SOUTH DAKOTA'S

REGIONAL HAZE

STATE IMPLEMENTATION PLAN

South Dakota Department of Environment and Natural Resources

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Executive Summary

The Department of Environment and Natural Resources (DENR) worked with the Western Regional Air Partnership (WRAP), states not members of WRAP, federal land managers, the Environmental Protection Agency (EPA), the regulated community, and others to develop this document as part of South Dakota's Regional Haze State Implementation Plan (SIP). This document along with the applicable Administrative Rules of South Dakota (ARSD) and the addition of ARSD, Chapter 74:36:21 will be South Dakota's Regional Haze State Implementation Plan and implemented by DENR to ensure South Dakota's Regional Haze Program meets the goal of achieving natural conditions in the Badlands and Wind Cave National Parks by 2064 as specified in Title 40 of the Code of Federal Regulations (CFR) §51.308.

Chapter 1 provides background information on the initial federal visibility protection program, describes the causes of visibility impairment, and describes the new federal regional haze program regulations. Chapter 2 provides information on South Dakota's two Class I areas. The two Class I areas are the Badlands National Park and Wind Cave National Park and both are located in the western third of South Dakota.

Chapter 3 describes the process DENR followed to determine natural conditions, baseline conditions, and the uniform rate of improvement for both Class I areas. Chapter 4 discusses the IMPROVE (Interagency Monitoring of Protected Visual Environments) monitoring data for both Class I areas. This chapter looked at the aerosols impacting both Class I areas, what time of year they occur, and if they are increasing or decreasing over time.

Chapter 5 describes South Dakota's emission inventory for past, present, and future air emission inventories in South Dakota, what type of activities are emitting the air emissions, and if the air emissions are generated within South Dakota or from neighboring states and countries. Chapter 6 describes the BART review DENR conducted and establishes the BART requirements for the BART-eligible sources in South Dakota. The BART review covers an analysis to determine BART-eligible sources, a modeling analysis to determine if the BART-eligible source contributes to visibility impairment in a Class I area, and the establishment of BART for those BART-eligible sources that reasonably contribute to visibility impairment in any Class I area.

The BART review identified one electrical generating unit subject to the BART requirements. Otter Tail Power Company's Big Stone I facility determined that it reasonably contributes to visibility impairment in Class I areas. DENR determined the control equipment considered BART for Big Stone I is the existing baghouse, a semi-dry flue gas desulfurization system, and selective catalytic reduction. The installation of the new control equipment and establishment of BART emission limits, compliance demonstration, recordkeeping, and reporting requirements will be established in an air quality construction permit and eventually in Otter Tail Power Company's Title V air quality operating permit. The installation of the new control equipment and other requirements will be completed within five years of EPA's approval of South Dakota's Regional Haze State Implementation Plan.

Chapter 7 discusses South Dakota's goals for demonstrating reasonable progress such as outlining existing rules that already help minimize air emissions that cause visibility impairment and the modeling WRAP conducted of the western United States to determine if states are meeting the reasonable progress goals in 2018. Sulfur dioxide emissions in South Dakota from 2002 through 2018 are expected to decline by 36%, nitrogen oxides emissions are expected to decline by 18%, organic carbon mass emissions are expected to decline by 6%, and elemental carbon emissions are expected to decline by 49%. Other states will also experience a reduction in air emissions that reasonably contribute to visibility impairment in Class I areas. Overall, sulfur dioxide emissions during the same time period are expected to decline by 26%, nitrogen oxide emissions are expected to decline by 29%, organic carbon mass are expected to decline by 6%, and elemental carbon emissions are expected to decline by 31%. These reductions are expected to demonstrate reasonable progress is being made to improve visibility at all Class I areas.

Chapter 8 describes South Dakota's long-term goals in achieving natural conditions by 2064. It also outlines DENR's proposed rules (ARSD, Chapter 74:36:21) to ensure new sources and modifications to existing sources will not reasonably contribute to visibility impairment at any Class I area. In addition, DENR will review, develop, and implement a Smoke Management Plan to address wildfires and prescribed fires.

Chapter 9 discusses DENR's monitoring plan for tracking our progress in achieving natural conditions by 2064. Chapter 10 describes the consultation DENR went through with federal land managers, states, and the public, how DENR responded to each comment, and their future involvement.

Chapter 11 describes the reviews and reporting DENR will perform to track South Dakota's progress in attaining natural conditions by 2064.

1.0 Introduction

1.1 Initial Visibility Protection Program

In August 1977, the federal Clean Air Act was amended by adding section 169A. In section 169A(a)(1), Congress established the following national goal for visibility protection:

> "Congress hereby declares as a national goal the prevention of any future, and the remedying of any existing, impairment of visibility in mandatory class I Federal areas which impairment results from man-made air pollution."

To address this goal for each of the 156 mandatory federal Class I areas across the nation, the federal Environmental Protection Agency (EPA) developed regulations to reduce the impact of large industrial sources on nearby Class I areas. It was recognized at the time that regional haze, which comes from a wide variety of sources that may be located far from a Class I area, was also a part of the visibility problem. However, monitoring networks and visibility models at that time were not developed to the degree necessary to understand the causes of regional haze.

The 1977 Clean Air Act Amendments also established the Prevention of Significant Deterioration (PSD) permit program, which included requirements for protecting visibility in national parks, national wilderness areas, national monuments and national seashores. The PSD permit program included area specific (e.g., Class I, II and III) increments or limits on the maximum allowable increase in air pollutants (e.g., particulate matter and sulfur dioxide) and a preconstruction permit review process for new or modifying major sources that allows for careful consideration of control technology, consultation with federal land managers on visibility impacts and public participation in permitting decisions. The PSD permit program was delegated to South Dakota on July 6, 1994, and later approved in South Dakota's State Implementation Plan on January 22, 2008.

Under Section 169A(b) of the Clean Air Act, Congress established new requirements on major stationary sources in operation within a 15-year period prior to enactment of the 1977 amendments. Major stationary sources within that timeframe that may reasonably be anticipated to cause or contribute to visibility impairment in a Class I area must install best available retrofit technology (BART) as determined by the state. In determining BART, the state must take into consideration the costs of compliance, the energy and non-air quality environmental impacts of compliance, any existing pollution control technology in use at the source, the remaining useful life of the source, and the degree of improvement in visibility which may reasonably be anticipated to result from the use of such technology.

In 1980, EPA adopted regulations to address "reasonably attributable visibility impairment", or visibility impairment caused by one or a small group of man-made sources generally located in close proximity to a specific Class I area. At that time, EPA deferred writing rules to address regional haze, because they lacked the monitoring, modeling and scientific information needed to understand the nature of long range transport and formation of regional haze. South Dakota did not adopt the visibility rules of 1980 in its State Implementation Plan. Therefore, EPA is currently implementing the program in a Federal Implementation Plan.

1.2 Visibility Impairment

Most visibility impairment occurs when pollution in the form of small particles scatters or absorbs light. Air pollutants are emitted from a variety of natural and anthropogenic (man-made) sources. Natural sources can include windblown dust and smoke from wildfires. Anthropogenic sources can include motor vehicles, electric utility and industrial fuel burning, prescribed burning, and manufacturing operations. More pollutants mean more absorption and scattering of light, which reduce the clarity and color of scenery. Some types of particles such as sulfates and nitrates scatter more light, particularly during humid conditions. Other particles like elemental carbon from combustion processes are highly efficient at absorbing light.

Commonly, visibility is observed by the human eye and the object may be a single viewing target or scenery. In the 156 Class I areas across the nation, a person's visual range has been substantially reduced by air pollution. In eastern parks, the average visual range decreased from 90 miles to 15-25 miles. In the West, the visual range decreased from an average of 140 miles to 35-90 miles.

Some particles that cause haze are directly emitted into the air while others are formed when gases emitted into the air form particles as they are carried from the source of the pollutants. Some haze forming pollutants are also linked to human health problems and others to environmental damage. Exposure to very small particles in the air has been linked with increased respiratory illness, decreased lung function, and premature death. In addition, particles such as nitrates and sulfates contribute to acid deposition potentially making lakes, rivers, and streams unsuitable for some forms of aquatic life and impacting flora in the ecosystem. These same acid particles can also erode materials such as paint, buildings or other natural and manmade structures.

1.3 1990 Amendments to Regional Haze Program

In the 1990 Clean Air Act Amendments, Congress added section 169B to strengthen and reaffirm the national goal and address visibility impairment from a collection of sources whose emissions are mixed and transported over long distances to the Class I areas. Section 169B(e) calls for EPA to "carry out the Administrator's regulatory responsibilities under section 169A, including criteria for measuring 'reasonable progress' toward the national goal."

In response to these mandates, EPA promulgated the regional haze rule on July 1, 1999. Under 40 CFR, § 51.308(d)(1), states must "establish goals (expressed in deciviews) that provide for reasonable progress towards achieving natural visibility conditions" for each Class I area within a state by 2064. The reasonable progress goals must provide for an improvement in visibility for the most impaired days over the period of the implementation plan and ensure no degradation in visibility for the least impaired days over the same period.

The purpose of this submittal is to address the State Implementation Plan requirements for the State of South Dakota found in 40 CFR § 51.308 – Regional Haze Program Requirements of 40 CFR Part 51 Subpart P – Protection of Visibility. The South Dakota Department of Environment and Natural Resources (DENR), the agency designated to administer and coordinate a statewide program of air pollution control, has general legal authority under South Dakota Codified Laws Title 34A-1 – Air Pollution Control to adopt and enforce rules for visibility protection including regional haze visibility impairment.

This document along with the adopted rules is South Dakota's State Implementation Plan for adopting a Regional Haze Program meets these goals. Pursuant to the requirements in 40 CFR § 51.308(a) and (b), the State Implementation Plan is intended to meet the requirements in EPA's regional haze regulations that were adopted to comply with the requirements established in Section 169B of the Clean Air Act. This document addresses the following elements of South Dakota's State Implementation Plan:

1. In accordance with 40 CFR § 51.308(d), the core regional haze program requirements (e.g., identification of Class I areas; determination of baseline conditions, natural conditions, and uniform rate of progress; and baseline, current and future emissions inventories);
2. In accordance with 40 CFR § 51.308(e), who is subject to BART and BART controls, emissions limits, compliance determinations, recordkeeping, and reporting requirements;
3. In accordance with 40 CFR § 51.308(f), a commitment to conduct comprehensive periodic revisions of South Dakota's Regional Haze State Implementation Plan;
4. In accordance with 40 CFR § 51.308(g), a commitment to periodically report the progress towards achieving reasonable progress goals;
5. In accordance with 40 CFR § 51.308(h), a commitment to determine the adequacy of the existing implementation plan; and
6. In accordance with 40 CFR § 51.308(i), the requirements for continued coordination with states and federal land managers.

South Dakota is a member of WRAP which is a collaborative effort of tribal governments, state governments and various federal agencies to help states and tribes develop and implement a regional haze program that complies with the EPA's regional haze regulations.

2.0 Class I Areas in South Dakota

In accordance with 40 CFR § 51.308(d), states must address regional haze in each Class I area located within the state and in each Class I area located outside the state which may be affected by emissions from within the state. There are 156 national parks and wilderness areas in the nation that are considered Class I areas in the Clean Air Act (see Figure 2-1). South Dakota is home to two of the 156 national parks and wilderness areas. They are the Badlands National Park and the Wind Cave National Park.

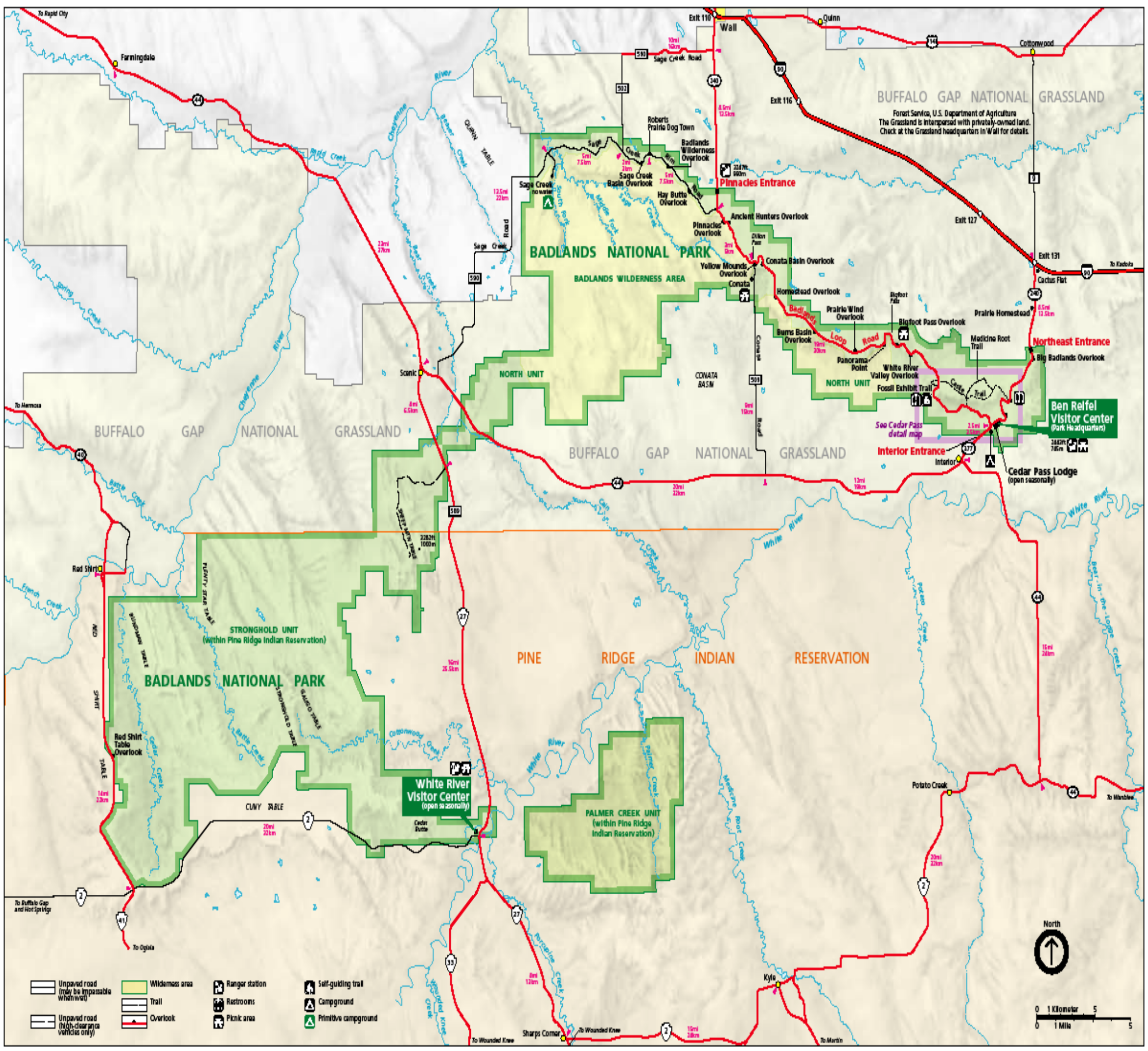
Figure 2-1 – Class I Areas in the United States

There are also national parks and wilderness areas considered Class I areas in our neighboring states. In Wyoming the Class I areas are located in the western part of the state. Montana's Class I areas are located throughout the state but none are located in the southeastern corner which borders South Dakota. North Dakota has probably the closest Class I area of any neighboring state. Minnesota's Class I areas are located in the northeastern corner of the state. Iowa and Nebraska do not have Class I areas.

2.1 Badlands National Park

The Badlands National Park is located in southwestern South Dakota and consists of 244,000 acres of sharply eroded buttes, pinnacles, and spires blended with the largest protected mixed grass prairie in the United States (see Figure 2-2). The closest industrial area from the park boundary is in Rapid City which is approximately 40 miles to the northwest. The general topography is plains; therefore this site is well exposed to regional scale transport winds. The surrounding terrain is predominantly mixed grass prairie and bare rock and sand.

Figure 2-2 –Badlands National Park's Boundary

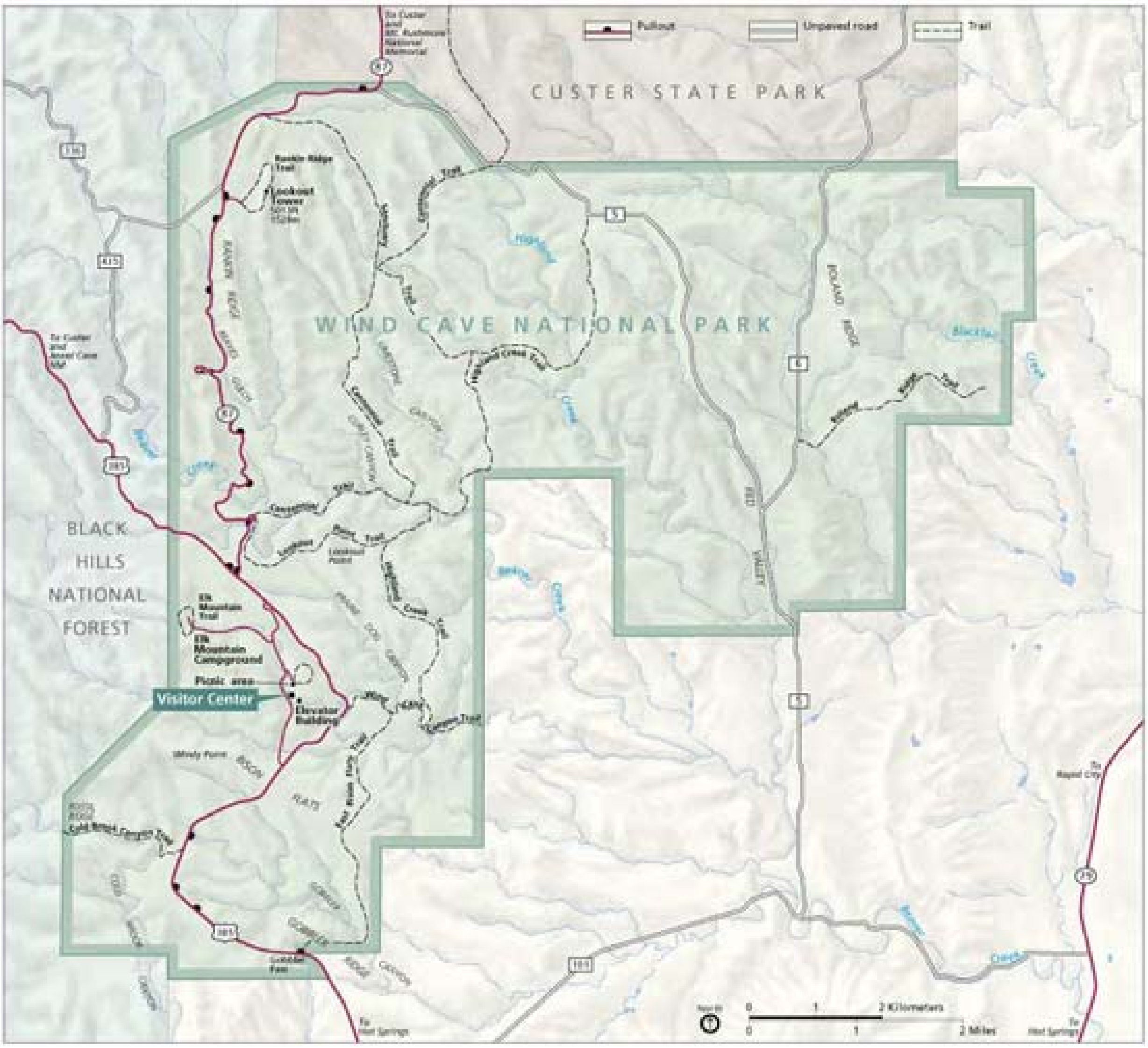


It was established as the Badlands National Monument in 1939, and was redesignated as a national park in 1978. The area of the park that is actually considered a Class I area is the Badlands Wilderness Area, which consists of 64,000 acres in the north unit.

2.2 Wind Cave National Park

Wind Cave National Park lies approximately 10 miles north of Hot Springs in southwestern South Dakota (see Figure 2-3). It was the first cave to be designated a national park anywhere in the world and is currently the fourth longest cave in the world with 119.58 miles (192.45 kilometers) of explored cave passageways.

Figure 2-3 – Wind Cave National Park's Boundary



Aboveground, the park includes 28,295 acres of mixed-grass prairie, ponderosa pine forest, and associated wildlife (see Figure 2-4). The park's mixed-grass prairie is one of the largest remaining and home to bison, elk, pronghorn, mule deer, and prairie dogs. The view from

Lookout Tower on Rankin Ridge displays a spectacular view of the mixed-grass prairie and ponderosa pine forest (see Figure 2-5).

Figure 2-4 –Prairie, Forest, and Bison at Wind Cave (Courtesy of National Park Service)

Figure 2-5 – View from Lookout Tower (Courtesy of National Park Service)

3.0 Baseline, Natural and Uniform Rate of Improvement

In the mid-1980’s, the IMPROVE (Interagency Monitoring of Protected Visual Environments) program was established to measure visibility impairment in Class I areas throughout the United States. The monitoring sites are operated and maintained through a formal cooperative relationship between the EPA, National Park Service, U.S. Fish and Wildlife, Bureau of Land Management, and U.S. Forest Service.

The objectives of the IMPROVE program include establishing the current visibility and aerosol conditions in Class I areas; identifying the chemical species and emission sources responsible for existing human-made visibility impairment; documenting long-term trends for assessing progress towards the national visibility goals; and support the requirements of the regional haze rule by providing regional haze monitoring representing all visibility-protected Class I areas where practical.

The data collected at the IMPROVE monitoring sites are used by federal land managers, industry planners, scientists, public interest groups, and air quality regulators to better understand and protect the visual air quality resource in Class I areas. Most importantly, the IMPROVE program scientifically documents for American citizens, the visual air quality of their wilderness areas and national parks.

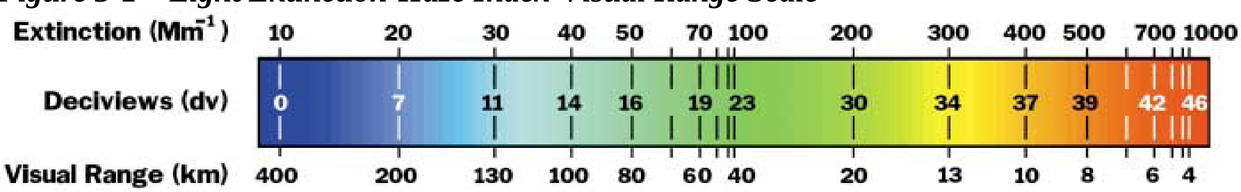
The IMPROVE network consists of aerosol and optical samplers. Every IMPROVE site deploys an aerosol sampler to measure speciated fine aerosols and coarse mass. Select sites also deploy a transmissometer and nephelometers to measure light extinction and scattering respectively, as well as automatic camera systems to visually measure the scenery. Particulate concentration data is obtained every 24 hours and converted into reconstructed light extinction through a complex calculation using the IMPROVE equation which may be viewed at:

http://vista.cira.colostate.edu/improve/Tools/ReconBext/reconBext.htm

Light extinction, the impairment of visibility, occurs due to particles and gases that reflect and absorb light. Reconstructed light extinction (denoted as b_{ext}) is expressed in units of inverse mega meters (1/Mm or Mm-1).

In accordance with 40 CFR 51.308(d)(2), states are required to track visibility conditions in terms of the Haze Index (HI) metric expressed in the deciviews. The relationship between light extinction in Mm-1, Haze Index in deciviews, and visual range in kilometers is indicted by the scale in Figure 3-1.

Figure 3-1 – Light Extinction-Haze Index-Visual Range Scale [1]



A comparison of the light extinction, haze index, and visual range at different levels may be viewed in Figure 3-2 for the Badlands National Park. Generally, a one deciview change in the Haze Index is likely humanly perceptible under ideal conditions regardless of background visibility conditions.

