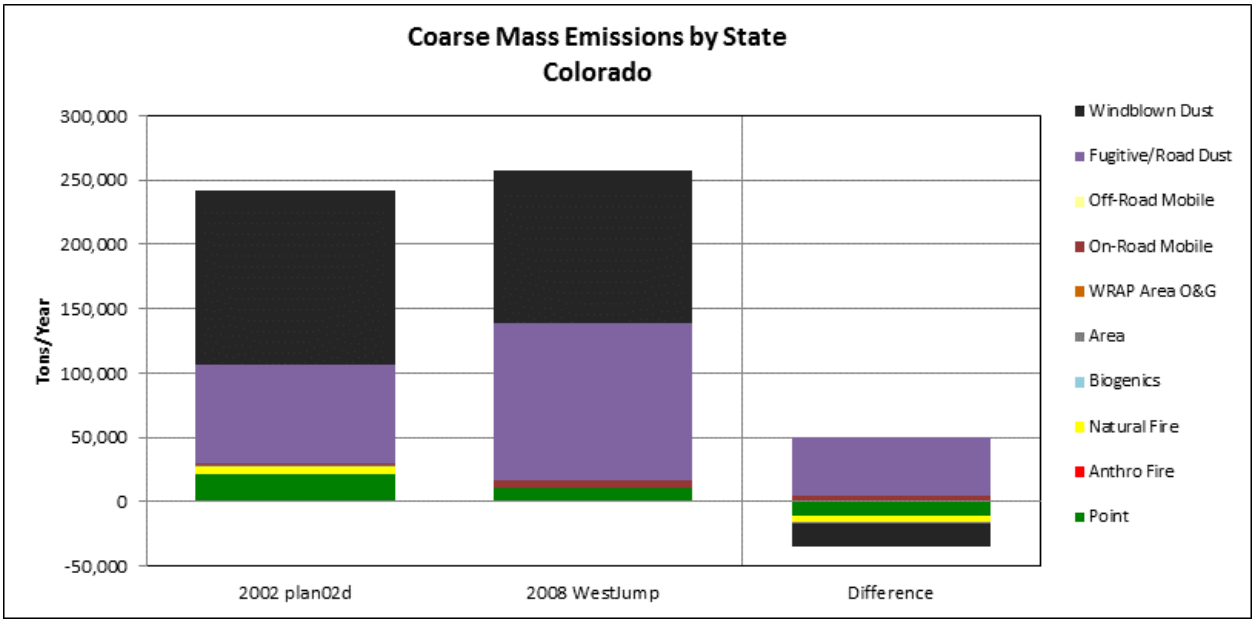

Figure 6.4-14. 2002 and 2008 Emission and Difference between Emissions Inventory Totals, for Coarse Mass by Source Category for Colorado.

6.4.2.2 EGU Summary

As described in previous sections, differences between the baseline and progress period inventories presented here do not necessarily represent changes in actual emissions because numerous updates in inventory methodologies have occurred between the development of the separate inventories. Also, the 2002 baseline and 2008 progress period inventories represent only annual snapshots of emissions estimates, which may not be representative of entire 5-year monitoring periods compared. To better account for year-to-year changes in emissions, annual emission totals for Colorado electrical generating units (EGU) are presented here. EGU emissions are some of the more consistently reported emissions, as tracked in EPA's Air Markets Program Database for permitted Title V facilities in the state (http://ampd.epa.gov/ampd/). RHR implementation plans are required to pay specific attention to certain major stationary sources, including EGUs, built between 1962 and 1977.

Figure 6.4-17 presents a sum of annual NO_X and SO_2 emissions as reported for Colorado EGU sources between 1996 and 2010. While these types of facilities are targeted for controls in state regional haze SIPs, it should be noted that many of the controls planned for EGUs in the WRAP states had not taken place yet in 2010, while other controls separate from the RHR may have been implemented. The chart shows periods of sharpest decline for SO_2 between 2002 and 2004, and again between 2007 and 2009. NO_X emissions showed notable decreases between 1996 and 1998, 2004, 2008 and 2009.

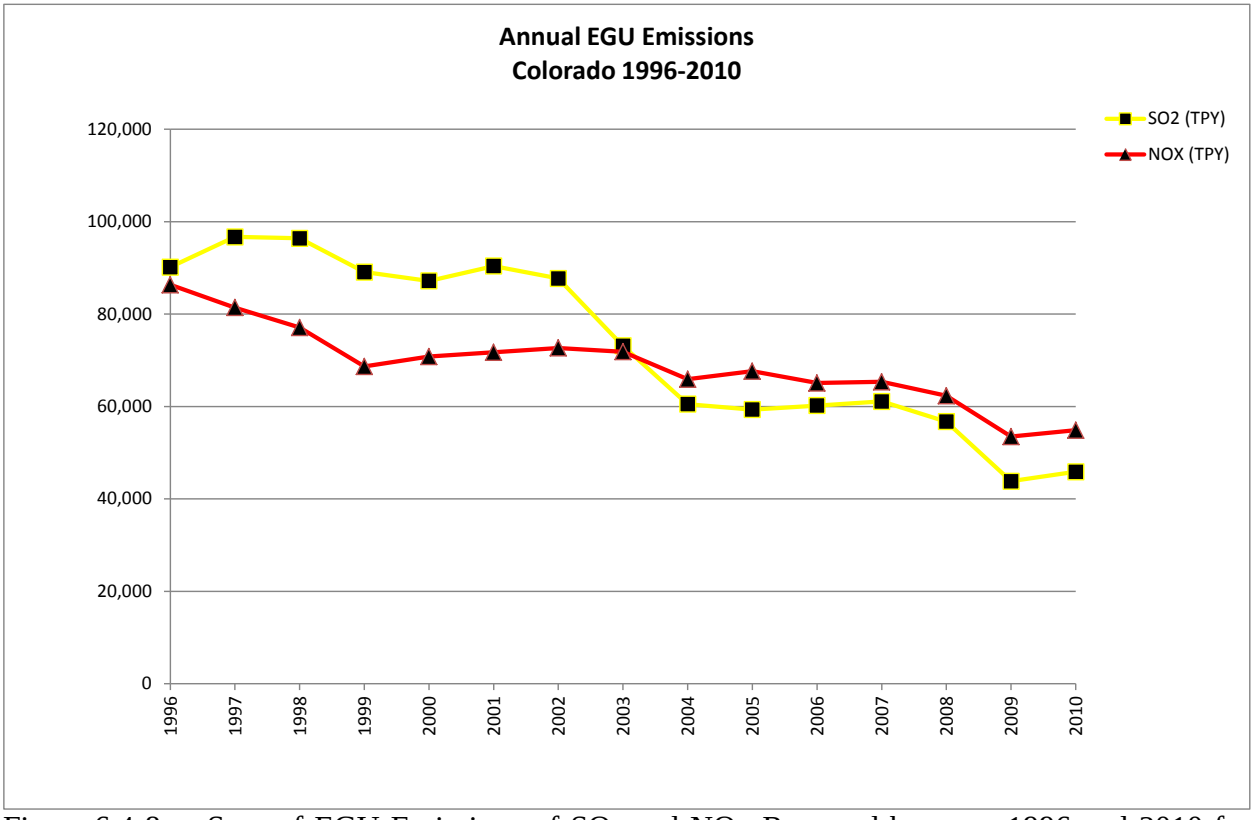

Figure 6.4-8. Sum of EGU Emissions of SO_2 and NO_X Reported between 1996 and 2010 for Colorado.