The IMPROVE data undergo quality assurance and control procedures and analyses by its contractors and the National Park Service before it is released. The aerosol and optical data are made publicly available approximately nine months after collection. In addition, seasonal analysis reports are prepared. IMPROVE program resources are available at:

http://vista.cira.colostate.edu/Improve.

There are two IMPROVE monitoring sites in South Dakota. One is located at the Badlands National Park and the other at Wind Cave National Park. The Badlands National Park operates an IMPROVE site (identified as "BADL1") located on a gently sloping flat in the eastern portion of the Badlands National Park, approximately two miles northeast of Interior, South Dakota. DENR operates an ambient air monitoring site at the same location (see Figure 3-3). The site elevation is 2,415 feet and the lowest elevation in the area is the White River at 2,320 feet, approximately two miles south of the monitoring site.

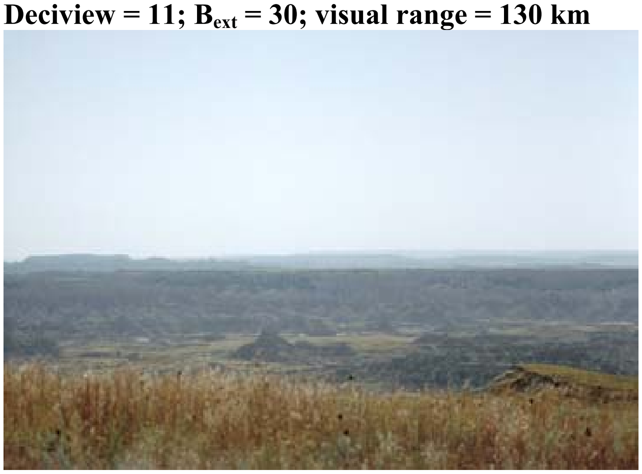
The Wind Cave National Park operates an IMPROVE site (identified as “WICA1”) located near the park’s visitors center (see Figure 3-4). Site elevation at the monitoring site is 4,240 feet and the general topography is hilly.

Figure 3-2 – Comparison at Different Levels

Deciview = 5; B_{ext} = 16; visual range = 240 km

Deciview = 19; B_{ext} = 65; visual range = 60 km

Deciview = 11; B_{ext} = 30; visual range = 130 km



Deciview = 23; B_{ext} = 98; visual range = 40 km

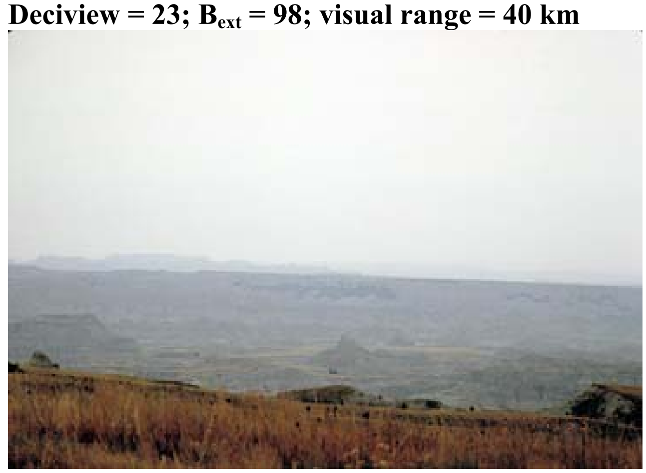


Figure 3-3 – Badlands' IMPROVE and State Monitoring Site

Figure 3-4 – Wind Caves' IMPROVE and State Monitoring Site

3.1 Baseline Visibility Conditions

In accordance with 40 CFR § 51.308(d)(2)(i), baseline visibility conditions for the most impaired and least impaired days are calculated using available monitoring data from calendar year 2000 to 2004. The rule requires the state to establish the average degree of visibility impairment for the most and least impaired days for each calendar year from 2000 to 2004 and average these annual values to determine the baseline visibility conditions.

DENR determined the baseline visibility conditions for the Badlands and Wind Cave National Parks based on IMPROVE data from the respective park. In the case where a day in the IMPROVE database did not have enough data to calculate a deciview value, the data was not considered in determining the baseline visibility conditions. The baseline visibility conditions was determined by calculating the average deciview value for the 20% least impaired (best) and most impaired (worst) days for each of the five years (2000 through 2004) and by averaging those five year values. The baseline visibility conditions for the Badlands and Wind Cave National Parks are summarized in Table 3-1.

Table 3-1 – Baseline Visibility Conditions in South Dakota's National Parks

	Badlands National Park		Wind Cave National Park	
	20% Least	20% Most	20% Least	20% Most
Calendar Year	Deciviews	Deciviews	Deciviews	Deciviews
2000	7.46	18.14	5.62	16.07
2001	7.45	17.63	5.11	15.47
2002	6.69	16.18	5.24	16.75
2003	6.34	17.81	5.02	16.12
2004	6.62	16.04	4.82	15.25
5-Year Average	**6.91**	**17.14**	**5.16**	**15.84**

The actual raw IMPROVE data used to determine the baseline visibility conditions may be viewed at the following website:

http://views.cira.colostate.edu/web/DataWizard/

3.2 Natural Visibility Conditions

In accordance with 40 CFR § 51.308(d)(2)(iii), a core requirement in the State Implementation Plan for the regional haze program is the establishment of natural visibility conditions for the 20% most impaired and 20% least impaired days. To assists states in determining natural visibility conditions, EPA published "*Guidance for Estimating Natural Visibility Conditions Under the Regional Haze Program*", in September 2003. The guidance identifies the primary cause of regional haze for many parts of the country is due to light scattering resulting from fine particles (e.g., particulate matter 2.5 microns in diameter or less). The fine particulate is composed of a variety of chemical species such as carbonaceous species (e.g., organics and elemental carbon) as well as ammonia, nitrate, sulfates, and soil. Coarse particulate which is particulate matter ranging in size from 2.5 to 10 microns in diameter can also contribute to light scattering. These components can occur both naturally and as the result of human activity.

The ultimate goal of the regional haze program is to remedy existing and prevent human-caused impairments of visibility and achieve natural conditions in each Class I area by 2064. It is recognized that natural conditions are not constant; but change over time. To compensate for varying natural processes, natural visibility conditions are based on a long term average condition analogous to the 5-year average conditions for the 20% most impaired and 20% least impaired days. In addition, as the difference between current and natural conditions become smaller and methods of estimating natural conditions improve, natural conditions may change as the regional haze program for each state is re-evaluated.

The natural condition for each Class I area is defined as the level of visibility (in deciviews) for the 20% most impaired days and 20% least impaired days that would exist if there were no manmade impairment. Since no visibility monitoring data exists from the pre-manmade impairment period, the EPA developed guidance on how to estimate natural conditions. Generally, for each Class I area in the western United States, the natural condition for the 20% most impaired days is determined by adding two standard deviations to the annual average of IMPROVE monitoring data. Similarly, the natural condition for the 20% least impaired days is determined by subtracting two standard deviations to the annual average of the IMPROVE monitoring data.

EPA's guidance on determining natural conditions provides two methods of estimating natural conditions. The first method is considered the default natural conditions. In this method, EPA provides estimates of natural conditions for each Class I area. In the second method, states may estimate site specific natural conditions if the state can provide sufficient evidence that supports refined natural conditions.

3.2.1 Default Natural Conditions

EPA developed default values for natural conditions to assist states in determining natural conditions. EPA's estimates for the natural levels of fine particulate constituents and of coarse particles were derived from the National Acid Precipitation Assessment Program (NAPAP) "*Acidic Deposition: State of Science and Technology: Report 24 – Visibility: Existing and Historical Conditions – Cause and Effects*", published in October 1990. The estimate of natural conditions presented in the NAPAP report separates the regions of the United States into the eastern half and western half. The eastern half consists of all states east of the Mississippi River, and up to one tier of states west of the Mississippi River. The western half includes the desert and mountain regions of the Mountain and Pacific Time zones. From this description, South Dakota is located in the western region; but should be evaluated to determine which natural conditions best represent South Dakota since it is on the border of the eastern and western half.

The NAPAP report estimated natural background concentrations for six major components of fine aerosols: sulfates, organics, elemental carbon, ammonium nitrate, soil dust, and water for the eastern and western regions of the United States. The NAPAP report also estimated the natural background for coarse particulate matter. The estimates of natural concentration were based on the following:

1. Compilations of natural versus manmade emission levels;
2. Ambient measurements in remote areas (especially in the Southern hemisphere); and
3. Regressions studies using manmade and/or natural tracers.

EPA mentioned in the guidance the studies cited in the Appendix of the NAPAP report were conducted in relatively remote areas. Therefore, EPA believes it is reasonable to assume the contribution of fire to the particulate matter mass in the NAPAP estimates represents the natural regional contribution of fire. DENR is not sure it agrees with this assumption since fire suppression has occurred for many years disrupting the natural fire process even in remote areas.

Table 3-2 lists the average natural background levels of aerosols and light extinction and was derived from Table 2-1 of EPA's guidance, which is different than the natural background levels established in the NAPAP report. The reason for the difference is noted in the footnotes for Table 3-2. There was no value listed for sea salt.

Table 3-2 – Average Natural Background Concentration Levels

Aerosol Component	East (μg/m^3)	West (μg/m^3)
Ammonium sulfate [1]	0.23	0.12
Organic carbon mass [2]	1.40	0.47
Elemental carbon	0.02	0.02
Ammonium nitrate	0.1	0.1
Soil Dust	0.5	0.5
Coarse Mass	3.0	3.0

[1] – Values adjusted to represent chemical species in current IMPROVE light extinction algorithm; Trijonis estimates were 0.1 micrograms per cubic meter (μg/m^3) and 0.2 μg/m^3 of ammonium bisulfate; and

[2] – Values adjusted to represent chemical species in current IMPROVE light extinction algorithm; Trijonis estimates were 0.5 μg/m^3 and 1.5 μg/m^3 of organic compounds.

The average natural background concentrations levels in Table 3-2 were used in the formula displayed in Equation 3-1 to determine the natural light extinction (b_{ext}), which is used to characterize air pollution impacts on visibility. Light extinction is the fractional loss of the intensity of light per unit of distance caused by the scattering and absorption of gases and particles in the air.

Equation 3-1 – Natural Light Extinction Formula

$$b_{ext} = (3)f(RH)(sulfate) + (3)f(RH)(nitrate) + (4)(OCM) + (10)(LAC) + (soil) + (0.6)(CM) + 10$$

Where:

- b_{ext} = natural light extinction, in Mm^{-1};
- *f*(RH) = relative humidity correction factor;
- OCM = organic carbon mass, in μ/m^3;
- LAC = elemental carbon, in μ/m^3; and
- CM = coarse mass, in μ/m^3.

The natural condition for South Dakota's Class I areas based on the formula in Equation 3-1 are listed in Table 3-3 and derived from Appendix B in EPA's guidance for estimating natural conditions.

Table 3-3 –Natural Background Conditions for South Dakota's Class I Areas

Class I Area	Bext [1]	Annual Average	20% Least Impaired Days	20% Most Impaired Days
Badlands	16.06	4.74 deciview	2.18 deciview	7.30 deciview
Wind Cave	15.97	4.68 deciview	2.12 deciview	7.24 deciview

[1] – Natural light extinction in inverse Mega meters (Mm^{-1}).

3.2.2 Improved Default Natural Conditions

Since EPA's guidance was written a revised natural light extinction formula was developed and adopted by EPA as the basis for the regional haze metric used to track progress in reducing haze levels in Class I areas. The new IMPROVE equation accounts for the effect of particle size distribution on light extinction of small and large size sulfate, nitrate and organic carbon mass. The revised formula is displayed in Equation 3-2.

Equation 3-2 – Revised Natural Light Extinction Formula

$$\begin{aligned} b_{ext} &= 2.2 f_s(RH)[small\ sulfate] + 4.8 f_L(RH)[large\ sulfate] + 2.4 f_s(RH)[small\ nitrate] \\ &+ 5.1 f_L(RH)[large\ nitrate] + 2.8[small\ organic\ mass] + 6.1[large\ organic\ mass] \\ &+ 10[light\ absorbing\ carbon] + [soil] + 0.6[coarse\ matter] + 1.7 f_{ss}(RH)[sea\ salt] \\ &+ Rayleigh\ Scattering + 0.33[NO_2(ppb)] \end{aligned}$$

The total sulfate, nitrate and organic compound concentrations are split into two fractions representing small and large size distributions of each component. The formula for the large and small sulfate, nitrate and organic mass is displayed in Equation 3-3. In addition, the relative humidity correction factor in Equation 3-2 is also based on small size distribution (f_S(RH)) and large size distribution (f_L(RH)) for sulfate and nitrate and for sea salt (f_{SS}(RH)). The relative humidity correction factors were derived from the "*Federal Land Managers' Air Quality Related Values Workgroup (FLAG)*," drafted June 27, 2008, and can be viewed in Table 3-4.

Equation 3-3 – Large and Small Formulas

$$(Large) = \frac{(Total)}{20\frac{ug}{m^3}} \times (Total),\ for\ Total < 20\frac{ug}{m^3}$$

$$(Large) = (Total)\ for\ Total > 20\frac{ug}{m^3}$$

$$(Small) - (Total) - (Large)$$

Table 3-4 – Relative Humidity Correction Factor (f(RH))

Class I Size	Month											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Badlands												
Small	2.94	2.96	3.01	2.87	3.10	2.91	2.64	2.59	2.56	2.58	3.11	2.98
Large	2.31	2.31	2.31	2.21	2.34	2.25	2.08	2.05	2.02	2.05	2.38	2.33
Sea Salt	3.37	3.33	3.27	3.05	3.25	3.15	2.89	2.81	2.74	2.82	3.41	3.38
Wind Cave												
Small	2.81	2.81	2.86	2.82	3.06	2.81	2.50	2.46	2.44	2.52	2.97	2.83
Large	2.23	2.22	2.22	2.18	2.32	2.18	2.00	1.97	1.95	2.00	2.30	2.24
Sea Salt	3.25	3.20	3.13	3.01	3.22	3.06	2.75	2.68	2.63	2.75	3.28	3.24

The result of the revised light extinction is used in the formula displayed in Equation 3-4 to estimate the annual average of the haze index values (HI), in deciviews. DENR calculated the HI value for each month for each Class I area. The average HI value for each Class I area may be viewed in Table 3-5.

Equation 3-4 – Annual Average Haze Index

$$HI = 10\ln(b_{ext} \div 10)$$

Where:

- HI = annual average of the haze index values, in deciviews; and
- b_{ext} = natural light extinction, in Mm^{-1}.

In EPA's guidance, it was determined that the frequency distribution behaves normally (10th and 90th percentile HI) for Class I areas. This allows the 20% least impaired and 20% most impaired days to be determined using the annual average haze index and the formulas in Equation 3-5 and 3-6, respectively. In EPA's guidance, it was determined that the average standard deviation in the East is 3 deciviews and in the West it is 2 deciviews. DENR stayed consistent with using western values and used a standard deviation of 2 deciviews. The 10th and 90th percentile was calculated for each month for each Class I area. The results may be viewed in Table 3-5.

Equation 3-5 – Natural Least Impaired Days Formula

$$P10 = HI - 1.28sd$$

Equation 3-6 – Natural Most Impaired Days Formula

$$P90 = HI + 1.28sd$$

Where:

- P10 = Natural 20% least impaired days, in deciviews;
- P90 = Natural 20% most impaired days, in deciviews;
- HI = annual average haze index, in deciviews; and
- sd = standard deviation of the daily haze index values for that area, in deciviews.

Table 3-5 –New Formula Natural Background Conditions for South Dakota's Class I Areas

Class I Area	Annual Average Haze Index	Natural Background	
		Least Impaired Days	Most Impaired Days
Badlands	**4.88 deciview**	2.32 deciview	8.06 deciview
Wind Cave	**4.85 deciview**	2.29 deciview	7.41 deciview

3.2.3 Baseline and Default Natural Conditions Comparison

The natural background concentration levels are estimated for long term average conditions. In some cases the natural background concentration level may have higher concentrations than the baseline concentrations or for any other 5-year period. If this occurs, EPA's guidance recommends that the natural background concentration level should be replaced with the corresponding measured value.

DENR used the IMPROVE data from each national park to determine the baseline concentration and compared the concentrations to the natural background concentrations in Table 3-2. Table 3-6 displays the comparison.

Table 3-6 – Comparison of Natural versus Baseline Concentrations [1]

Aerosol Component	Natural West ($\mu g/m^3$)	Background			
		Badlands		Wind Cave	
		Least ($\mu g/m^3$)	Most ($\mu g/m^3$)	Least ($\mu g/m^3$)	Most ($\mu g/m^3$)
Ammonium sulfate	0.12 [2]	0.49	2.63	0.41	2.07
Organic carbon mass	0.47 [3]	0.62	3.17	0.50	3.55
Elemental carbon	0.02	0.08	0.26	0.07	0.30
Ammonium nitrate	0.10	0.16	0.76	0.12	0.98
Soil Dust	0.50	**0.33**	0.98	**0.24**	0.86
Coarse Mass	3.00	**2.53**	9.90	**1.78**	5.89

[1] – Units are in micrograms per cubic meter ($\mu g/m^3$);
[2] – Values adjusted to represent chemical species in current IMPROVE light extinction algorithm; Trijonis estimate was 0.1 $\mu g/m^3$ of ammonium bisulfate; and
[3] – Values adjusted to represent chemical species in current IMPROVE light extinction algorithm; Trijonis estimate was 0.5 $\mu g/m^3$ of organic compounds.

Based on the comparison, the aerosol components in the baseline data for 2000 through 2004 for the 20% least impaired days are less than the natural conditions for soil dust and coarse mass at both the Badlands and Wind Cave National Parks (see bolded values in Table 3-6). Although the soil dust and coarse mass for the baseline data is less than the values for natural conditions, DENR will use the values established in EPA's guidance for the initial Regional Haze State Implementation Plan and re-evaluate this in future State Implementation Plan reviews. Table 3-7 displays the natural conditions and compares it to the baseline data for 2000-2004.

Table 3-7 – Baseline versus Natural Background (Deciviews)

Class I Area	Baseline	Natural	Difference	Baseline	Natural	Difference
	20% Least Impaired Days			20% Most Impaired Days		
Badlands	6.91	2.32	4.59	17.14	8.06	9.08
Wind Cave	5.16	2.29	2.87	15.84	7.41	8.43

3.2.4 Refined Natural Conditions

EPA identifies any refined approach for determining natural visibility conditions should be based on accurate, complete, and unbiased information and should be developed using a high degree of scientific rigor. The refined natural concentration estimates must retain the distinction between natural and anthropogenic components. For example, just like EPA's default natural concentrations, the refined natural concentrations should not exceed actual measured concentrations of that species over a 5-year period.

EPA indicates additional information will become available over the years to improve on the default natural concentrations such as the following:

1. Implementation of a coordinated fire data system or fire tracking system;
2. The collection of multiple years of speciated particulate matter data in mandatory Class I areas and the assessment of potential contributions by natural fire events using data from the fire tracking system;
3. Development of chemical analysis techniques to identify carbon attributed to fire versus other sources;
4. Development of improved emissions factors and tracking of fire activity levels; and
5. Improved regional scale fire modeling or remote sensing tools to retrospectively determine whether smoke from a fire impacted a Class I area air shed.

DENR agrees more refined natural species concentrations will be developed in the coming years that are more specific to a national park and will review this new information as it periodically reviews its Regional Haze State Implementation Plan.

3.3 Uniform Rate of Improvement

In accordance with 40 CFR § 51.308(d)(2)(iv)(A), the initial implementation plan shall address the difference between the baseline and natural conditions for the 20% most impaired and 20% least impaired days. In accordance with 40 CFR § 51.308(d)(1)(i)(B), the state is required to determine the rate of progress needed to attain natural visibility conditions by the year 2064. The rate of progress is based on the difference between the baseline visibility conditions and the natural visibility conditions for 20% most impaired days for each Class I area.

The uniform rate of visibility improvement, measured in deciviews, is determined by taking the difference between the baseline visibility conditions and the natural visibility conditions and dividing by 60 years, which is the time frame for attaining natural visibility conditions by 2064. The uniform rate of improvement is required to be considered as the state establishes its reasonable progress goals for attaining natural visibility conditions. The uniform rate of improvement for the Badlands and Wind Cave National Parks is based on the formula in Equation 3-7 and the baseline and natural background valued in Table 3-7. The results are displayed in Table 3-8. The uniform rate of improvement was calculated for the 20% most impaired days for each national park.

Equation 3-7 – Uniform Rate of Progress

$$Uniform\ Rate\ of\ \mathrm{Pr}ogress = (Baseline - Natural) \div 60$$

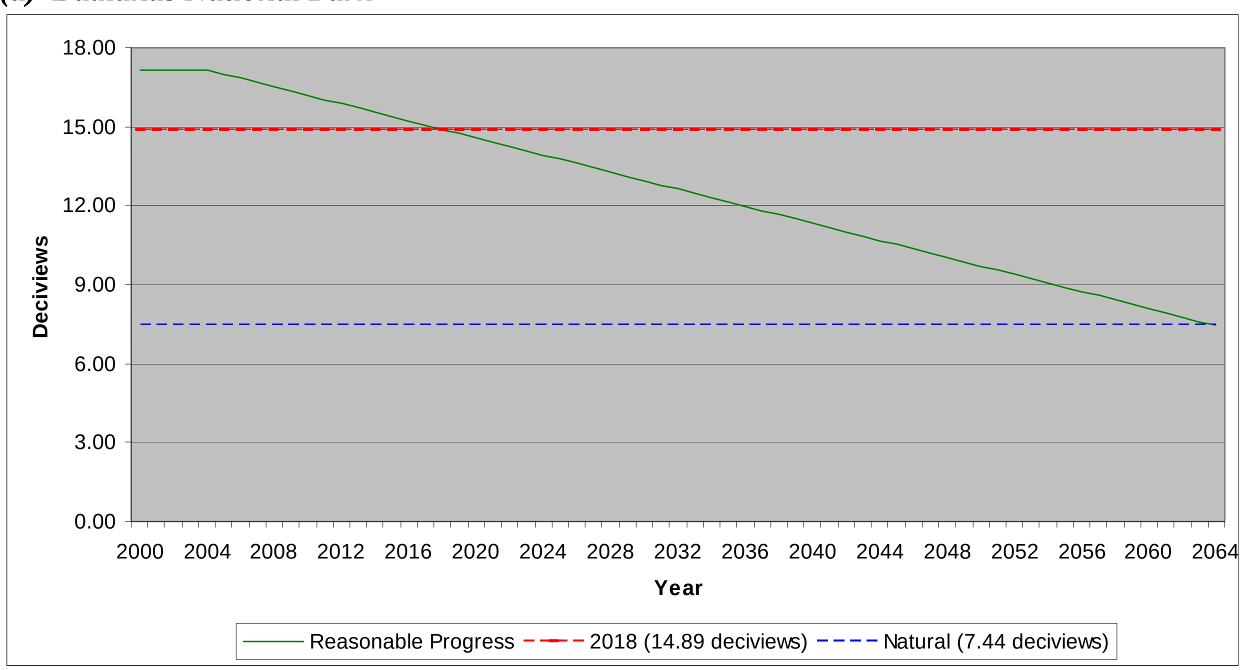
Table 3-8 – Annual Uniform Rate of Improvement

Description	Badlands	Wind Cave
Annual Improvement	0.1620 deciviews	0.1420 deciviews

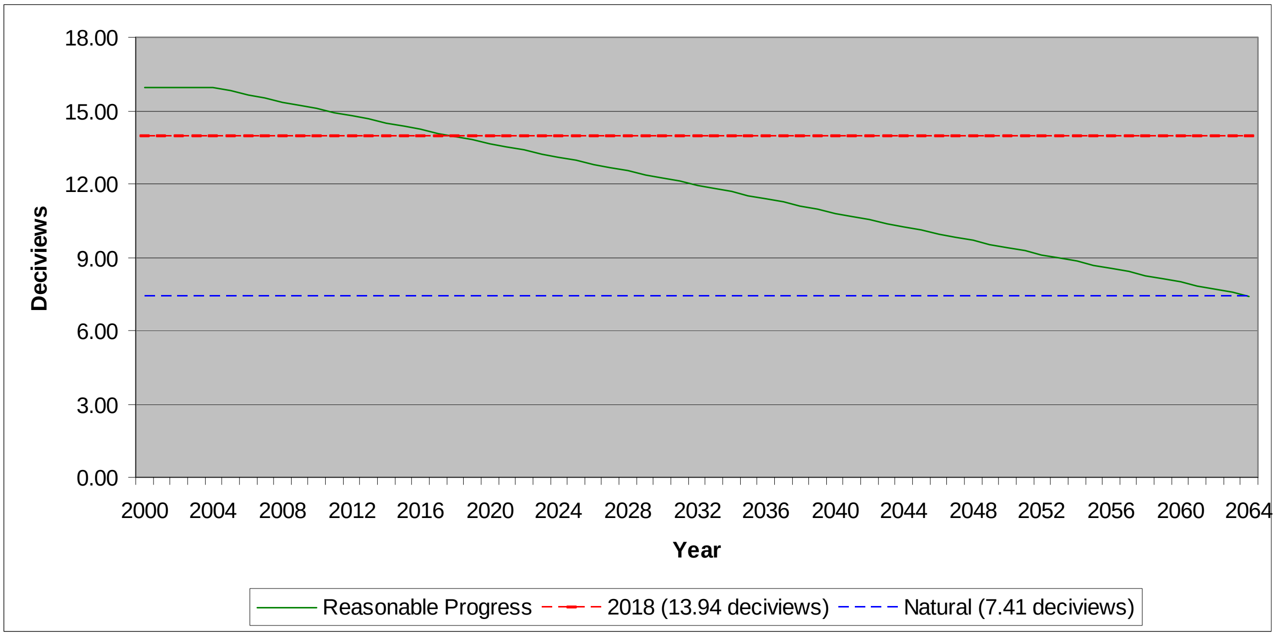
The uniform rate of improvement was used to establish the slope of reduction necessary to achieve the natural visibility conditions in 2064. The slope of reduction for the 20% most impaired days for the Badlands and Wind Cave National Parks are displayed in Figure 3-5.

The improvement needed by 2018 was calculated based on the annual uniform rate of improvement identified for each Class I area. The baseline is based on calendar years 2000 through 2004. Therefore, there are 14 years from the baseline to the first planning period or 2018. The improvement needed for the 20% most impaired days by calendar year 2018 for each Class I area was determined by multiplying the annual uniform rate of improvement by 14 years then subtracting that from the baseline value for the 20% most impaired days in Table 3-7. The result is displayed in Figure 3-5.

Figure 3-5 – Uniform Rate of Improvement
(a) Badlands National Park



(b) Wind Cave National Park



4.0 IMPROVE Data for Class I Areas

The data from the IMPROVE monitoring sites identifies the composition of the pollutants impacting our Class I areas and consists of ammonia sulfates fine (ammSO4f), ammonia nitrates fine (ammNO3f), organic mass carbon (OMC), elemental carbon fine (Ecf), soil, coarse mass (CM), and sea salt. The IMPROVE data has been collected at the Badlands National Park since 1988 and the Wind Cave National Park since 2000. DENR is using the IMPROVE data to help determine what air pollutants are causing or contributing to visibility impairment in the Class I areas and assist in evaluating if each state is achieving the reasonable progress goals.

4.1 Aerosol Concentrations

The average aerosol concentration (micrograms per cubic meter (ug/m^3)) and visibility (deciviews) per year during the baseline period (2000-2004) for the 20% least (P10) and 20% most (P90) impaired days are summarized in Table 4-1 for the Badlands National Park and Table 4-2 for the Wind Cave National Park. The last line in each Table provide the default natural conditions that should be achieved for the 20% most impaired days by 2064.

The baseline aerosol concentrations at the Badlands and Wind Cave National Parks during the 20% most impaired days are all similar and within 22% or less of each other except for the coarse mass and sea salt. If you neglect sea salt, the aerosol with the greatest dissimilarity is coarse mass with the Badlands National Park's coarse mass baseline concentrations being greater than at the Wind Cave National Park. This would be expected because of the drier conditions associated with the Badlands National Park. Coarse mass is typically generated from crushing or grinding operations, dust from paved or unpaved roads, windblown dust, etc.

Table 4-1 – Badlands National Park Baseline Aerosol Concentrations [1]

a) Aerosol Concentrations for 20% Least Impaired

Year	P10 (Deciview)	ammSO4f (u/m^3)	ammNO3f (u/m^3)	OMC (u/m^3)	Ecf (u/m^3)	SOIL (u/m^3)	CM (u/m^3)	Sea Salt (u/m^3)
2000	7.46	0.64	0.20	0.64	0.08	0.26	2.08	0.01
2001	7.45	0.57	0.21	0.64	0.09	0.39	2.60	0.00
2002	6.69	0.37	0.12	0.62	0.09	0.44	3.21	0.00
2003	6.34	0.44	0.11	0.61	0.06	0.25	2.38	0.00
2004	6.62	0.43	0.17	0.57	0.07	0.33	2.39	0.01
5-yr	**6.91**	**0.49**	**0.16**	**0.62**	**0.08**	**0.33**	**2.53**	0.00
Natural	**2.32**	**0.12**	**0.10**	**0.47**	**0.02**	**0.50**	**3.00**	**0.00**

b) Aerosol Concentrations for 20% Most Impaired

Year	P90 (Deciview)	ammSO4f (u/m^3)	ammNO3f (u/m^3)	OMC (u/m^3)	Ecf (u/m^3)	SOIL (u/m^3)	CM (u/m^3)	Sea Salt (u/m^3)
2000	18.14	2.72	0.50	4.78	0.40	1.00	10.14	0.00
2001	17.63	3.13	0.95	2.38	0.26	1.29	9.79	0.00
2002	16.18	2.45	0.63	2.22	0.19	1.14	12.17	0.10
2003	17.81	2.27	0.91	4.03	0.29	0.73	11.65	0.06
2004	16.04	2.55	0.83	2.43	0.16	0.74	5.77	0.02
5-yr	**17.16**	**2.63**	**0.76**	**3.17**	**0.26**	**0.98**	**9.90**	**0.04**
Natural	**7.44**	**0.12**	**0.10**	**0.47**	**0.02**	**0.50**	**3.00**	**0.00**

[1] – Units are in micrograms per cubic meter ($\mu g/m^3$), "P10" = 20% least impaired days, "P90" = 20% most impaired days, "ammSO4f" = ammonia sulfate fine; "ammNO3f" = ammonia nitrate fine, "OMC" = organic mass carbon, "Ecf" = Elemental carbon fine, and "CM" = coarse mass.

Table 4-2 – Wind Cave National Park Baseline Aerosol Concentrations [1]

a) Aerosol Concentrations for 20% Least Impaired

Year	P10 (Deciview)	ammSO4f (u/m^3)	ammNO3f (u/m^3)	OCM (u/m^3)	Ecf (u/m^3)	SOIL (u/m^3)	CM (u/m^3)	Sea Salt (u/m^3)
2000	5.62	0.49	0.15	0.59	0.09	0.18	1.24	0.00
2001	5.11	0.43	0.13	0.44	0.06	0.28	1.75	0.00
2002	5.24	0.36	0.10	0.48	0.07	0.30	2.57	0.01
2003	5.02	0.40	0.08	0.54	0.06	0.22	1.89	0.00
2004	4.82	0.38	0.12	0.44	0.07	0.22	1.44	0.00
5-yr	**5.16**	**0.41**	**0.12**	**0.50**	**0.07**	**0.24**	**1.78**	**0.00**
Natural	**2.29**	**0.12**	**0.10**	**0.47**	**0.02**	**0.50**	**3.00**	**0.00**

b) Aerosol Concentrations for 20% Most Impaired

Year	P90 (Deciview)	ammSO4f (u/m^3)	ammNO3f (u/m^3)	OCM (u/m^3)	Ecf (u/m^3)	SOIL (u/m^3)	CM (u/m^3)	Sea Salt (u/m^3)
2000	16.07	1.86	0.68	4.33	0.37	0.97	6.57	0.00
2001	15.47	2.25	1.26	2.48	0.23	0.82	5.99	0.00
2002	16.75	2.26	0.87	4.15	0.31	0.98	6.78	0.00

Year	P90 (Deciview)	ammSO4f (u/m^3)	ammNO3f (u/m^3)	OCM (u/m^3)	Ecf (u/m^3)	SOIL (u/m^3)	CM (u/m^3)	Sea Salt (u/m^3)
2003	16.12	2.03	0.86	4.00	0.24	0.75	6.60	0.01
2004	15.25	1.94	1.24	2.79	0.33	0.77	3.49	0.02
5-yr	**15.93**	**2.07**	**0.98**	**3.55**	**0.30**	**0.86**	**5.89**	**0.01**
Natural	**7.41**	**0.12**	**0.10**	**0.47**	**0.02**	**0.50**	**3.00**	**0.00**

[1] – Units are in micrograms per cubic meter (μg/m^3), "P10" = 20% least impaired days, "P90" = 20% most impaired days, "ammSO4f" = ammonia sulfate fine; "ammNO3f" = ammonia nitrate fine, "OMC" = organic mass carbon, "Ecf" = Elemental carbon fine, and "CM" = coarse mass.

The aerosol concentrations that appear to need to be reduced the most to achieve natural concentrations at both national parks are ammonia sulfate and elemental carbon. Ammonia sulfates are derived from fossil fuel combustion and the combustion of organic mass such as forest fires and the burning of grass. Elemental carbon is also generated from fossil fuel combustion; but is generally used as the main indicator of emissions from fires and other combustion sources such as diesel emissions.

Organic carbon mass and ammonia nitrate aerosol concentrations at the two national parks would also need to be reduced since current concentrations are approximately seven to 10 times greater than natural conditions. Organic carbon mass is derived from biomass burning, automobile emissions, fossil fuel combustion, gas-to-particle conversion of hydrocarbons, etc. Ammonia nitrates are generated from similar sources that generate ammonia sulfates along with organic decomposition.

4.2 Extinction Comparison

Extinction (inverse mega meters (Mm^{-1})) is useful in relating visibility directly to particle species concentrations. DENR took the IMPROVE data for the baseline period (2000-2004) for the 20% least and 20% most impaired days and summarized it in Table 4-3 for the Badlands National Park and Table 4-4 for the Wind Cave National Park, except for sea salt since the concentrations for sea salt are minimal.

Table 4-3 – Badlands National Park [1]
a) Baseline Aerosol Concentrations for 20% Least Impaired

Year	Extinction (bext) (Mm^{-1})	ammSO4f (Mm^{-1})	ammNO3f (Mm^{-1})	OMC (Mm^{-1})	Ecf (Mm^{-1})	SOIL (Mm^{-1})	CM (Mm^{-1})
2000	21.28	4.53	1.50	1.88	0.82	0.26	1.25
2001	21.15	3.85	1.58	1.87	0.89	0.39	1.56
2002	19.58	2.57	0.91	1.82	0.91	0.44	1.93
2003	18.90	3.00	0.81	1.78	0.63	0.25	1.43
2004	19.44	3.01	1.32	1.64	0.66	0.33	1.43
5-yr	**20.07**	**3.39**	**1.23**	**1.80**	**0.78**	**0.33**	**1.52**
% Without Rayleigh		**36%**	**14%**	**20%**	**9%**	**4%**	**17%**

b) Baseline Aerosol Concentrations for 20% Most Impaired

Year	Extinction (bext) (Mm^{-1})	ammSO4f (Mm^{-1})	ammNO3f (Mm^{-1})	OMC (Mm^{-1})	Ecf (Mm^{-1})	SOIL (Mm^{-1})	CM (Mm^{-1})
2000	63.49	18.99	3.63	18.74	4.04	1.00	6.08
2001	59.32	23.25	7.41	7.93	2.56	1.29	5.87
2002	51.28	17.43	4.68	7.36	1.86	1.14	7.30
2003	61.53	16.19	7.18	16.22	2.90	0.73	6.99
2004	50.73	18.83	6.48	8.53	1.57	0.74	3.46
5-yr	**57.27**	**18.94**	**5.88**	**11.76**	**2.59**	**0.98**	**5.94**
% Without Rayleigh		**41%**	**13%**	**25%**	**6%**	**2%**	**13%**

[1] – Units are in inverse Mega meters (Mm^{-1}), "B_{ext}" = natural light extinction, "ammSO4f" = ammonia sulfate fine; "ammNO3f" = ammonia nitrate fine, "OMC" = organic mass carbon, "Ecf" = Elemental carbon fine, and "CM" = coarse mass.

Table 4-4 – Wind Cave National Park [1]

a) Aerosol Concentrations for 20% Least Impaired

Year	Extinction (bext) (Mm^{-1})	ammSO4f (Mm^{-1})	ammNO3f (Mm^{-1})	OMC (Mm^{-1})	Ecf (Mm^{-1})	SOIL (Mm^{-1})	CM (Mm^{-1})
2000	17.71	3.12	1.07	1.72	0.87	0.18	0.74
2001	16.75	2.65	0.88	1.27	0.63	0.28	1.05
2002	16.95	2.27	0.68	1.38	0.74	0.30	1.54
2003	16.58	2.48	0.53	1.58	0.63	0.22	1.14
2004	16.26	2.41	0.82	1.27	0.67	0.22	0.86
5-yr	**16.85**	**2.58**	**0.80**	**1.44**	**0.71**	**0.24**	**1.07**
% Without Rayleigh		**38%**	**12%**	**21%**	**10%**	**3%**	**16%**

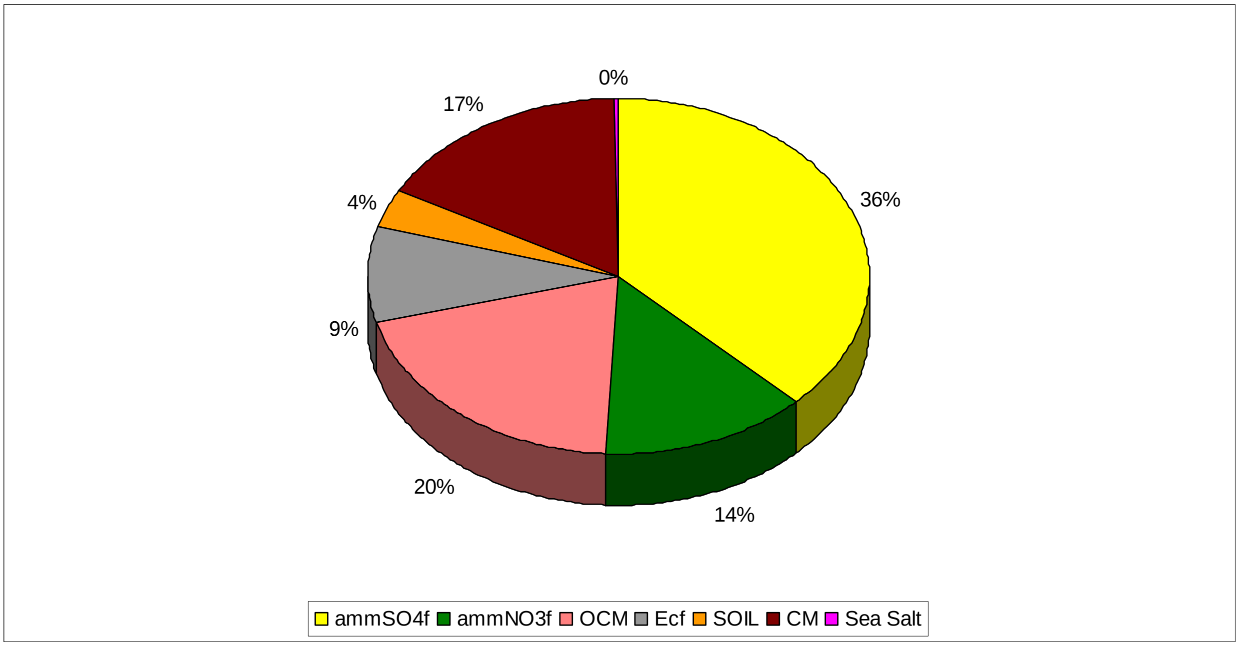
b) Aerosol Concentrations for 20% Most Impaired

Year	Extinction (bext) (Mm^{-1})	ammSO4f (Mm^{-1})	ammNO3f (Mm^{-1})	OMC (Mm^{-1})	Ecf (Mm^{-1})	SOIL (Mm^{-1})	CM (Mm^{-1})
2000	51.94	11.60	4.69	17.00	3.74	0.97	3.94
2001	48.76	14.58	9.25	8.22	2.28	0.82	3.59
2002	56.18	14.98	6.06	16.95	3.14	0.98	4.07
2003	51.05	12.66	6.19	15.05	2.40	0.75	3.96
2004	47.94	12.80	9.19	9.73	3.25	0.77	2.09
5-yr	**51.18**	**13.32**	**7.07**	**13.39**	**2.96**	**0.86**	**3.53**
% Without Rayleigh		**32%**	**17%**	**33%**	**7%**	**2%**	**9%**

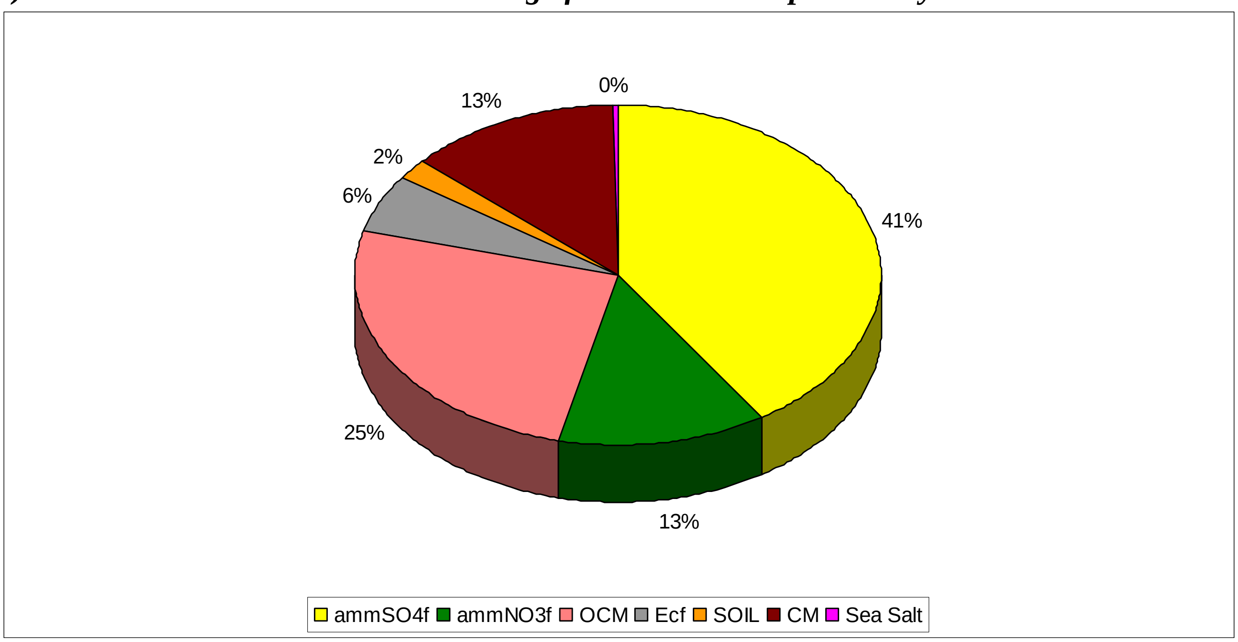
[1] – Units are in inverse Mega meters (Mm^{-1}), "B_{ext}" = natural light extinction, "ammSO4f" = ammonia sulfate fine; "ammNO3f" = ammonia nitrate fine, "OMC" = organic mass carbon, "Ecf" = Elemental carbon fine, and "CM" = coarse mass.

DENR included in each table the percentage of visibility impairment based on each aerosol's contribution to the extinction after subtracting out the Rayleigh affect. The Rayleigh affect is the scattering of light by particles much smaller than the wavelength of light. The percentages of extinction per aerosol for the 20% least and most impaired days for the Badlands and Wind Cave National Parks are displayed in Figure 4-1 and 4-2, respectively.

Figure 4-1 – Badlands National Park Baseline Aerosol Extinction Comparison [1]
a) Baseline Aerosol Extinction Percentage for 20% Least Impaired Days



b) Baseline Aerosol Extinction Percentage for 20% Most Impaired Days



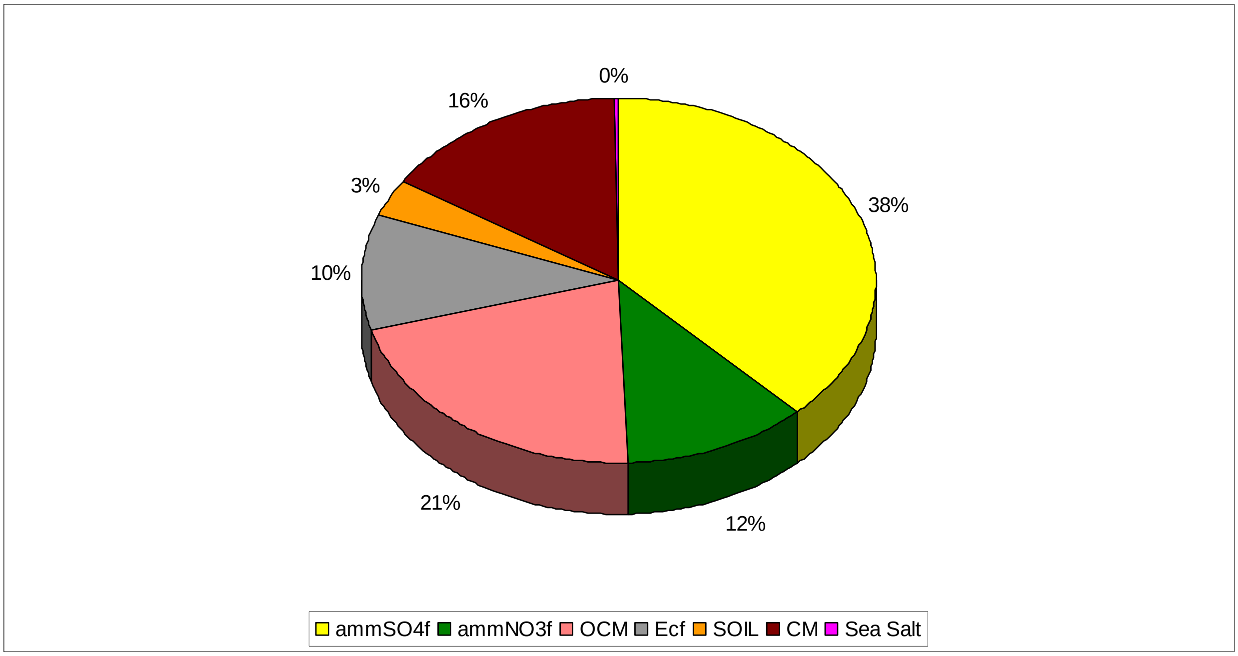
[1] – "ammSO4f" = ammonia sulfate fine; "ammNO3f" = ammonia nitrate fine, "OMC" = organic mass carbon, "Ecf" = Elemental carbon fine, and "CM" = coarse mass.

In the 20% least impaired days for the Badlands National Park, the aerosol that contributed the greatest visibility impairment is ammonia sulfate at 36%, which is almost double the percentage of the second greatest contributor. The second greatest contributor is organic carbon mass at 20%. The third greatest contributor is coarse mass at 17% followed closely by ammonia nitrates at 14%. Ammonia sulfate, organic carbon mass, coarse mass and ammonia nitrate represent 87%

of the aerosol concentrations impacting the 20% least impaired days in the Badlands National Park.

In the 20% most impaired days for the Badlands National Park, the aerosol that contributed the greatest visibility impairment again is ammonia sulfate at 41%. Its contribution is not double the percentage of the second greatest contributor; but is close. The second greatest contributor is organic carbon mass at 25%. The third greatest contributor is coarse mass and ammonia nitrates at 13%, each. Ammonia sulfate, organic carbon mass, coarse mass and ammonia nitrate represent 92% of the aerosol concentrations impacting the 20% most impaired days in the Badlands National Park.

Figure 4-2 – Wind Cave Baseline Aerosol Extinction Percentage
a) Baseline Aerosol Extinction Percentage for 20% Least Impaired Days [1]

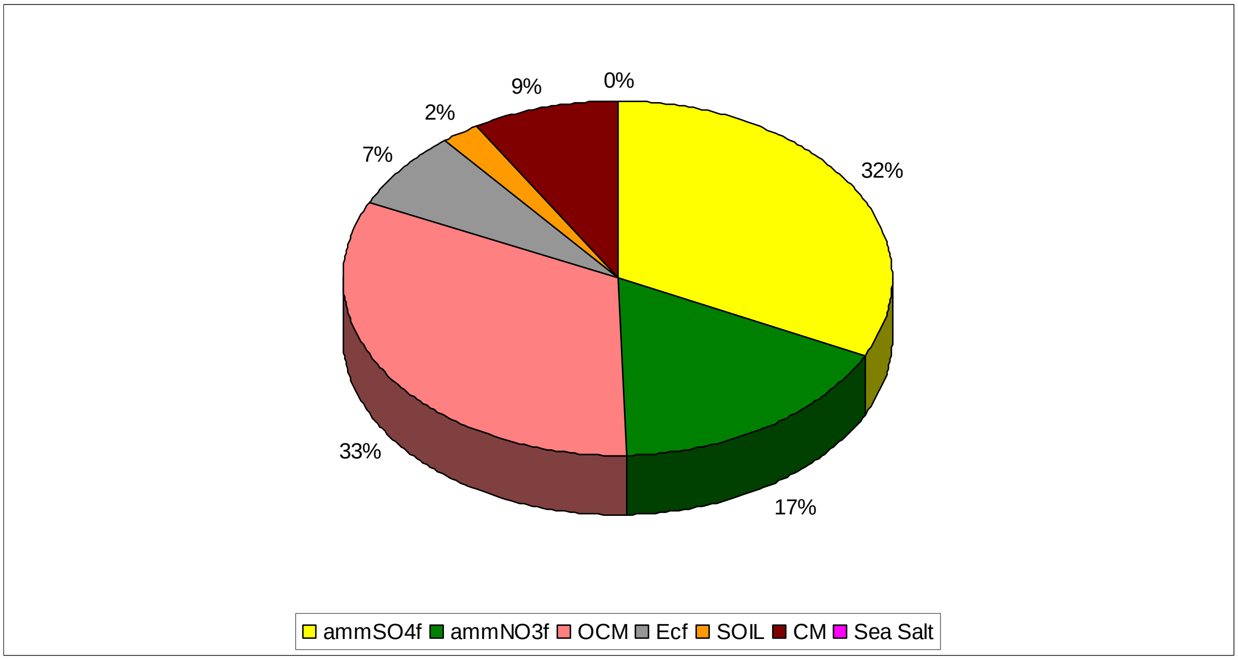


[1] – "ammSO4f" = ammonia sulfate fine; "ammNO3f" = ammonia nitrate fine, "OMC" = organic mass carbon, "Ecf" = Elemental carbon fine, and "CM" = coarse mass.

In the 20% least impaired days for the Wind Cave National Park, the aerosol that contributed the greatest visibility impairment is ammonia sulfate at 38%, which is almost double the percentage of the second greatest contributor. The second greatest contributor is organic carbon mass at 21%. The third greatest contributor is coarse mass at 16% followed by ammonia nitrates at 12%. Ammonia sulfate, organic carbon mass, coarse mass and ammonia nitrate represent 87% of the aerosol concentrations impacting the 20% least impaired days in the Wind Cave National Park.

In the 20% most impaired days for the Wind Cave National Park, the aerosol that contributed the greatest visibility impairment is organic carbon mass at 33%, followed closely by ammonia sulfate at 32%. The third greatest contributor is ammonia nitrates at 17% followed by coarse mass at 9%. Ammonia sulfate, organic carbon mass, coarse mass and ammonia nitrate represent 91% of the aerosol concentrations impacting the 20% most impaired days in the Wind Cave National Park.

b) Baseline Aerosol Extinction Percentage for 20% Most Impaired Days [1]



[1] – "ammSO4f" = ammonia sulfate fine; "ammNO3f" = ammonia nitrate fine, "OMC" = organic mass carbon, "Ecf" = Elemental carbon fine, and "CM" = coarse mass.

There is a good comparison between the 5-year average concentration for each aerosol at the Badlands and Wind Cave National Park during the 20% least impaired days (see Figure 4-3(a)). Although these concentrations represent the 20% least impaired days, the concentrations are still greater than natural conditions. DENR did not anticipate the two national parks to have similar concentrations since the Badlands National Park is predominantly mixed prairie grasses, bare rock and sand while the Wind Cave National Park is mixed prairie grasses and ponderosa pine forest.

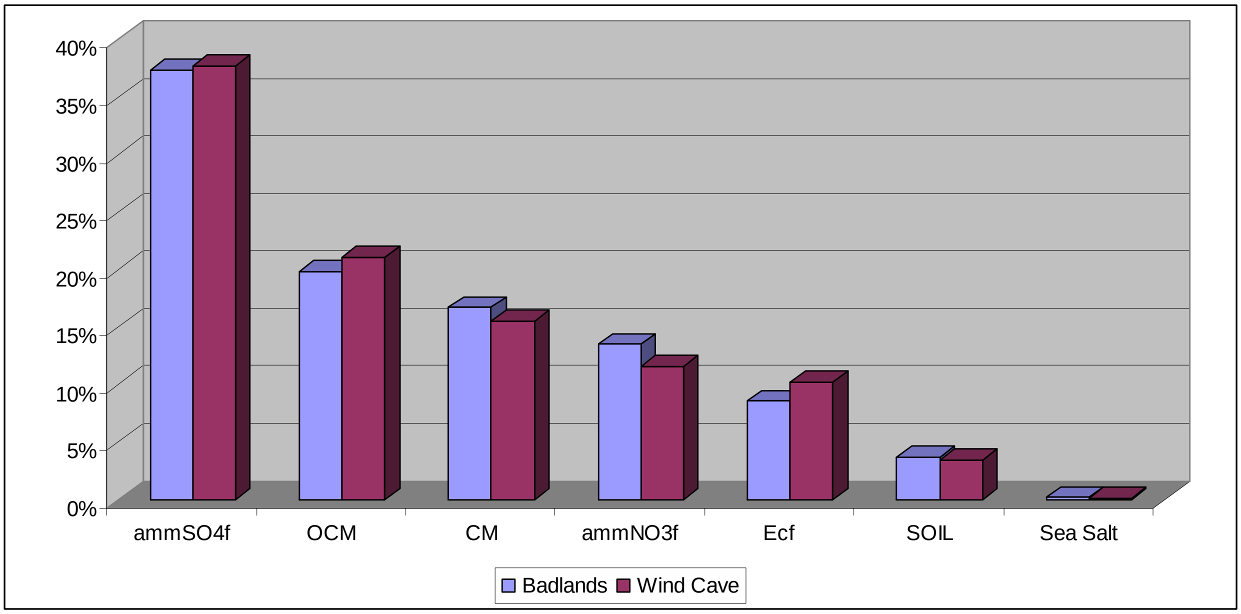
Local influences on the 20% least impaired days would tend to influence just the park it is next to and not the other. If local influences were impacting the 20% least impaired days, concentrations at both parks would not be that similar. However, the 5-year averaging may smooth this out.

Depending on the distance, concentrations from regional influence would be well mixed and uniform as it impacts South Dakota's two Class I areas. A uniform regional influence would tend to influence both national parks similarly.

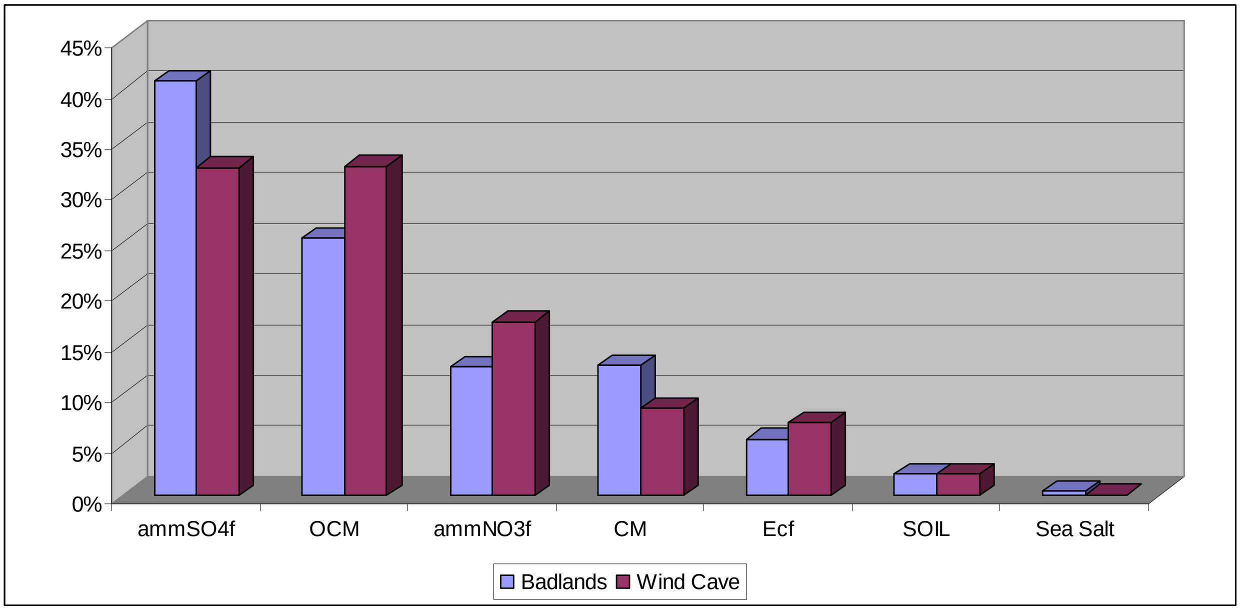
DENR will evaluate this in its long-term strategy to determine if there are any impacts from local sources hidden by the 5-year average and/or if regional influence is the main reason for the elevated concentrations on the 20% least impaired days.

Figure 4-3 – National Park Extinction Comparison [1]

a) National Park Comparison for 20% Least Impaired Days



b) National Park Comparison for 20% Most Impaired Days



[1] – "ammSO4f" = ammonia sulfate fine; "ammNO3f" = ammonia nitrate fine, "OMC" = organic mass carbon, "Ecf" = Elemental carbon fine, and "CM" = coarse mass.

For the 20% most impaired days, the comparison is not as similar. From Figure 4.3(b), ammonia sulfate is impacting visibility at the Badlands National Park at a greater degree than it is at the Wind Cave National Park. At the Wind Cave National Park, organic carbon mass and ammonia sulfate have the greatest impact and provide approximately the same percentage of visibility impairment. This indicates that fires contribute more to visibility impairment at Wind Cave

National Park then at Badlands National Park because of the higher organic carbon mass contribution.

Ammonia sulfates and organic carbon mass are generated from similar sources. Ammonia sulfates are derived from fossil fuel combustion and the combustion of organic mass such as forest fires and the burning of grass. Organic carbon mass is derived from biomass burning, automobile emissions, fossil fuel combustion, gas-to-particle conversion of hydrocarbons, etc. The contribution of ammonia sulfates and organic carbon mass from fossil fuel combustion from industrial sources and mobile sources should tend to be constant throughout the year. The contribution from the burning of organic mass or from heating should tend to occur at certain times of the year and be evident by quarter.

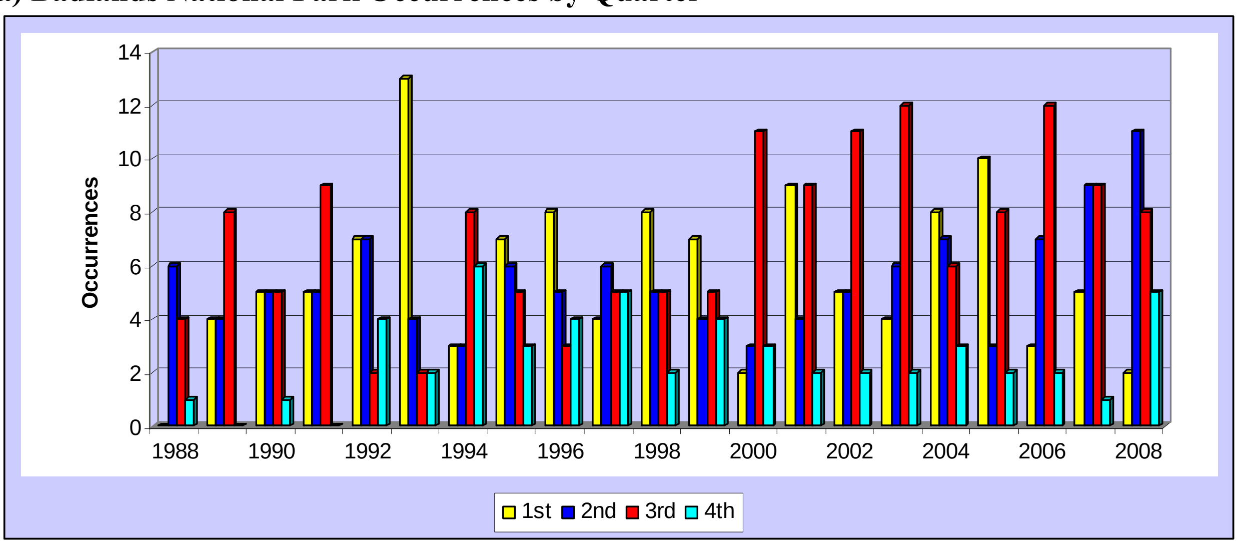
4.3 Visibility Impairment Quarterly Trends

Visibility impairment is impacted by the aerosol concentrations, type of aerosols, and time of year. DENR looked at various charts to determine if there were any trends based on the time of year for the 20% most impaired days. DENR reviewed the charts by quarter. For this review, the first quarter represents the winter months (January through March); the second quarter represents the spring months (April through June); the third quarter represents the summer months (July through September); and the fourth quarter represents the fall months (October through December).

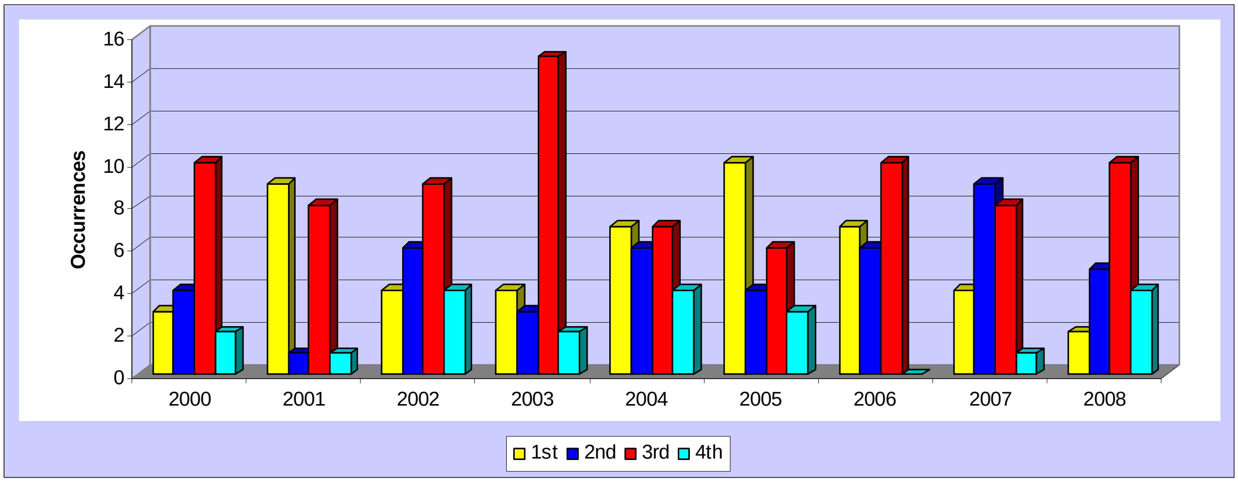
4.3.1 Number of Occurrences per Quarter

The first type of chart DENR looked at was the number of occurrences per quarter for the 20% most impaired days. Figure 4-4 provides the quarterly comparison for the Badlands National Park and Wind Cave National Park.

Figure 4-4 –Number of Occurrences by Quarter – 20% Most Impaired Days
a) Badlands National Park Occurrences by Quarter



b) Wind Cave National Park Occurrences by Quarter



Based on the Badlands National Park data, the 4th quarter (fall months) consistently appear to have the least number of visibility impairment occurrences during the 20% most impaired days, especially for the baseline period (2000-2004). The 4th quarter did experience an increase in 2008, which will need to be reviewed in the future to see if the increase continues. The occurrences in the remaining quarters increase and decrease with the 3rd quarter (summer months) having the most occurrences in the baseline period and in the last four years of data. One thing to note is the 2nd quarter (spring months) is showing an increase in occurrences in the last three years, which will also need to be reviewed if this trend continues.

The number of occurrences ranged from zero to 13 occurrences per quarter. The greatest number of occurrences peaked in the 1st quarter of 1993 at 13. From 2000 to 2008, the greatest number of occurrences occurs in the 3rd quarter ranging from six to 12 occurrences per year. The 2nd and 4th quarter saw a rise in 2008 with the 1st quarter showing a decline.

Overall, in the last few years the 2nd and 3rd quarter tend to have the most occurrences while the 1st and 4th quarter have the least number of occurrences. The number of occurrences in the 2nd quarter has increased to where they had the most occurrences in 2008, followed by the 3rd quarter, 4th quarter and 1st quarter.

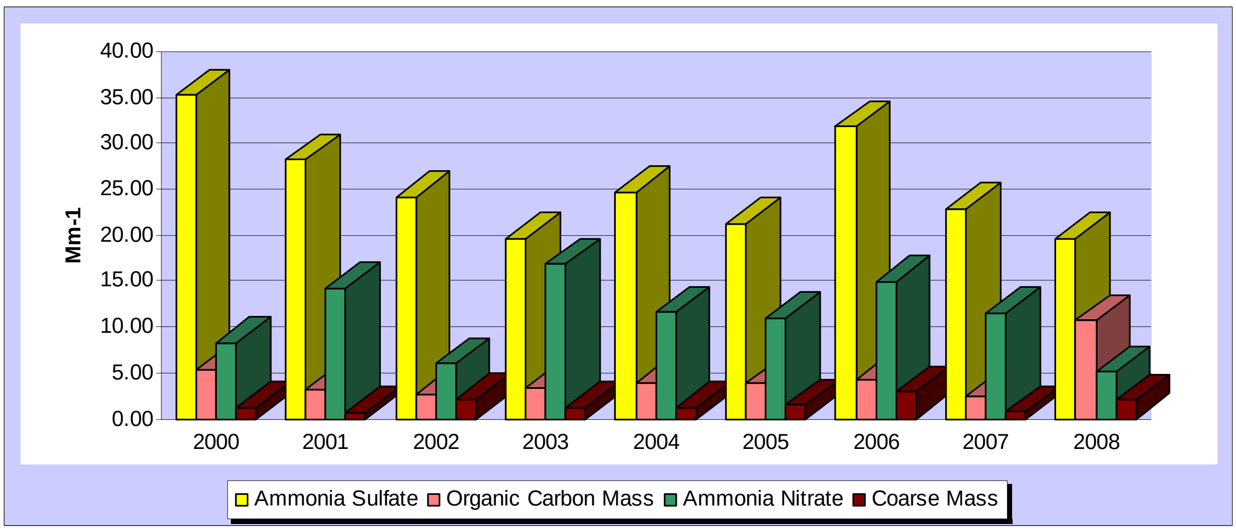
The number of occurrences in the Wind Cave National Park range from zero to 15 occurrences per quarter during the 20% most impaired days. The greatest number of occurrences occurred in the 3rd quarter during the baseline period (2000-2004) and peaked in 2003 at 15 occurrences. The 4th quarter consistently had the least number of occurrences in the baseline period and ranged from two to four occurrences per quarter. For the last four years, the greatest number of occurrences occurred in the 3rd quarter ranging from six to 10 occurrences per year. The 4th quarter appears to have the least amount of occurrences ranging from zero to four occurrences per year. However, in 2008 the number of occurrences in the 1st quarter dropped to where it has the least number of occurrences at two.

4.3.2 Extinction Trends by Quarter

DENR also charted the average extinction value for each quarter for ammonia sulfate, ammonia nitrate, organic carbon mass, and coarse mass during the 20% most impaired days for each national park since these four air pollutants comprise over 90% of the visibility impairment in each park. Figure 4-5 and 4-6 display the quarterly data from 2000, which is the start of the baseline period, to 2008 for the Badlands and Wind Cave National Parks, respectively. In some cases, there is no quarterly extinction value for a certain year, which means there were no days that contributed to the 20% most impaired days during that quarter.

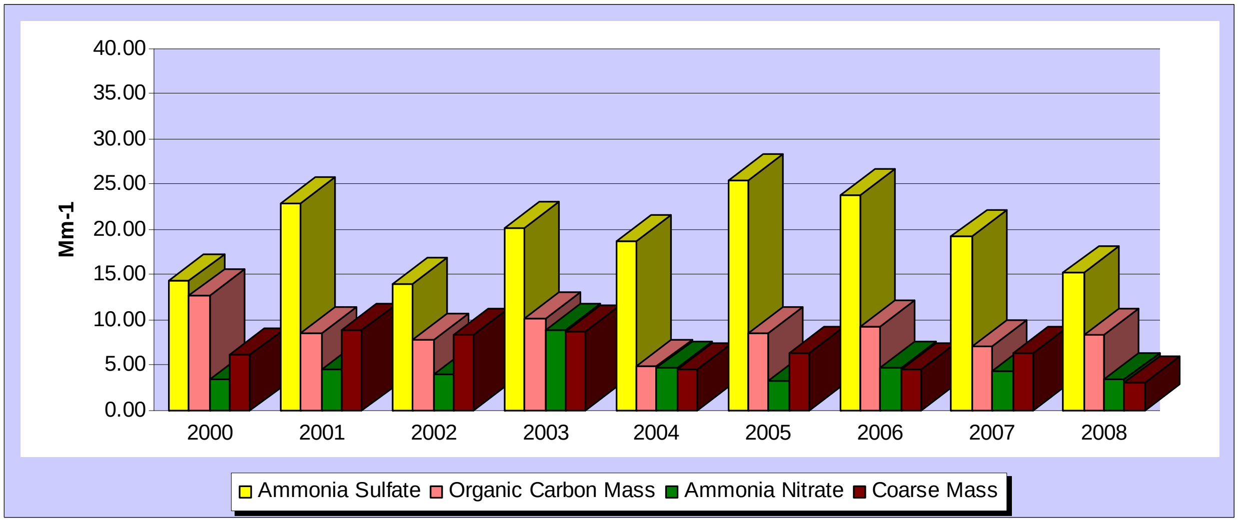
In the 1st quarter, ammonia sulfate followed by ammonia nitrate have the greatest impact on visibility impairment in the Badlands National Park. Organic carbon mass and coarse mass have minimal impact in the 1st quarter with an extinction value of approximately 5.0 inverse mega meters or less per pollutant. However, in 2008 organic carbon mass did increase from the normal trend to exceed ammonia nitrate in impacting visibility impairment but still had less impact then ammonia sulfate.

Figure 4-5 – Badlands' Quarterly Extinction Values for 20% Most Impaired Days
a) Badlands: 1st Quarter Average Extinction Comparison



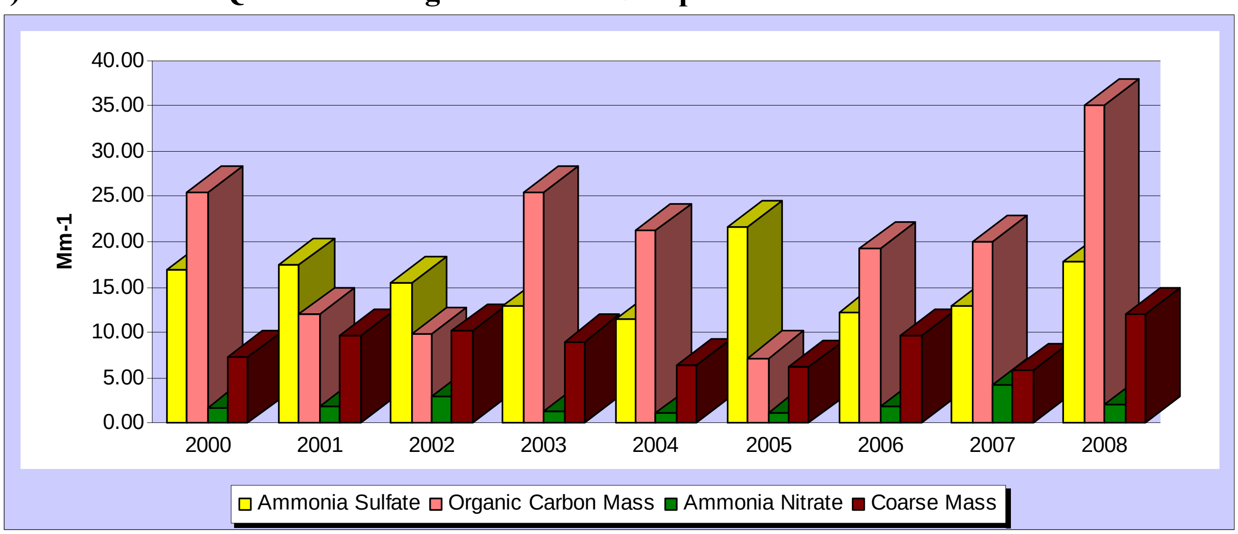
In the 2nd quarter, ammonia sulfate still has the greatest impact on visibility impairment in the Badlands National Park. The 2nd quarter differs from the 1st quarter with organic carbon mass tending to contribute more than ammonia nitrate. However, in some cases, organic carbon mass, ammonia nitrate, and coarse mass have approximately equal share in visibility impairment.

b) Badlands: 2nd Quarter Average Extinction Comparison

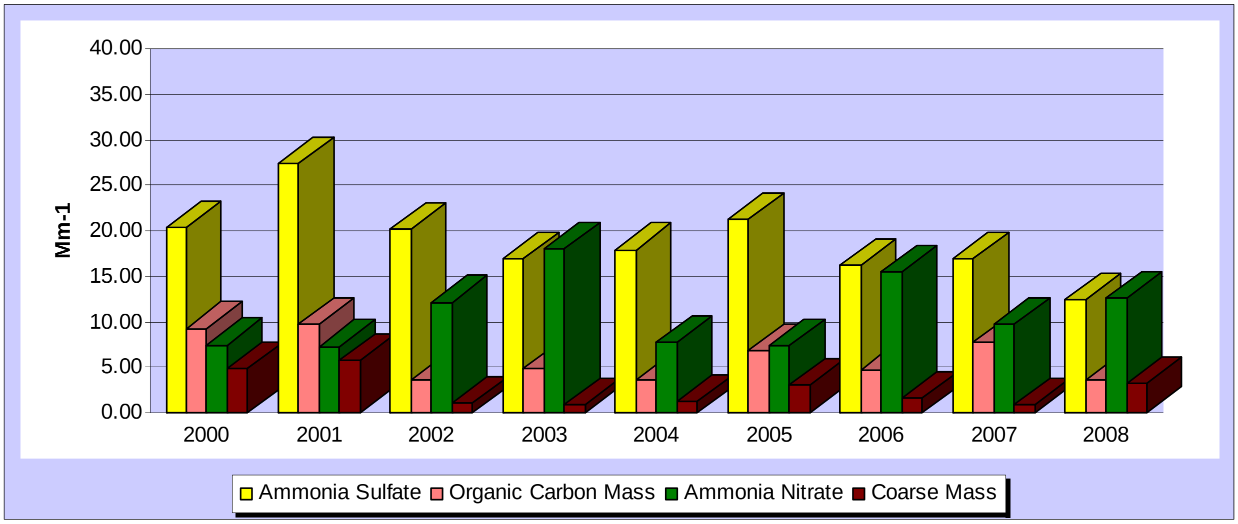


In the 3rd quarter, organic carbon mass tends to contribute the greatest impact on visibility impairment followed by ammonia sulfate. What is interesting is ammonia nitrate in the 3rd quarter consistently contributes the least to visibility impairment with coarse mass being consistently higher than ammonia nitrate. The 3rd quarter is typically the driest months in the Badlands National Park which would increase in coarse mass contributions from windblown dust and from traffic on paved and unpaved roads. In 2008, organic carbon mass increased dramatically due to a one day extinction value in the 3rd quarter of 192 inverse mega meters on July 2, 2008. Looking ahead to the 3rd quarter for the Wind Cave National Park (see Figure 4-6(d)), Wind Cave National Park experienced a high level of organic carbon mass on that same day.

c) Badlands: 3rd Quarter Average Extinction Comparison



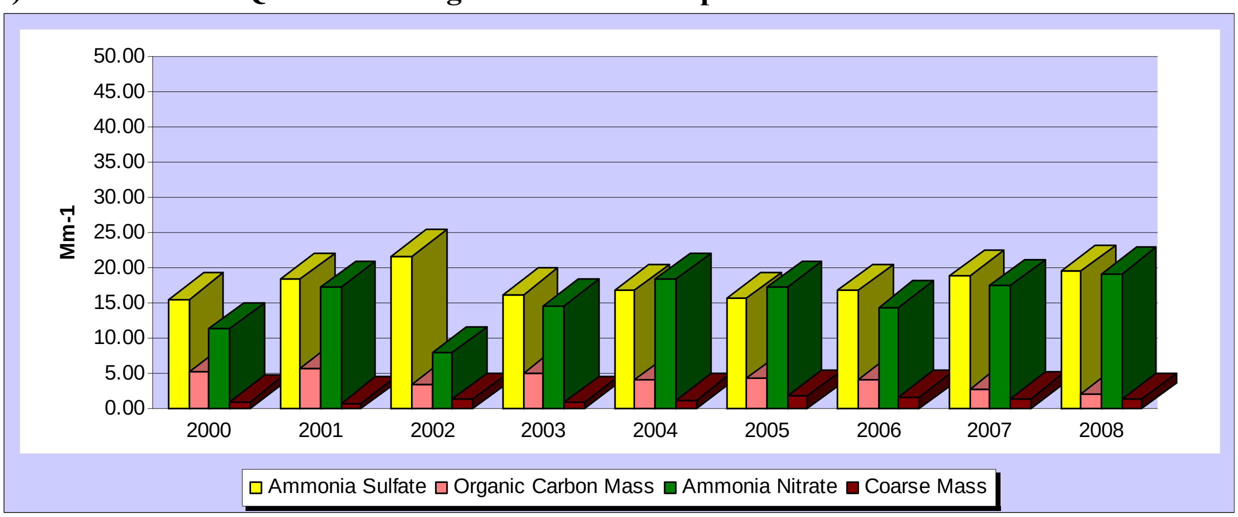
d) Badlands: 4th Quarter Average Extinction Comparison



In the 4th quarter, ammonia sulfate continues to contribute the greatest to visibility impairment in the Badlands National Park followed by ammonia nitrate. Organic carbon mass tends to be a significant contributor with extinction values greater than 5.0 inverse mega meters. Coarse mass extinction values were greater than 5.0 inverse mega meters in the early 2000 but have since dropped below that level and have minimal impacts on visibility in the 4th quarter.

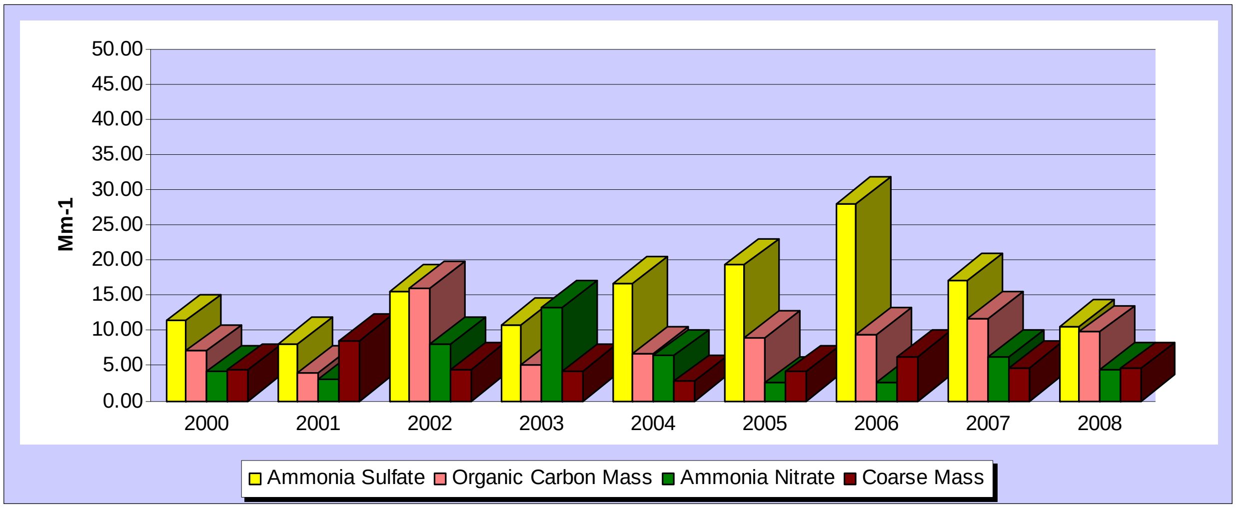
Figure 4-6 – Wind Cave's' Quarterly Extinction Values for 20% Most Impaired Days

a) Wind Cave: 1st Quarter Average Extinction Comparison



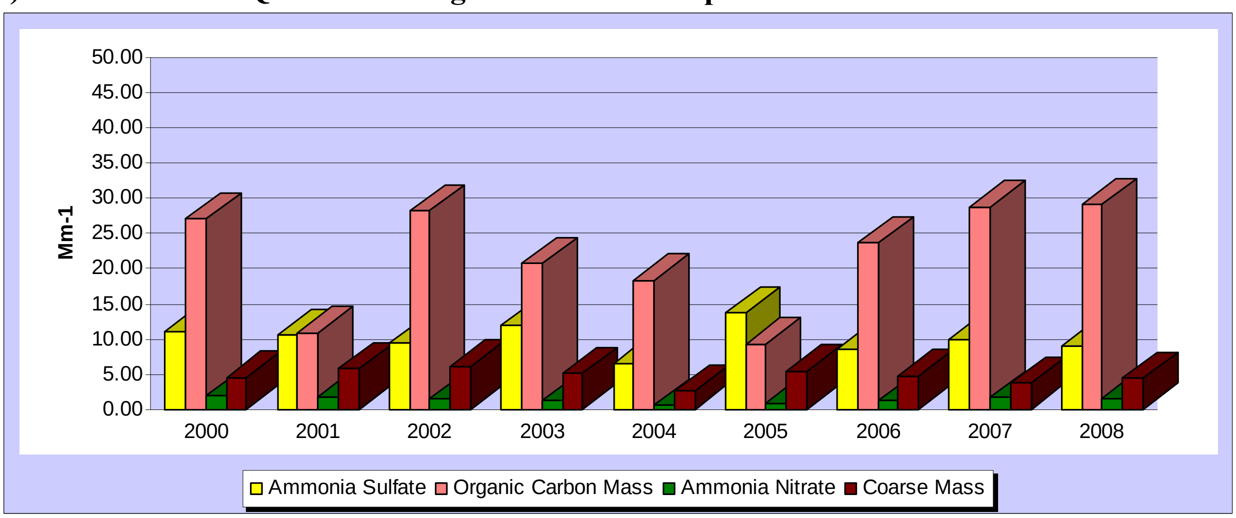
In the 1st quarter, ammonia sulfate and ammonia nitrate have the greatest impact on visibility impairment in the Wind Cave National Park. Organic carbon mass and coarse mass do not appear to have as much impact in the 1st quarter with extinction values of around 5.0 inverse mega meters or less.

b) Wind Cave: 2nd Quarter Average Extinction Comparison



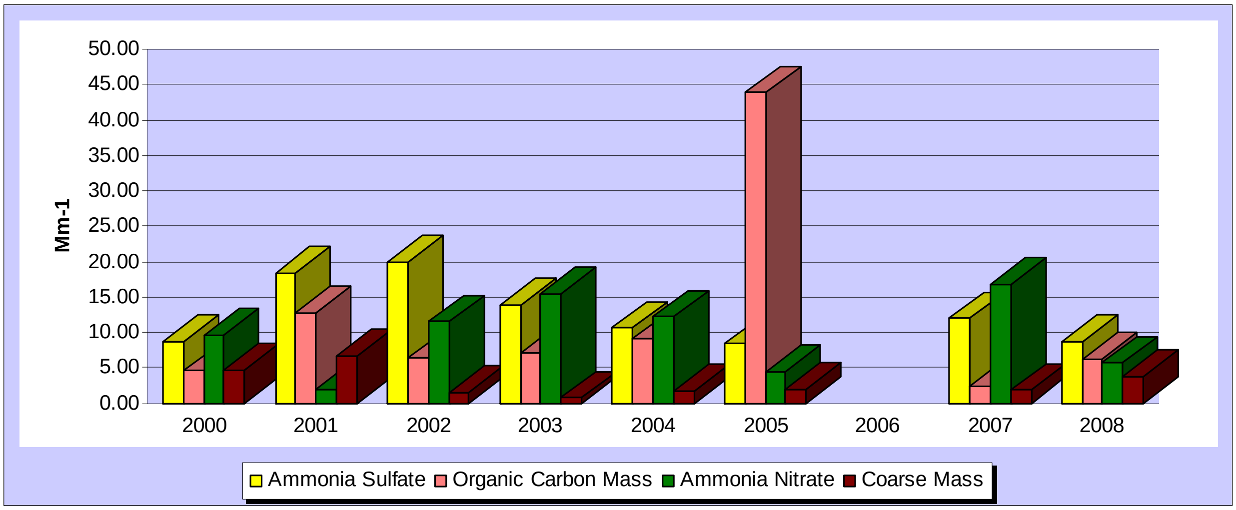
In the 2nd quarter, ammonia sulfate has the greatest impact on visibility impairment in the Wind Cave National Park in the last five years. Organic carbon mass increased during that period with ammonia nitrate and coarse mass having minimal impact.

c) Wind Cave: 3rd Quarter Average Extinction Comparison



In the 3rd quarter, organic carbon mass has the greatest impact on visibility impairment followed by ammonia sulfate. Coarse mass is next and consistently around 5.0 inverse mega meters. Ammonia nitrate tends to have minimal impact in the 3rd quarter. The high organic carbon mass average in 2008 was also due to a 179 inverse mega meter reading on July 2, 2008. This is the same date which resulted in a high reading at the Badlands National Park, which is indicative of regional transport. On June 28, 2008, smoke from Canada forest fires were observed in the Black Hills region and probably is the source of the organic carbon mass concentrations on July 2, 2008.

d) Wind Cave: 4th Quarter Average Extinction Comparison



In the 4th quarter, ammonia sulfates and ammonia nitrate continue to contribute the greatest with one exception in 2005. In 2005, organic carbon mass increased based on an October 25, 2005 extinction value of 109 inverse mega meters. In this case, the same high reading was not observed in the Badlands National Park, which means the higher level may be caused locally. After researching possible causes, it was discovered on October 25, 2005, a prescribed fire covering 1,215 acres was burned in the Wind Cave National Park which could be the contributor of the high organic carbon mass concentration.

This analysis indicates that ammonia sulfates and ammonia nitrate contributions are the greatest in the 1st and 4th quarter of each year at both national parks which is an indication the sources are being impacted by fuel combustion or even prescribed fires. Since it is occurring during the colder months, the sources of these emissions could also be caused by industrial and residential heating. Organic carbon mass tends to start contributing more in the 2nd quarter and is the greatest contributor in the 3rd quarter at both national parks. The driest months usually occur in the 3rd quarter, which is also when most wild fires typically occur.

Coarse mass contributions are the greatest during the 2nd and 3rd quarters. During these quarters, you would typically have greater coarse mass emissions from windblown dust, traffic on paved and unpaved roads, etc.

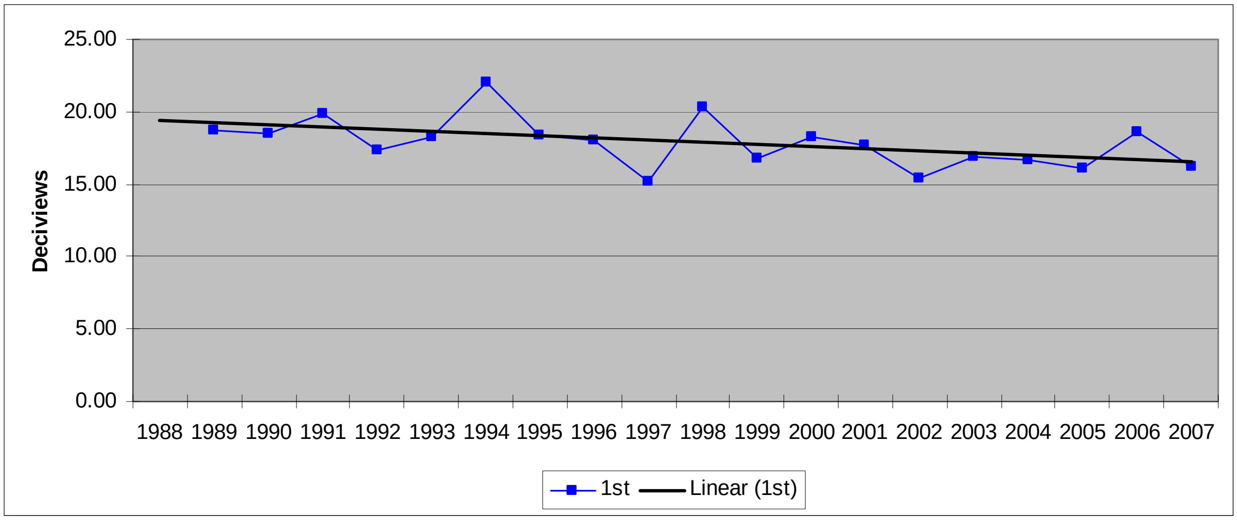
4.3.3 Visibility Impairment Trends

DENR charted the average visibility (deciviews) that occurred in each national park for each quarter during the 20% most impaired days. Figure 4-7 and 4-8 display the quarterly data for the Badlands and Wind Cave National Parks, respectively.

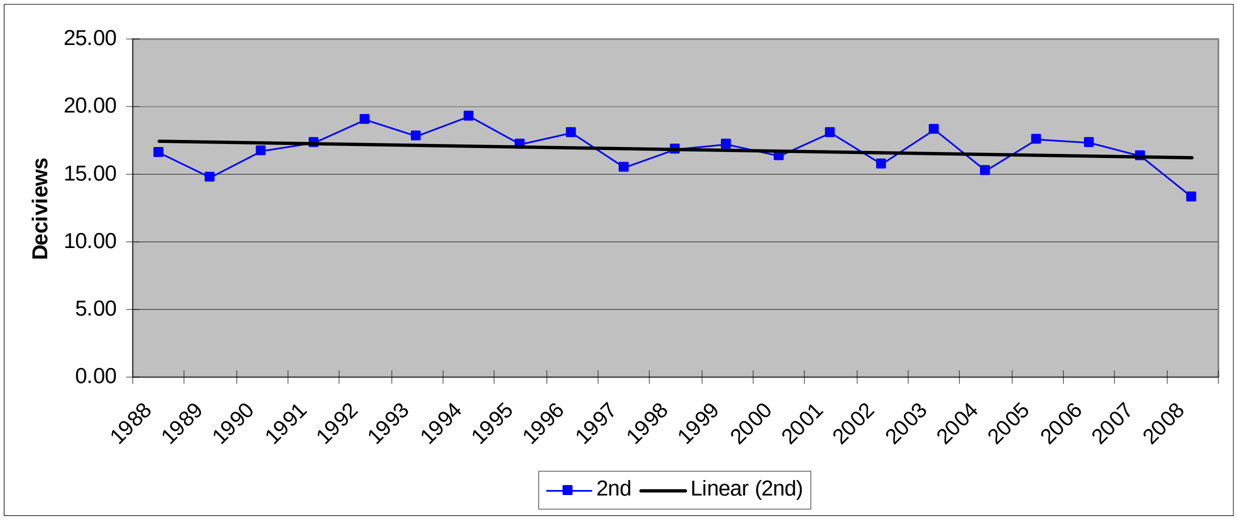
The average visibility impairment for the 20% most impaired days per quarter per year in the Badlands National Park, measured in deciviews, appears to be declining in every quarter except the 3rd quarter. In the 3rd quarter the slope appears to be flat. As seen in the quarterly extinction review, the aerosol with the greatest contribution in the 3rd quarter is organic carbon mass and may be the reason the deciview values in the 3rd quarter are flat.

Figure 4-7 – Badlands' Quarterly Data for 20% Most Impaired Days

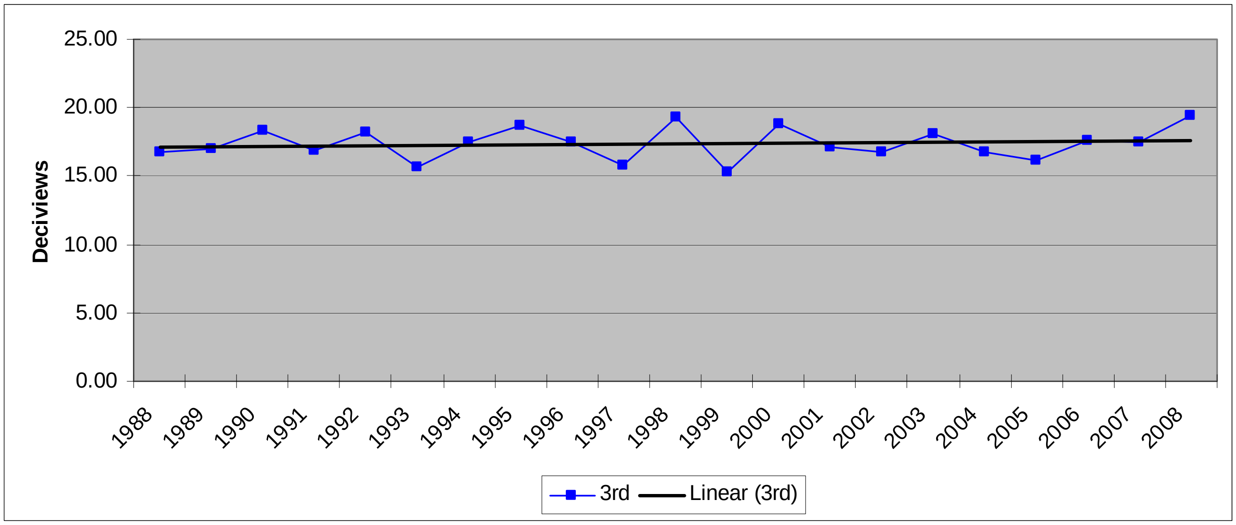
a) Badlands: 1st Quarter Visibility Impairment Trend



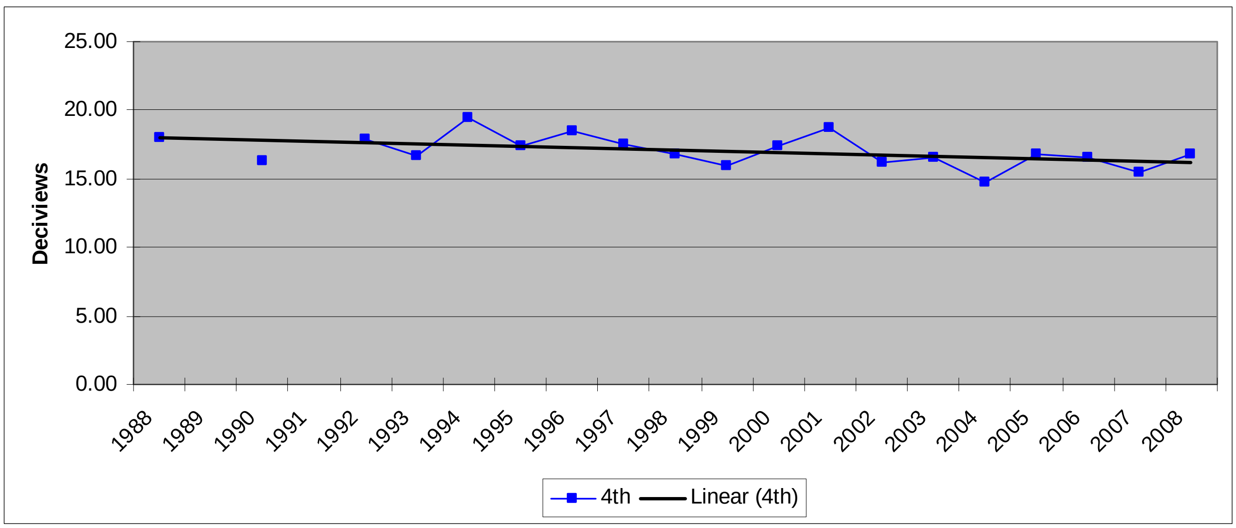
b) Badlands: 2nd Quarter Visibility Impairment Trend



c) Badlands: 3rd Quarter Visibility Impairment Trend



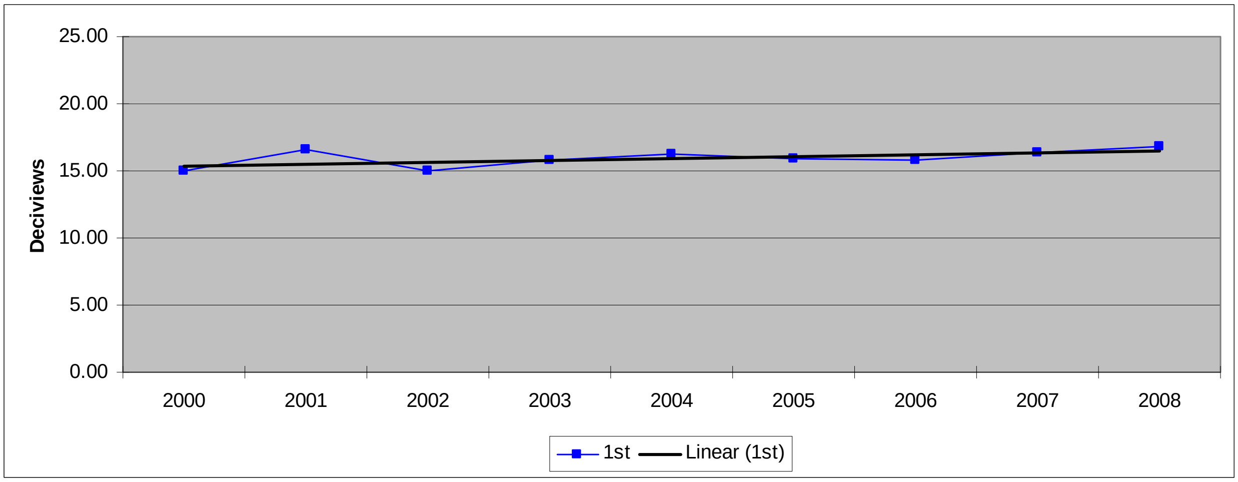
d) Badlands: 4th Quarter Visibility Impairment Trend



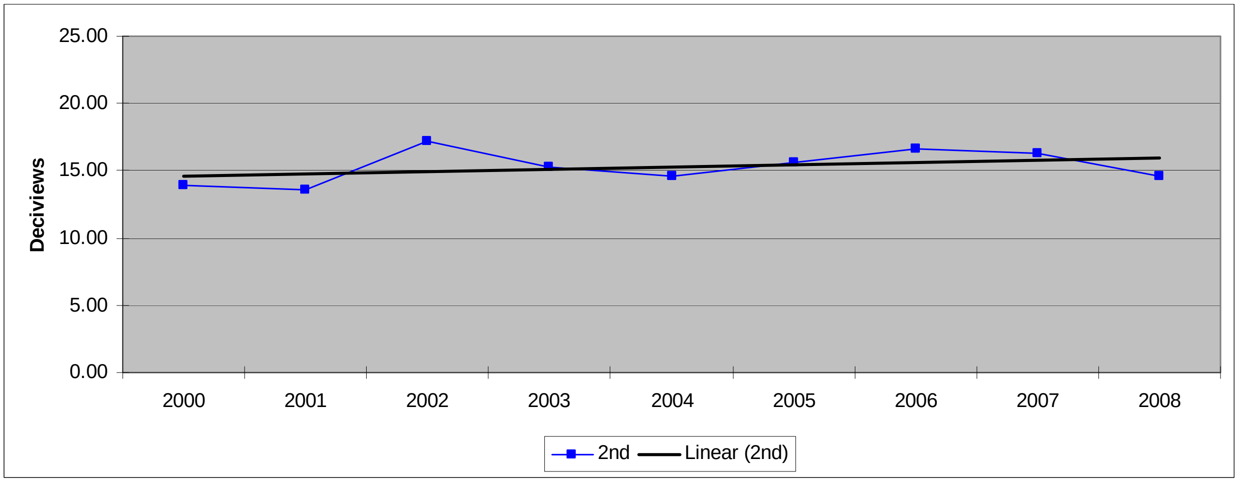
The average visibility impairment for the 20% most impaired days per quarter per year in the Wind Cave National Park, measured in deciviews, appear flat with a slight increase in the 1st and 2nd quarter. The slight increase in the 1st quarter appears to be the greatest. A review of the quarterly extinction data for the 1st quarter does not display an increase in any particular pollutant (see Figure 4.6(a)). There is some fluctuation in the ammonia sulfate and ammonia nitrate extinction values but that does not appear to be enough to result in such an increase in the slope. This will need to be reviewed in the future to see if the trend continues and what may be causing it.

Figure 4-8 – Wind Cave's Quarterly Data for 20% Most Impaired Days

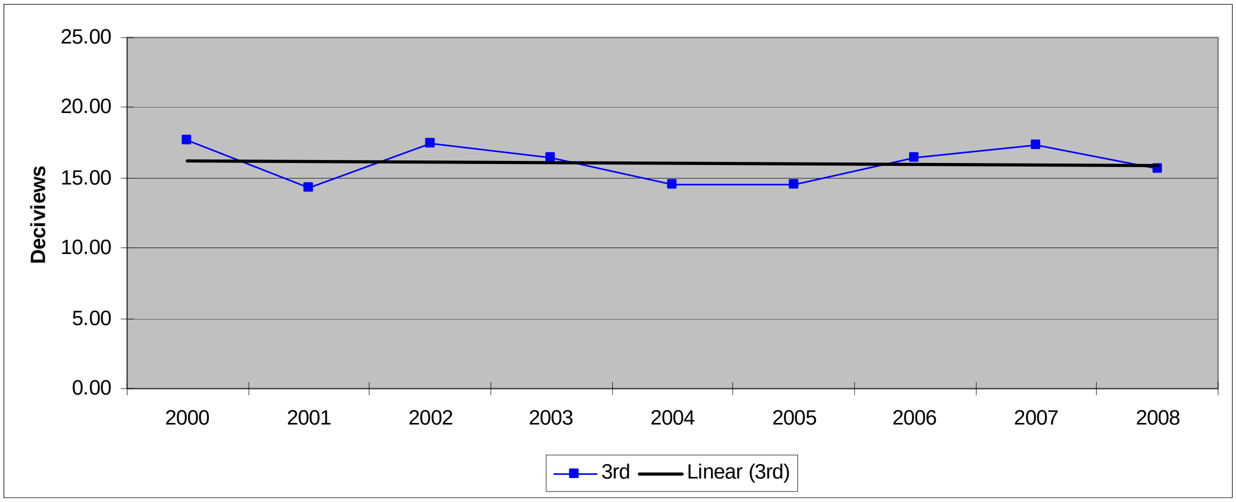
a) Wind Cave: 1st Quarter Visibility Impairment Trend



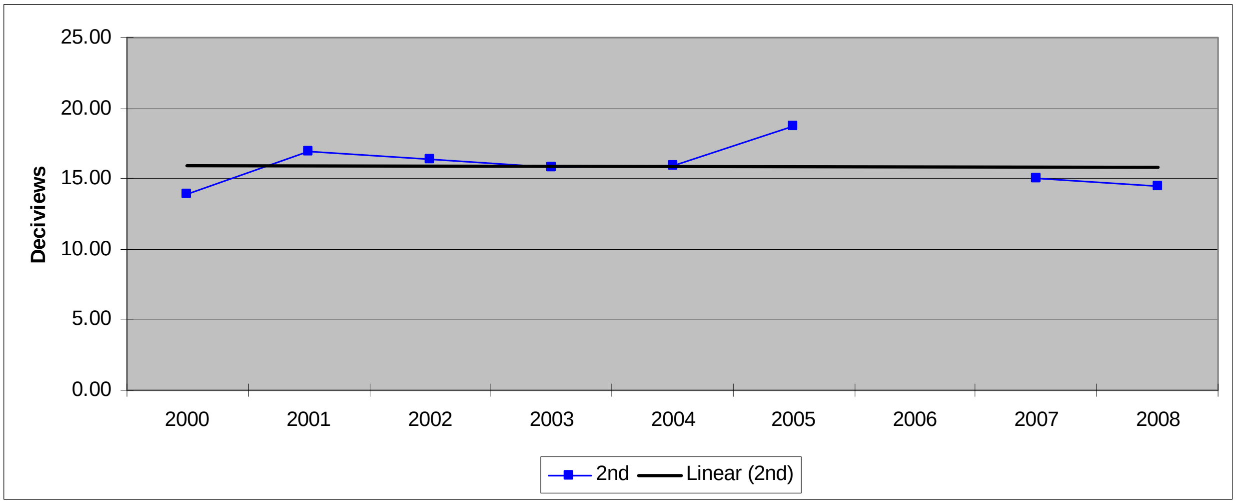
b) Wind Cave: 2nd Quarter Visibility Impairment Trend



c) Wind Cave: 3rd Quarter Visibility Impairment Trend



d) Wind Cave: 4th Quarter Visibility Impairment Trend



5.0 Source Apportionment

5.1 Air Emission Inventory

In accordance with 40 CFR § 51.308(d)(4)(v), a statewide inventory of emissions of pollutants that are reasonably anticipated to cause or contribute to visibility impairment in any Class I area shall be included as part of the state's monitoring strategy. The inventory must include emissions for a baseline year, emissions for the most recent year for which data is available, and estimates of future projected emissions.

DENR and WRAP based the emission inventory on EPA's "*Emissions Inventory Guidance for Implementation of Ozone and Particulate Matter National Ambient Air Quality Standards (NAAQS) and Regional Haze Regulations*." The guidance establishes the baseline year as 2002. WRAP projected an emission inventory for 2018. The most current air emission inventory for South Dakota is 2009; but only contains air emissions from Title V air quality permitted sources.

The guidance specified what pollutants should be inventoried, which are reasonably anticipated to cause or contribute to visibility impairment in a mandatory Class I area. The air pollutants of concern are primary particulate matter (PM), sulfur dioxide (SO_2), nitrogen oxides (NO_x), volatile organic compounds (VOCs), and ammonia (NH_3). Particulate matter will be further separated into primary particulate matter coarse and fine. Primary particulate matter coarse is particulate matter 10 microns in diameter or less (PM10) minus primary particulate matter fine, which is particulate matter 2.5 microns in diameter or less (PM2.5). Where available, DENR will include primary organic aerosol (organic carbon) and elemental carbon (EC). The definition of VOC is defined in the Administrative Rules of South Dakota, Section 74:36:01:01(77), which is derived from 40 CFR § 51.100.

The pollutants that are reasonably anticipated to cause or contribute to visibility impairment are emitted by natural and anthropogenic sources. The goal of the regional haze program is to minimize the impacts from anthropogenic sources and bring our Class I areas into their natural condition. Determining natural condition is difficult since anthropogenic activity has influenced our Class I areas for many years. This influence includes mobile sources, electric generation, prescribed burning, manufacturing activities, farming, preventing and fighting fires, and many other activities that result in the air emissions of the above pollutants.

In support of WRAP's regional haze air quality modeling efforts, the Regional Modeling Center developed annual emissions inventories for a 2002 actual emissions base case, a planning case to represent the 2000-04 regional haze baseline period using averages for key emissions categories, and a 2018 base case of projected emissions determined using factors known at the end of 2005. All emission inventories developed by WRAP used the Sparse Matrix Operator Kernel Emissions (SMOKE) modeling system. Each of these inventories has undergone a number of revisions throughout the development process to arrive at the final versions used in Community Multi-Scale Air Quality (CMAQ) and CAMx air quality modeling. The WRAP emission inventories developed by the Regional Modeling Center include:

1. The 2002 base case emissions scenario, referred to as "2002 Base Case" or "Base02". The purpose of the Base02 inventory is to represent the actual conditions in calendar year 2002 with respect to ambient air quality and the associated sources of criteria and particulate matter air pollutants. The Base02 emissions inventories are used to validate the air quality model and associated databases and to demonstrate acceptable model performance with respect to replicating observed particulate matter air quality.
2. The 2000-04 baseline period planning case emissions scenario is referred to as "Plan02". The purpose of the Plan02 inventory is to represent baseline emission patterns based on average, or "typical", conditions. This inventory provides a basis for comparison with the 2018 projected emissions as well as to gauge reasonable progress with respect to future year visibility.
3. The 2018 base case emissions scenario is referred to as "2018 Base Case" or "Base18". These emissions are used to represent conditions in 2018 with respect to sources of criteria and particulate matter air pollutants taking into consideration growth and controls. Modeling results based on this emission inventory are used to define the future year ambient air quality and visibility metrics.

5.1.1 Baseline Emission Inventory

WRAP developed a baseline emission inventory for point, all fires (anthropogenic and wild), biogenic sources, area, oil and gas, on-road mobile, off-road mobile, road dust, fugitive dust, and windblown dust sources for calendar year 2002. The emission inventories includes sulfur dioxide, sulfur dioxide and particulate, nitrogen oxide, nitrogen oxide and particulate, primary organic aerosol, elemental carbon, particulate matter 2.5 microns in diameter or less (fine), particulate matter 10 microns in diameter or less but greater than particulate matter 2.5 microns in diameter (coarse), ammonia, volatile organic compounds, and carbon monoxide. Information on how these inventories were developed and quality assurance measures may be reviewed at the following website:

http://vista.cira.colostate.edu/tss/results/Emissions.aspx

There were two versions of the baseline emission inventory conducted by WRAP. The two baseline versions were identified as “base 02a and 02b”. Version “a” of the 2002 base case inventory was developed based on preliminary 2002 modeling (Tonnesen et al., 2005). Improved 2002 emissions data for the United States, Mexico, and Canada were used to create a final base 2002 annual emissions database for use in the CMAQ and CAMx model performance evaluations. Sources for emissions inventory and ancillary modeling data included WRAP emissions inventory contractors, other regional planning organizations, and EPA. Building from the WRAP preliminary 2002 modeling cases completed earlier, several updates to the inventories and ancillary data were incorporated to create final 2002 emissions input files for the 2002 base case A, or Base02a. The purpose of the “base 02” scenario is to represent the actual conditions in calendar year 2002 with respect to ambient air quality and the associated sources of visibility-impairing air pollutants. The second versions, base 02b, represents updates to the first version and is summarized in Table 5-1 for each of the emission sources.

The 2000 through 2004 baseline period planning case emissions scenario is referred to as “plan 02”. As with the “base 02” inventories, “plan 02” underwent a number of revisions and enhancements to arrive at the final versions used in visibility and source apportionment modeling. The “plan 02”series of inventories was developed to represent baseline period emissions patterns based on average, or “typical” conditions. The “plan 02”inventory was developed from the “base 02”emissions modeling scenarios by incorporating:

1. Replacement of actual 2002 fire emissions inventories with the baseline typical fire emissions inventories;
2. Replacement of the temporal profiles for large stationary point sources with profiles developed from an average of several years surrounding 2002; and
3. Corrections to the off-road mobile, on-road mobile, offshore Pacific shipping lane and WRAP oil and gas inventories.

The “plan 02d” emission inventory was based on the minor changes to the “plan 02c”emission inventory. The revisions included:

1. Updating the current status of point sources related to the BART requirements under the regional haze rule; and
2. Correcting erroneous or missing Standard Industrial Classification and/or source classification codes (SCC).

Table 5-2 provides a summary of the 2002 South Dakota baseline planning emission inventory (plan 02d) for each of the emission sources. The base 02b and the plan 02d emissions data are similar except for the sulfur dioxide and nitrogen oxide emissions from area sources. Based on a Technical Memorandum from Paula Fields and Marty Wolf with ERG to WRAP Forums and Workgroups dated January 10, 2008, the South Dakota area source emissions from distillate fuel combustions was revised using data received during the PRP18 project. The end result was a reduction of just over 9,000 tons of sulfur dioxide and 3,000 tons of nitrogen oxide emissions. The January 10, 2008, memorandum may be viewed at:

Table 5-1 – South Dakota's 2002 Baseline Emission Inventory Summary (Base 02b) [1, 2]

Source	SO_2	SO_2 [3]	NOx	NOx [3]	POA	EC	Particulate Matter		Ammonia	VOCs	CO
							Fine	Coarse			
Point	14,022	14,059	20,697	20,698	46	2	160	727	100	2,542	4,700
All Fires	278	318	1,371	1,388	3,172	409	1,338	544	494	3,135	49,109
Biogenic Sources	0	0	52,852	52,852	0	0	0	0	0	445,241	103,402
Area	10,159	10,387	5,978	5,987	1,887	317	2,129	2,177	118,920	42,372	24,239
Oil/Gas [4]	8	8	367	367	0	0	0	0	0	**33,721**	10
On-Road Mobile	872	922	29,224	29,224	472	632	180	169	842	13,741	221,726
Off-Road Mobile	5,733	6,066	39,039	39,039	942	3,234	0	0	25	12,764	92,508
Road Dust	0	4	0	5	255	18	4,061	38,164	0	0	0
Fugitive Dust	0	9	0	26	1,277	87	25,035	93,734	0	0	0
Wind Blown Dust	0	0	0	0	0	0	50,274	452,470	0	0	0
Total	**31,072**	**31,773**	**149,528**	**149,586**	**8,051**	**4,699**	**83,177**	**587,985**	**120,381**	**553,516**	**495,694**

[1] – Derived from WRAP's website at http://vista.cira.colostate.edu/TSS/Results/HazePlanning.aspx. To get to the data, the individual needs to click on "Emissions and Source Apportionment", and click on "Emission Review Tool";

[2] – "SO_2" means sulfur dioxide, "NOx" means nitrogen oxide, "POA" means primary organic aerosol, "EC" means elemental carbon, "VOCs" means volatile organic compounds, and "CO" means carbon monoxide;

[3] – The emission total for sulfur dioxides and nitrogen oxides includes gas and particulate; and

[4] – VOC emissions from secondary oil and gas production were estimated based on an analysis of the gas and gas flow rates.

Table 5-2 –South Dakota's 2002 Planning Emission Inventory Summary (Plan 02d) [1, 2]

Source	SO_2	SO_2 [3]	NOx	NOx [3]	POA	EC	Particulate Matter Fine	Particulate Matter Coarse	Ammonia	VOCs	CO
Point	14,024	14,037	20,698	20,699	10	0	216	727	100	2,542	4,700
Big Stone I [4]	11,171		14,552				209	209	29	107	490
All Fires	367	469	1,698	1,713	4,574	717	839	754	562	3,853	64,326
Biogenic Sources	0	0	52,852	52,852	0	0	0	0	0	445,241	103,402
Area	1,071	1,198	2,897	2,903	1,792	306	1,804	156	118,877	40,511	23,029
Oil/Gas [5]	6	6	361	361	0	0	0	0	0	**33,721**	11
On-Road Mobile	872	922	29,224	29,224	278	339	0	169	842	13,741	221,726
Off-Road Mobile	5,733	6,066	39,039	39,039	942	3,234	0	0	25	12,764	92,508
Road Dust	0	4	0	5	255	18	4,061	38,164	0	0	0
Fugitive Dust	0	24	0	27	1,317	89	25,220	122,914	0	0	0
Wind Blown Dust	0	0	0	0	0	0	50,274	452,470	0	0	0
Total	**22,073**	**22,726**	**146,769**	**146,823**	**9,168**	**4,703**	**82,414**	**615,354**	**120,406**	**552,373**	**509,702**

[1] – Derived from WRAP's website at http://vista.cira.colostate.edu/TSS/Results/HazePlanning.aspx. To get to the data, the individual needs to click on "Emissions and Source Apportionment", and click on "Emission Review Tool";

[2] – "SO_2" means sulfur dioxide, "NOx" means nitrogen oxide, "POA" means primary organic aerosol, "EC" means elemental carbon, "VOCs" means volatile organic compounds, and "CO" means carbon monoxide;

[3] – The emission total for sulfur dioxides and nitrogen oxides includes gas and particulate;

[4] – Otter Tail Power Company's Big Stone I emissions are included in the "Point" emissions row but separated here for comparison to Table 5-4, 6-1 and 6-3; and

[5] – VOC emissions from secondary oil and gas production were estimated based on an analysis of the gas and gas flow rates.

http://www.wrapair.org/forums/ssjf/documents/Pivot_Tables/2008-01_Plan02d_Tech_Memo%281-10%29.pdf

DENR revised the data for South Dakota for both the baseline and planning emission inventories to include oil and gas area source emissions. Through a compliance initiative in EPA's Region VIII, it was determined that secondary oil and gas production in northwestern South Dakota was generating volatile organic compound emissions from storage tanks that needed to be addressed.

The oil companies quantified the volatile organic compound emissions which resulted in air emissions of 33,433 tons. DENR added the volatile organic compound emissions from a secondary oil recovery field to the 2002 baseline and planning emission inventory calculated by WRAP to account for the area volatile organic compound emissions from the oil and gas fields.

The 33,433 tons of volatile organic compound emissions in Table 5-1 and 5-2 were not included in the modeling conducted by WRAP. However, the increase in criteria air pollutants (e.g., particulate matter, nitrogen oxide, and carbon monoxide) from the reduction in volatile organic compound emissions were used in the modeling for 2018 projections and reasonable progress purposes.

5.1.2 Current Emission Inventory

A complete air emission inventory is not available for the most recent year. DENR does calculate an annual air emission inventory for point sources that are required to pay fees under the Title V air quality permit program. The most current year is 2009. The point source data for 2009 is displayed in Table 5-3 and compared to the same data collected in WRAP's 2002 baseline emission inventory to compare air emission trends from point sources.

Table 5-3 – Comparison of 2002 and 2009 South Dakota Point Source Emissions [1]

Year	PM10 [2]	SO_2	NOx	VOCs	CO
2002 WRAP	887	14,022	20,697	2,542	4,700
2009 DENR	1,125	13,321	15,611	3,694	2,907
Difference	**238**	**-701**	**-5,086**	**1,152**	**-1,793**

[1] – "PM10" means particulate matter less than or equal to 10 microns in diameter or less, "SO2" means sulfur dioxide, "NOx" means nitrogen oxide, "VOCs" means volatile organic compounds, and "CO" means carbon monoxide; and

[2] - The PM10 emissions are based on coarse and fine particulate matter.

The comparison shows that air emissions increased from 2002 to 2009 for all pollutants except sulfur dioxide, nitrogen oxide and carbon monoxide.

5.1.3 WRAP's 2018 Projections

WRAP projected an air emissions inventory for 2018 (PRP18a) for the same source types and pollutants as the base year. The projection methodology included the following steps:

1. Adjustments: Emission increases for new facilities that have come on-line since 2002, deletion of emissions for facilities that retired in 2003 or 2004 and will not return to operation in the future; and other adjustments (e.g., ratios to correct certain PM10 and PM2.5 emission factors/Standard Classification Codes for combustion of natural gas);
2. Control Factors: Emission reductions due to known (e.g., on-the-books) controls, consent decrees reductions, State Implementation Plan control measures, and other relevant regulations that have gone into effect since 2002, or will go into effect before the end of 2018. These controls do not include impacts from any future control scenarios that have yet to be determined;
3. Growth Factors: Standard Classification Code specific growth factors developed from the Economic Growth and Analysis System projection factor model; special analysis of electric generating unit growth relative to unit capacity threshold;
4. Retirement & Replacement Rates: Effects of retirement estimates using annual retirement rates based on expected equipment lifetimes. Retired equipment replaced by lower-emitting new equipment. Unit lifetime examined for natural gas-fired electric generating units. No retirements assumed for coal-fired electric generating units;
5. Permit Limits: Used in the cases where the projected emissions may have inadvertently exceeded an enforceable emission limit (e.g., emissions were adjusted downward to the permit limit, as applicable); and
6. Section 309 Flags: Point sources in the Grand Canyon Visibility Transport States (e.g., AZ, CA, CO, ID, NV, NM, OR, UT, and WY) whose 2002 facility-level sulfur dioxide emissions are at least 100 tons per year.)

Just like the baseline inventory, WRAP improved on the projections and produced a second version. The objective of the “PRP 18b” version was to make a second revision to the 2018 emissions inventory projections for point and area sources in the WRAP region to provide a more current assessment of the reasonable progress toward visibility goals by the WRAP. The focus of this project was to address specific changes that have occurred since completion of the “PRP 18a” inventory in 2007. The resulting product is the second version of the WRAP region Preliminary Reasonable Progress emissions inventory for 2018, known as “PRP 18b”.

The “PRP 18b” inventory revisions included the following elements:

1. Included all updated BART information available such as incorporating all available formal BART determinations; incorporating estimates of expected BART control levels where BART determinations had not been finalized (BART estimates made for both sulfur dioxide and nitrogen oxide); and addressing all “BART-eligible” or “Subject to BART” sources, both for electric generating units and for the non-electric generating unit universe;
2. Revised projections of “future” fossil-fuel plants needed to meet federal electrical generation demand forecasts in 2018 (e.g., used updated Energy Information Administration of the federal Department of Energy projections of 2018 energy requirements – for the first time incorporated Renewable Energy Portfolios where available – determined that existing WRAP region electric generating capacity, when added to existing State and Local agency electric generating unit permits, was sufficient to meet 2018 demand without addition of any new future electric generating units);

3. Incorporated all new rulemaking, permit limits, and consent decrees instituted since 2007; and
4. Corrected other outstanding issues that were identified by the federal, state, or local agencies within the WRAP domain as needing to be revised/updated such as modification of various inventory data to be consistent with the Plan 02d emissions inventory (e.g., name changes, updated stack parameters, new or removed sources); revision of a limited number of area source categories (e.g., fuel combustion emissions in South Dakota and California, gasoline distribution emissions in Idaho, residential wood combustion emissions in Washington, construction dust in Clark County, Nevada); revision of facility information (e.g., facility identifications, facility names, unit identifications, process identifications, Standard Classification Codes, Standard Industrial Classifications) based upon agency input; revision of stack parameters based upon agency input; and addition of WRAP Phase II oil and gas project emissions to "PRP 18a" area source emission summaries in order to provide relevant comparisons to the emission totals in "PRP 18b" which also contained oil and gas emission totals.

The 2018 projected air emissions for South Dakota included three large facilities that are currently permitted but not constructed or have submitted an application to construct. The first facility is Big Stone II, which was a proposed 600 megawatt coal-fired power plant located next to an existing coal-fired power plant (Big Stone I) in the northeast corner of the state. A Prevention of Significant Deterioration air quality permit was issued to Big Stone II on November 20, 2008. The increase in air emissions from this facility would be limited to particulate matter, volatile organic compounds, and possibly ammonia. There would be no increase of air emissions for sulfur dioxide and nitrogen oxide because of decreases in air emissions from the Big Stone I facility. The air emission increases from this facility are included in the 2018 projections and are shown in Table 5-4. However, on December 1, 2009, Otter Tail Power Company submitted a letter notifying DENR the Big Stone II facility will not be built and it relinquished all rights and obligations granted through and by the Prevention of Significant Deterioration permit. Therefore, the 2018 emission inventory will need to be updated.

The other facility that was issued a Prevention of Significant Deterioration air quality permit was the Hyperion Energy Center that received a permit on August 20, 2009. The Hyperion Energy Center will be located in Union County which is located in the southeastern corner of the state and is a 400,000 barrel per day oil refinery and integrated gasification combine cycle power plant. The air emission increases from this facility are included in the 2018 projections and are shown in Table 5-4.

The third facility involves Basin Electric Power Cooperative's NextGen application for another coal-fired power plant with a maximum capacity of 700 megawatts located in the north central area of the state. The application is currently on hold; but the air emission increases from this facility are included in the 2018 projections and are shown in Table 5-4.

DENR has also received a Prevention of Significant Deterioration permit application for a 300 megawatt natural gas fired combined cycle power generating facility in Brookings County, which is on eastern edge of South Dakota boarding Minnesota. The air emission increases from this facility will be included in the next 2018 projections and modeling analysis.

Table 5-4 displays the 2018 projected air emissions for South Dakota using the "PRP 18b" inventory. The specific contribution from each project are displayed in Table 5-4 and derived from WRAP website at the following location:

http://www.wrapair.org/forums/ssjf/pivot.html

To review, click on the 2018 PRP 18b zip file to review the pivot tables that when clicked on will display each facilities contribution.

As discussed for the baseline, through a compliance initiative in EPA's Region VIII, it was determined that secondary oil and gas production in northwestern South Dakota was generating volatile organic compound emissions from storage tanks that needed to be addressed. The installation of four thermal oxidizers in the northwestern portion of South Dakota resulted from the compliance initiative. Each of the thermal oxidizers are permitted under South Dakota's minor air quality permit program and requires the thermal oxidizers to maintain a volatile organic compound destruction efficiency of 98.6% or greater. The installation of four thermal oxidizers did increase the emission of fine particulate matter, nitrogen oxide, and carbon monoxide. South Dakota's minor air quality permit program is included in its State Implementation Plan.

DENR added volatile organic compound emissions to Table 5-4 to account for the volatile organic compounds that are not destroyed by the thermal oxidizers. The fine particulate matter, nitrogen oxide and carbon monoxide emissions from the thermal oxidizers are included as area sources in WRAP's projected air emissions in the "PRP 18b" inventory.

5.1.4 Air Emission Inventories for Other States and Countries

The visibility in the Class I areas in South Dakota is influenced not only by air emissions from within South Dakota but from surrounding states, Canada, and sources outside WRAP's modeling domain. The six contiguous states are North Dakota, Minnesota, Iowa, Nebraska, Wyoming and Montana. The 2002 plan year emissions (Plan 02d) and 2018 projected emissions (PRP 18b) from the respective states are shown in Table 5-6 and 5-7, respectively.

For the base year, South Dakota's emissions when combined with the neighboring states' emissions represent only three to 17 percent of the total emissions for each type of pollutant. For 2018, South Dakota's emissions are similar at two to 18 percent of the total emissions for each type of pollutant. The small percentage for each type of pollutant is a good indication that South Dakota's Class I areas are being influenced by emissions from sources beyond South Dakota's borders. Based on WRAP's attribution analysis, which will be discussed further, South Dakota's Class I areas are also impacted by states beyond the contiguous states and other countries such as Canada. Emission inventory data for the states beyond the contiguous states and other countries are available on WRAP's website but were not included in this document.

Table 5-4 –2018 South Dakota Projected Emission Inventory Summary (PRP 18b) [1, 2]

							Particulate Matter				
Source	**SO_2**	**SO_2** [3]	**NOx**	**NOx** [4]	**POA**	**EC**	**Fine**	**Coarse**	**Ammonia**	**VOCs**	**CO**
Point	11,986	11,996	30,185	30,186	8	0	205	9,847	102	4,510	16,632
Big Stone I	3,425		15,323					318		112	509
Big Stone II	3,942		2,891					6,758		96	3,947
Hyperion	627		455					1,041		438	954
NextGen	1,534		1,621					1,155		114	4,638
Existing	2,458		9,895					575		3,750	6,584
All Fires	365	465	1,679	1,694	4,531	715	821	751	553	3,808	63,843
Biogenic Sources	0	0	52,852	52,852	0	0	0	0	0	445,241	103,402
Area	1,662	1,789	3,303	3,309	1,769	314	1,920	190	118,992	49,659	23,773
Oil/Gas [5]	0	0	557	557	0	0	0	0	0	562	16
On-Road Mobile	108	129	8,059	8,059	270	86	0	188	1,075	5,101	120,041
Off-Road Mobile	50	199	23,785	23,785	386	1,072	0	0	36	7,686	95,276
Road Dust	0	5	0	6	325	23	5,190	48,773	0	0	0
Fugitive Dust	0	26	0	27	1,322	90	25,840	129,009	0	0	0
Wind Blown Dust	0	0	0	0	0	89	50,274	452,470	0	0	0
Total	**14,171**	**14,609**	**120,420**	**120,475**	**8,611**	**2,389**	**84,250**	**641,228**	**120,758**	**516,567**	**422,983**

[1] – Derived from WRAP's website at http://vista.cira.colostate.edu/TSS/Results/HazePlanning.aspx. To get to the data, the individual needs to click on "Emissions and Source Apportionment" and click on "Emission Review Tool";

[2] – "SO_2" means sulfur dioxide, "NOx" means nitrogen oxide, "POA" means primary organic aerosol, "EC" means elemental carbon, "VOCs" means volatile organic compounds, and "CO" means carbon monoxide;

[3] – Sulfur oxides (gas and particulate);

[4] – Nitrogen oxides (gas and particulate); and

[5] – VOC emissions from secondary oil and gas production were estimated based on an analysis of the gas and gas flow rates.

Table 5-5 provides the percent of difference between 2002 planned emission inventory (Table 5-6) and the 2018 projected emissions (Table 5-7). From this you can see that both South Dakota and the contiguous states will decrease air emissions for most pollutants from 2002 to 2018. This decrease will represent improvements in visibility in Class I areas in South Dakota and neighboring Class I areas.

Table 5-5 – Emission Changes projected for 2018 [1]

Pollutant	SD	Contiguous States
	% Difference	% Difference
SO_2	36% Decrease	26% Decrease
SO_2 [2]	36% Decrease	26% Decrease
NOx	18% Decrease	30% Decrease
NOx [3]	18% Decrease	30% Decrease
POA	6% Decrease	6% Decrease
EC	49% Decrease	29% Decrease
PM_{fine}	2% Increase	4% Increase
PM_{coarse}	4% Increase	1% Increase
Ammonia	No change	20% Increase
VOCs	6% Decrease	5% Increase
CO	17% Decrease	22% Decrease

[1] – “SO_2” means sulfur dioxide, “NOx” means nitrogen oxide, “POA” means primary organic aerosol, “EC” means elemental carbon, “PM” means particulate matter, “VOCs” means volatile organic compounds, and “CO” means carbon monoxide;
[2] – Sulfur oxides (gas and particulate); and
[3] – Nitrogen oxides (gas and particulate).

5.1.5 Future Emission Inventory by South Dakota

DENR conducts an annual air emission inventory for stationary sources that are required to pay air fees under the Title V air quality permit program. The air emission inventory consists of criteria air pollutants. The stationary sources required to report consist of major sources (actual air emissions that exceed 100 tons per year) and area sources. DENR will expand the air emission inventory to include all air emissions that impact visibility from these stationary sources.

DENR will continue to work with other organizations and states to ensure all inventory data used in future modeling will be accurate. The future emission inventories and the data provided by states in EPA’s National Emission Inventory database will be used to track the progress of South Dakota and neighboring states on controlling and reducing air pollution that cause or contribute to visibility impairment in our Class I areas and neighboring Class I areas.

Table 5-6 –2002 Contiguous State Planning Emission Inventory Summary (Plan 02d) [1, 2]

Source	SD	ND	Minnesota	Iowa	Nebraska	Wyoming	Montana	Total	SD %
SO_2	**22,073**	170,477	158,484	199,339	94,247	145,840	50,198	**840,658**	**3%**
SO_2 [3]	**22,726**	171,611	162,516	201,419	95,603	148,487	51,923	**854,285**	**3%**
NOx	**146,769**	229,460	522,727	378,150	322,915	287,974	242,978	**2,130,973**	**7%**
NOx [4]	**146,823**	229,536	523,008	378,306	323,015	288,095	243,142	**2,131,925**	**7%**
POA	**9,168**	8,840	33,414	13,953	10,709	29,194	48,089	**153,367**	**6%**
EC	**4,703**	4,847	13,034	7,790	6,312	8,066	11,873	**56,625**	**8%**
PM_{fine}	**82,414**	61,519	98,542	109,660	82,851	22,833	77,239	**535,058**	**15%**
PM_{coarse}	**615,354**	360,936	541,408	701,377	610,843	102,660	621,276	**3,553,854**	**17%**
Ammonia	**120,406**	120,493	194,699	272,173	177,774	33,032	66,229	**984,806**	**12%**
VOCs	**552,373**	334,020	1,127,795	574,151	561,172	816,904	1,181,318	**5,147,733**	**11%**
CO	**509,702**	470,129	2,644,613	1,809,356	1,054,477	909,702	1,639,949	**9,037,928**	**6%**

[1] – Derived from WRAP's website at http://vista.cira.colostate.edu/TSS/Results/HazePlanning.aspx. To get to the data, the individual needs to click on "Emissions and Source Apportionment" and click on "Emission Review Tool";

[2] – "SO_2" means sulfur dioxide, "NOx" means nitrogen oxide, "POA" means primary organic aerosol, "EC" means elemental carbon, "PM" means particulate matter, "VOCs" means volatile organic compounds, and "CO" means carbon monoxide;

[3] – Sulfur oxides (gas and particulate); and

[4] – Nitrogen oxides (gas and particulate).

Table 5-7 –2018 Contiguous State Emission Inventory Summary (PRP 18b) [1, 2]

Source	SD	ND	Minnesota	Iowa	Nebraska	Wyoming	Montana	Total	SD %
SO_2	**14,171**	66,942	111,532	198,444	60,473	122,446	44,269	**618,277**	**2%**
SO_2 [3]	**14,609**	67,810	115,735	200,953	61,912	125,692	45,794	**632,505**	**2%**
NOx	**120,420**	187,032	316,762	249,248	206,443	248,100	179,878	**1,507,883**	**8%**
NOx [4]	**120,475**	187,103	317,037	249,422	206,545	248,234	180,043	**1,508,859**	**8%**
POA	**8,611**	7,126	31,649	12,774	9,686	28,464	46,502	**144,812**	**6%**
EC	**2,389**	2,447	9,387	4,938	3,286	6,855	9,948	**39,250**	**6%**
PM_{fine}	**84,250**	62,731	97,229	114,324	83,456	28,055	83,047	**553,092**	**15%**
PM_{coarse}	**641,228**	373,428	517,566	697,526	591,464	116,054	675,985	**3,613,251**	**18%**
Ammonia	**120,758**	120,120	260,671	326,247	230,762	33,974	67,030	**1,159,562**	**10%**
VOCs	**516,567**	337,735	1,160,320	580,816	566,667	1,005,916	1,174,587	**5,342,608**	**10%**
CO	**422,983**	341,118	2,094,422	1,253,075	743,082	813,609	1,378,778	**7,047,067**	**6%**

[1] – Derived from WRAP's website at http://vista.cira.colostate.edu/TSS/Results/HazePlanning.aspx. To get to the data, the individual needs to click on "Emissions and Source Apportionment" and click on "Emission Review Tool";

[2] – "SO_2" means sulfur dioxide, "NOx" means nitrogen oxide, "POA" means primary organic aerosol, "EC" means elemental carbon, "PM" means particulate matter, "VOCs" means volatile organic compounds, and "CO" means carbon monoxide;

[3] – Sulfur oxides (gas and particulate); and

[4] – Nitrogen oxides (gas and particulate).

5.2 Source Apportionment Analysis

Visibility impairment occurs when pollutants emitted into the atmosphere scatter and absorb light thereby creating haze. These pollutants can remain suspended in the atmosphere for long periods and be transported long distances thereby contributing to regional-scale impacts on visibility in Class I areas. Air quality models are one of the tools that states can use to help understand how these impacts occur by identifying the sources contributing to haze and to select the most effective emissions reduction strategies to improve visibility.

In order to determine the significant sources contributing to haze in South Dakota's Class I areas, DENR relied on an apportionment analysis provided by WRAP, which can be reviewed on WRAP's website at:

http://vista.cira.colostate.edu/TSS/Results/HazePlanning.aspx.

There were two techniques used by WRAP for analyzing source apportionment of regional haze. One was the Particulate Matter Source Apportionment Technology (PSAT) analysis used for the attribution of sulfate and nitrate sources only. The second was the Weighted Emissions Potential (WEP) analysis used for attribution of sources of sulfate, nitrate, organic carbon, elemental carbon, fine particulate matter and coarse particulate matter.

The Particulate Matter Source Apportionment Technology analysis used the CAMx air quality model to show nitrate-sulfate-ammonia chemistry and applies this chemistry to a system of tracers or "tags" to track the chemical transformations, transport and removal of nitrogen oxides and sulfur dioxide. These pollutants are important because they tend to originate from anthropogenic (human-caused) sources. Therefore, the results from this analysis can be useful in determining contributing sources that may be controllable, both in-state and in neighboring states. Emission scenarios used for the Particulate Matter Source Apportionment Technology analyses were the "plan02c" and "base 18b".

The Weighted Emissions Potential analysis is a screening tool that helps to identify sources in regions that have the potential to contribute to haze formation at specific Class I areas. Unlike the Particulate Matter Source Apportionment Technology analysis, this method does not account for chemistry or deposition. The Weighted Emissions Potential analysis combines emissions inventories, wind patterns, and residence time of air mass over each area where emissions occur to estimate the percent contribution of different pollutants. Like the Particulate Matter Source Apportionment Technology analysis, the Weighted Emissions Potential analysis compares baseline (2000-2004) to 2018, to show the improvement expected by the 2018 uniform rate of progress for sulfate, nitrate, organic carbon, elemental carbon, fine particulate matter, and coarse particulate matter.

DENR believes the Particulate Matter Source Apportionment Technology analysis is a better tool than Weighted Emissions Potential tool for identifying the contribution of sulfates and nitrates to South Dakota's Class I areas because it accounts for chemistry and deposition and is better at identifying regional contribution of sources from outside the WRAP region. For these reasons, DENR relied on the Particulate Matter Source Apportionment Technology results as the primary source for determining apportionment for sulfates and nitrates and thus the better tool for identifying anthropogenic sources. The results from the Weighted Emissions Potential analysis were used by DENR primarily to identify the pollutants more commonly associated with natural sources. Even though these sources are mostly uncontrollable, it is still important to consider their relative contribution to haze.

The primary tool utilized by DENR for modeling regional haze improvements by 2018 and for determining South Dakota's Reasonable Progress Goals was the CMAQ model. The CMAQ model was used by WRAP to estimate 2018 visibility conditions in South Dakota and all Western Class I areas based on application of the regional haze strategies presented by states to WRAP, including assumed controls on BART sources.

The modeling was conducted by the Regional Modeling Center (RMC) at the University of California Riverside under the oversight of WRAP's Modeling Forum. A more in depth description of the CMAQ model used to project 2018 visibility conditions by WRAP and the results of the modeling can be found on WRAP's website at:

http://vista.cira.colostate.edu/TSS/Results/HazePlanning.aspx.

The CMAQ model was designed as a "one atmosphere" modeling system to encompass modeling of multiple pollutants and issues including ozone, particulate matter, visibility, and air toxics. This is in contrast to many earlier air quality models that focused on a single pollutant. CMAQ takes into account emissions, advection and dispersion, photochemical transformation, aerosol thermodynamics and phase transfer, aqueous chemistry, and wet and dry deposition of trace species. The model requires inputs of three-dimensional wind grids, temperature, humidity, cloud/precipitation, and boundary layer parameters. The current version of CMAQ can only utilize output fields from the MM5 meteorological model. MM5 meteorological model is a state-of-the-science atmosphere model that has proven useful for air quality applications and has been used extensively in past local, state, regional, and national modeling efforts. MM5 meteorological model has undergone extensive peer review, with all of its components continually undergoing development and scrutiny by the modeling community.

The Regional Modeling Center developed air quality modeling inputs including annual meteorology and emissions inventories for a 2002 actual emissions base case, a planning case to represent the 2000-2004 regional haze baseline period using averages for key emissions categories, and a 2018 base case of projected emissions determined using factors known at the end of 2005. All emission inventories were prepared for CMAQ using the Sparse Matrix Operator Kernel Emissions (SMOKE) modeling system. Each of these inventories underwent a number of revisions throughout the development process to arrive at the final versions used in CMAQ modeling. The development of each of these emission scenarios is documented under the emissions inventory sections on WRAP's website at:

http://vista.cira.colostate.edu/TSS/Results/HazePlanning.aspx.

The 2018 visibility projections were made using the planning case to represent the 2000-2004 regional haze baseline period (Plan02c) and base case projected emissions (Base18b). The CMAQ modeling grid design was established at 36-kilometers. Projections were made using relative response factors, which are defined as the ratio of the future-year modeling results to the current-year modeling results. The calculated relative response factors are applied to the baseline observed visibility conditions to project future-year observed visibility.

Generally, emissions inputs were prepared by individual states and tribes for point, area, and most dust emissions categories. The following WRAP forums were relied upon to summarize this data and provide it to the Regional Modeling Center:

1. Point source emissions were obtained from projects commissioned by the Stationary Sources Joint and Emissions forums;
2. Area source emissions were obtained from projects commissioned by the Stationary Sources Joint and Emissions forums;
3. Mobile source emissions were obtained from projects commissioned by the Emissions forum;
4. Fire (natural and anthropogenic) emissions were obtained from projects commissioned by the Fire Emissions Joint forum;
5. Ammonia, dust, and biogenic emissions were obtained from projects commissioned by the Dust Emissions Joint and Modeling forums;
6. Emissions from Pacific offshore shipping were obtained from a project conducted by the Regional Modeling Center;
7. Other emissions from North America were obtained from projects commissioned by the Emissions and Modeling forums. Mexico’s emissions were based on a 1999 emission inventory and Canada’s were based on a 2000 emission inventory. Both were held constant for 2018; and
8. Boundary conditions reaching North America from the rest of the world were obtained from a project commissioned by the VISTAS Regional Planning Organization on behalf of the five regional Planning organizations working on regional haze.

5.3 Regional Haze Contributions in South Dakota’s National Parks

WRAP developed graphs showing the profile of the relative contribution of in-state versus out-of-state sources contributing to air pollutant concentrations in South Dakota’s Class I areas for the 20% least and most impaired days during the 2002 baseline and 2018 projections using the Particulate Matter Source Apportionment Technology and Weighted Emissions Potential analyses.

As previously mentioned, there are several differences between the Particulate Matter Source Apportionment Technology analysis and Weighted Emissions Potential analysis. The Particulate Matter Source Apportionment Technology focuses on sulfate and nitrate contribution taking into account chemistry and deposition; but also estimates the contribution from all regions such as the WRAP states, CENRAP states, Canada, Mexico, Pacific offshore (shipping), and “outside the domain” (global transport). CENRAP is a regional planning organization similar to the WRAP that is comprised of Nebraska, Kansas, Oklahoma, Texas, Minnesota, Iowa, Missouri, Arkansas, and Louisiana.

The Weighted Emissions Potential analysis estimates the contribution from Canada and Pacific offshore regions; but does not include other regional contributions. Therefore, WRAP's apportionment analysis is based on the Particulate Matter Source Apportionment Technology results for identifying the contribution of sulfates and nitrates (the primary anthropogenic source pollutants) and Weighted Emissions Potential results for identifying the contribution of organic carbon mass, elemental carbon, fine particulate matter, and coarse particulate matter.

5.3.1 Sulfate Contributions

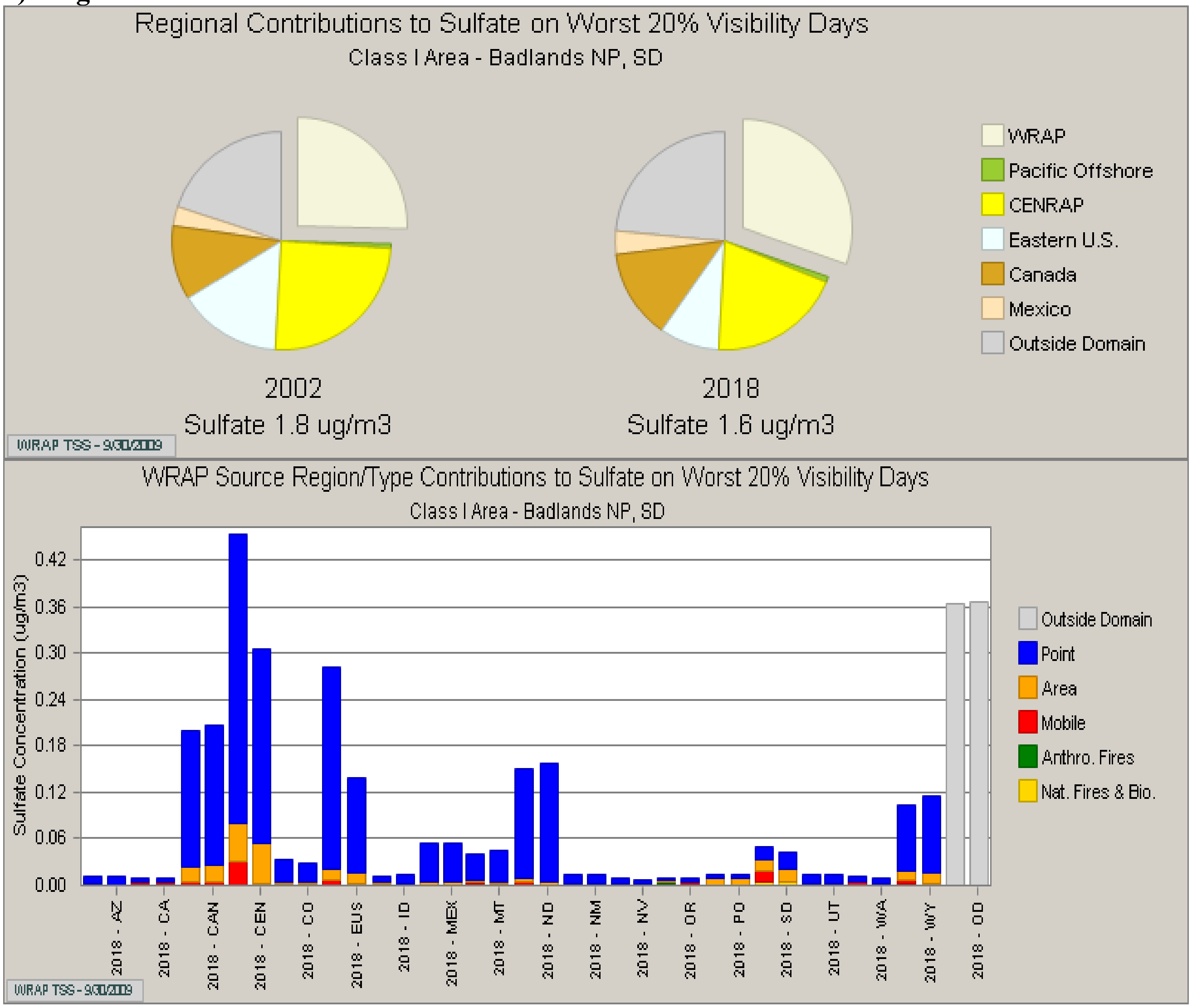
Based on the IMPROVE data, ammonia sulfate contributes to visibility impairment in both the Badlands and Wind Cave National Parks. At the Badlands National Park, ammonia sulfate has the greatest impact and at the Wind Cave National Park it has the second greatest impact during the 20% most impaired days. Figure 5-1 and 5-2 illustrates the state and regional contribution of sulfate during the 20% most and least impaired days in South Dakota's two Class I areas. The contributions are based on modeling of 2002 emission inventories of actual emissions and projected emissions in 2018. The pie chart in each figure displays the regional contribution to the total annual modeled sulfate mass at the respective sites for the 2002 base year and 2018 projections. The bar chart identifies what state or region is contributing, the amount of contribution, and what type of sources are contributing to sulfate concentrations in the 2002 base year and 2018 projections. There are five source categories listed: 1) point; 2) area; 3) mobile; 4) anthropogenic fires (controlled burns); and 5) natural fires and biogenic sources (mostly wildfire and windblown dust). In each figure, the first bar for each state and region is not labeled but represents the 2002 base year.

Based on the WRAP modeling, the sulfate concentrations for the 20% most impaired days (worst days) in the Badlands National Park will decrease from 1.8 micrograms per cubic meter in 2002 to 1.6 micrograms per cubic meter in 2018 (see Figure 5-1(a)). The decrease appears to be attributed to decreases of sulfate emission in the CENRAP region, Eastern U.S. region, South Dakota and Colorado.

The WRAP modeling indicates the greatest sulfate contribution for the 20% most impaired days at the Badlands National Park in 2002 is generated from the CENRAP region followed by Outside the Domain, Eastern U.S., Canada, and North Dakota. If you exclude Outside Domain because the source categories were not identified, a majority of the sulfate contribution is generated from point sources followed by area and mobile sources.

In 2018, the greatest sulfate contribution for the 20% most impaired days at the Badlands National Park switches from the CENRAP region to Outside the Domain. This occurs because Outside the Domain's sulfate contributions slightly increase while the CENRAP region's sulfate contribution decreases during the same period. Even with the decreases in sulfate emissions, the CENRAP region is the second greatest contributor followed by Canada, North Dakota and Eastern U.S.   Again, point sources are the major contributor followed by area sources with mobile source contribution minimized in 2018.

Figure 5-1 – Sulfate Contribution for 20% Most Impaired Days
a) Regional Sulfate Contributions at Badlands



(WRAP TSS – http://vista.cira.colostate.edu/tss/)

South Dakota's sulfate contribution in 2002 at the Badlands National Park is minimal at less than 0.06 micrograms per cubic meter. The sources of sulfate emissions in South Dakota are generated from point, area, and mobile sources evenly in 2002. In 2018, South Dakota's sulfate contribution switch mainly to point and area sources, and like other states and regions in the United States, mobile source contributions are minimal due to new changes in federal emission standards from mobile sources.

Based on the WRAP modeling, the sulfate concentrations for the 20% most impaired days (worst days) in the Wind Cave National Park will decrease from 1.4 micrograms per cubic meter in 2002 to 1.3 micrograms per cubic meter in 2018 (see Figure 5-1(b)). The decrease appears to be attributed to decreases of sulfate emission in the CENRAP region, Eastern U.S. region, South Dakota and Colorado.

The WRAP modeling indicates the greatest sulfate contribution for the 20% most impaired days at the Wind Cave National Park in 2002 is generated from Outside the Domain followed by the CENRAP region, Canada, Wyoming, and North Dakota. If you exclude Outside Domain because the source categories were not identified, a majority of the sulfate contribution is generated from point sources followed by area and mobile sources. The source category contribution is similar to what you see at the Badlands National Park

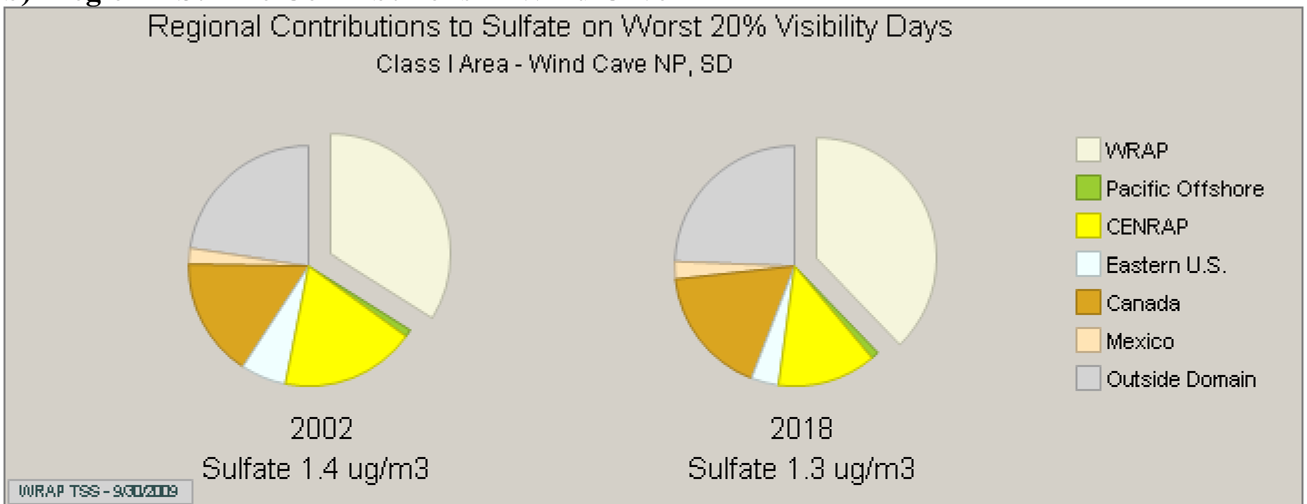
In 2018, the greatest sulfate contribution for the 20% most impaired days at the Wind Cave National Park remains from Outside the Domain. The next four greatest contributors is Canada, the CENRAP region, Wyoming and North Dakota. The CENRAP region’s sulfate contribution decreases in 2018 which reduces its contribution lower than Canada; but continues to be greater than Wyoming and North Dakota. Again, point sources are the major contributor followed by area sources with mobile source contribution minimized in 2018.

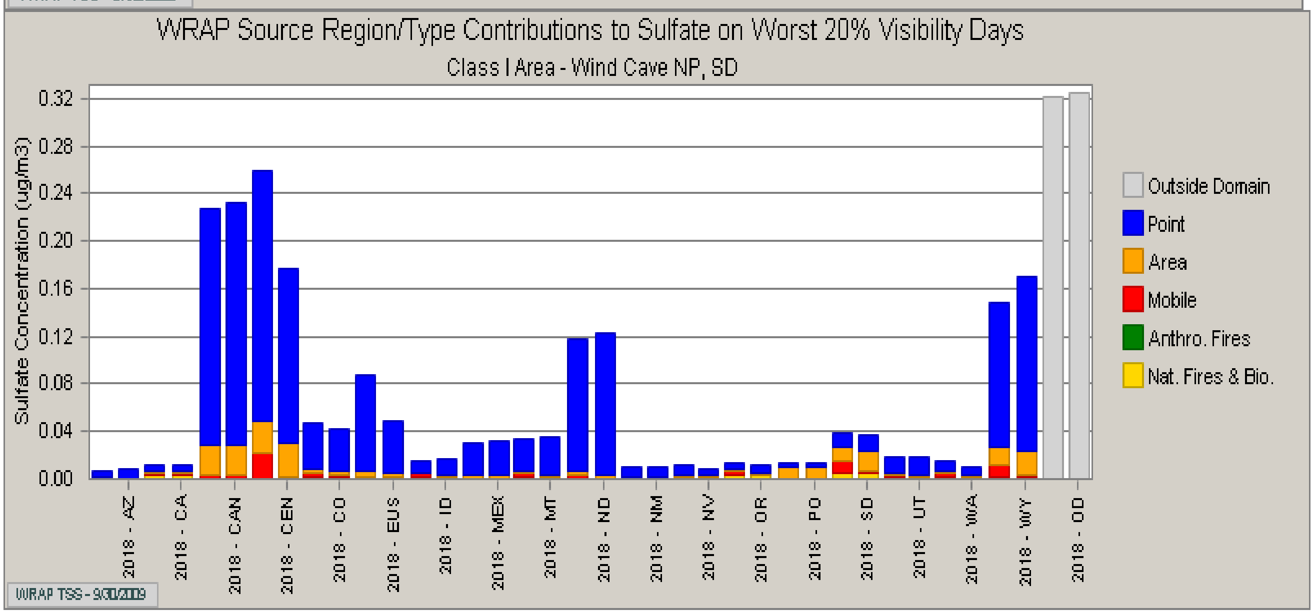
South Dakota’s sulfate contribution in 2002 at the Wind Cave National Park is minimal at approximately 0.04 micrograms per cubic meter. The sources of sulfate emissions in South Dakota are generated from point, area, and mobile sources evenly in 2002. In 2018, South Dakota’s sulfate contribution switch mainly to point and area sources, and like other states and regions in the United States, mobile source contributions are minimal due to new changes in federal emission standards from mobile sources.

Point sources contribute a majority to the sulfate concentrations in South Dakota’s two national parks during the 20% most impaired days. The state or region that contributes to the sulfate concentrations the greatest is dependent on where the national park is located. For example, in the WRAP region, North Dakota contributes more to the Badlands National Park while Wyoming contributes more to the Wind Cave National Park.

Based on the WRAP modeling, the sulfate concentrations for the 20% least impaired days (best days) in the Badlands National Park will increase from 0.6 micrograms per cubic meter in 2002 to 0.7 micrograms per cubic meter in 2018 (see Figure 5-2(a)). Although Wyoming is not the greatest sulfate contributor during the 20% least impaired days, the increase appears to be attributed to increases of sulfate emission in the Wyoming, Idaho, and Montana.

b) Regional Sulfate Contributions at Wind Cave





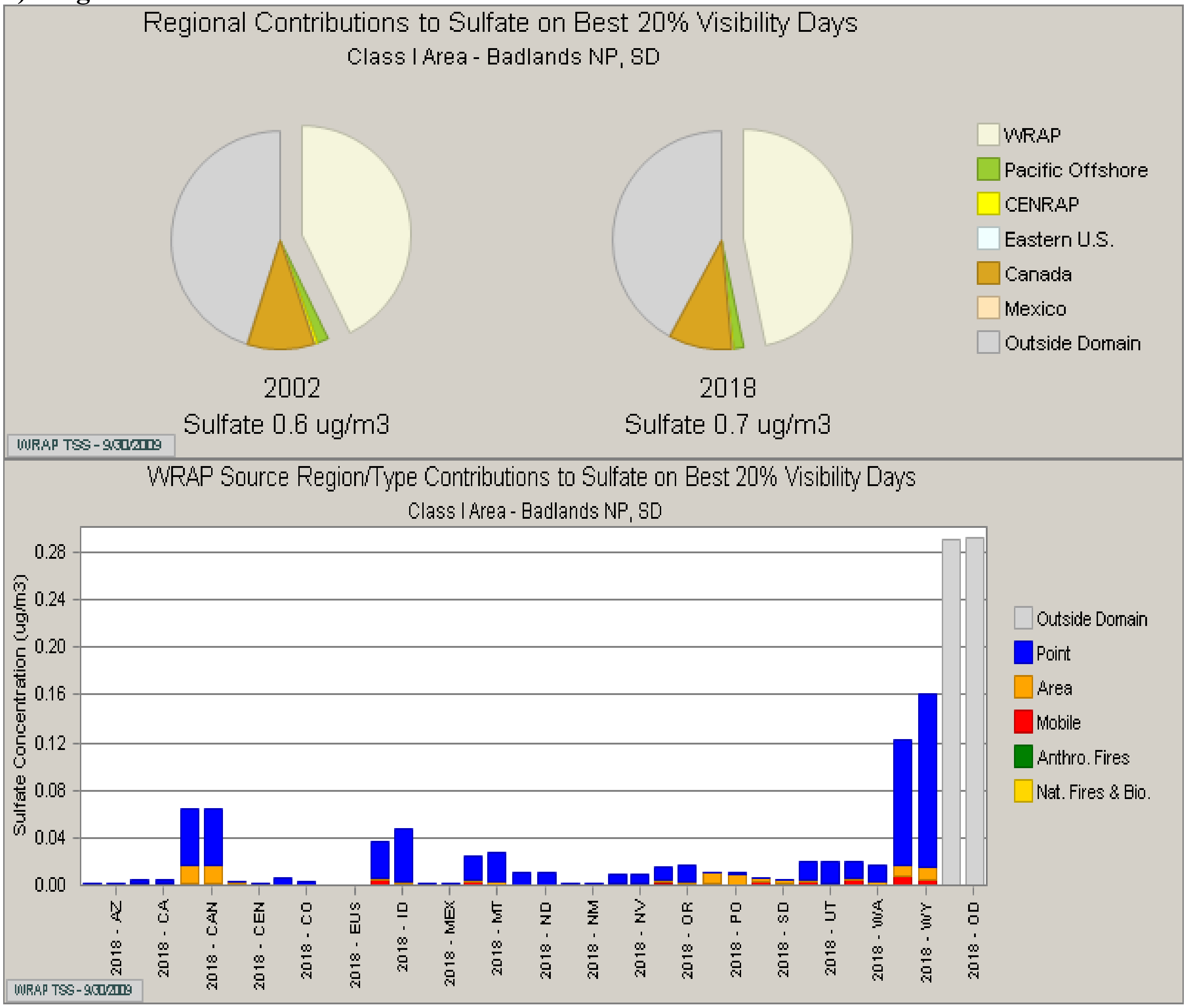
(WRAP TSS – http://vista.cira.colostate.edu/tss/)

The WRAP modeling indicates the greatest sulfate contribution for the 20% least impaired days at the Badlands National Park in 2002 is generated from Outside the Domain followed by Wyoming, Canada, Idaho, and Montana. If you exclude Outside Domain because the source categories were not identified, a majority of the sulfate contribution is generated from point sources.

In 2018, the greatest sulfate contribution for the 20% least impaired days at the Badlands National Park does not change from 2002. The five greatest sulfate contributors are Outside the Domain, Wyoming, Canada, Idaho, and Montana. Again, point sources are the major contributor of sulfate concentrations.

Figure 5-2 – Sulfate Contribution for 20% Least Impaired Days

a) Regional Sulfate Contributions at Badlands

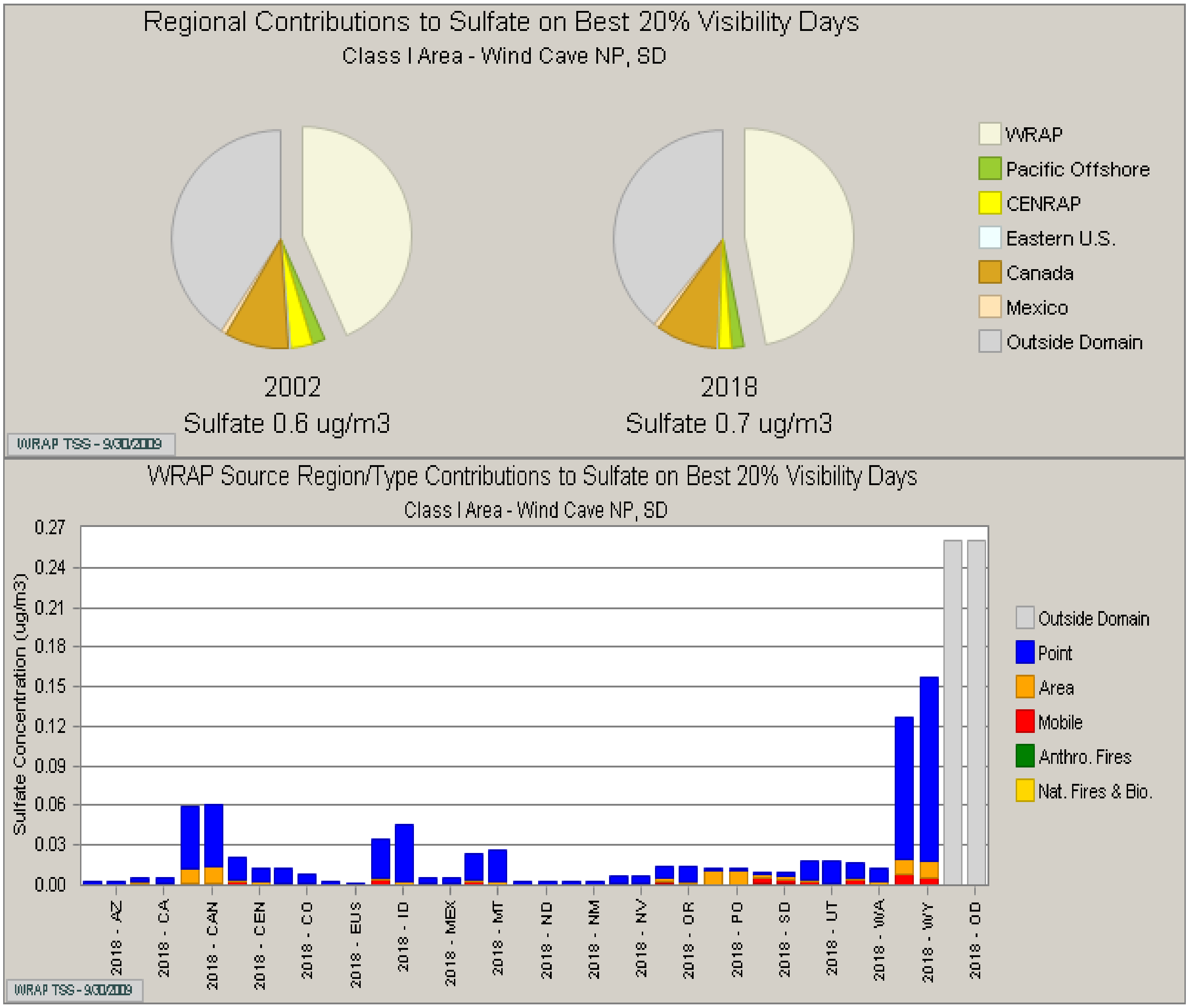


(WRAP TSS – http://vista.cira.colostate.edu/tss/)

South Dakota's sulfate contribution in 2002 at the Badlands National Park for the 20% least impaired days is minimal at approximately 0.01 micrograms per cubic meter. The sources of sulfate emissions in South Dakota are generated from point, area, and mobile sources in 2002. In 2018, South Dakota's sulfate contribution is less than 0.01 micrograms per cubic meter.

Based on the WRAP modeling, the sulfate concentrations for the 20% least impaired days (best days) in the Wind Cave National Park will also increase from 0.6 micrograms per cubic meter in 2002 to 0.7 micrograms per cubic meter in 2018 (see Figure 5-2(b)). Although Wyoming is not the greatest sulfate contributor during the 20% least impaired days, the increase appears to be attributed to increases of sulfate emission in the Wyoming, Idaho, and Montana, which is similar to what is predicted at the Badlands National Park.

b) Regional Sulfate Contributions at Wind Cave



(WRAP TSS – http://vista.cira.colostate.edu/tss/)

The WRAP modeling indicates the greatest sulfate contribution for the 20% least impaired days at the Wind Cave National Park in 2002 is generated from Outside the Domain followed by Wyoming, Canada, Idaho, and Montana. If you exclude Outside Domain because the source categories were not identified, a majority of the sulfate contribution is generated from point sources.

In 2018, the greatest sulfate contribution for the 20% least impaired days at the Wind Cave National Park does not change from 2002. The five greatest sulfate contributors are Outside the Domain, Wyoming, Canada, Idaho, and Montana. Again, point sources are the major contributor of sulfate concentrations.

South Dakota's sulfate contribution in 2002 at the Wind Cave National Park for the 20% least impaired days is minimal at approximately 0.01 micrograms per cubic meter. The sources of sulfate emissions in South Dakota are generated from point, area, and mobile sources in 2002. In 2018, South Dakota's sulfate contribution stays about the same.

Point sources contribute a majority to the sulfate concentrations in South Dakota's two national parks during the 20% least impaired days. The state or region that contributes to the sulfate concentrations the greatest is not dependent on where the national park is located. For each national park, the greatest contributors are the same.

5.3.2 Organic Carbon Mass Contributions

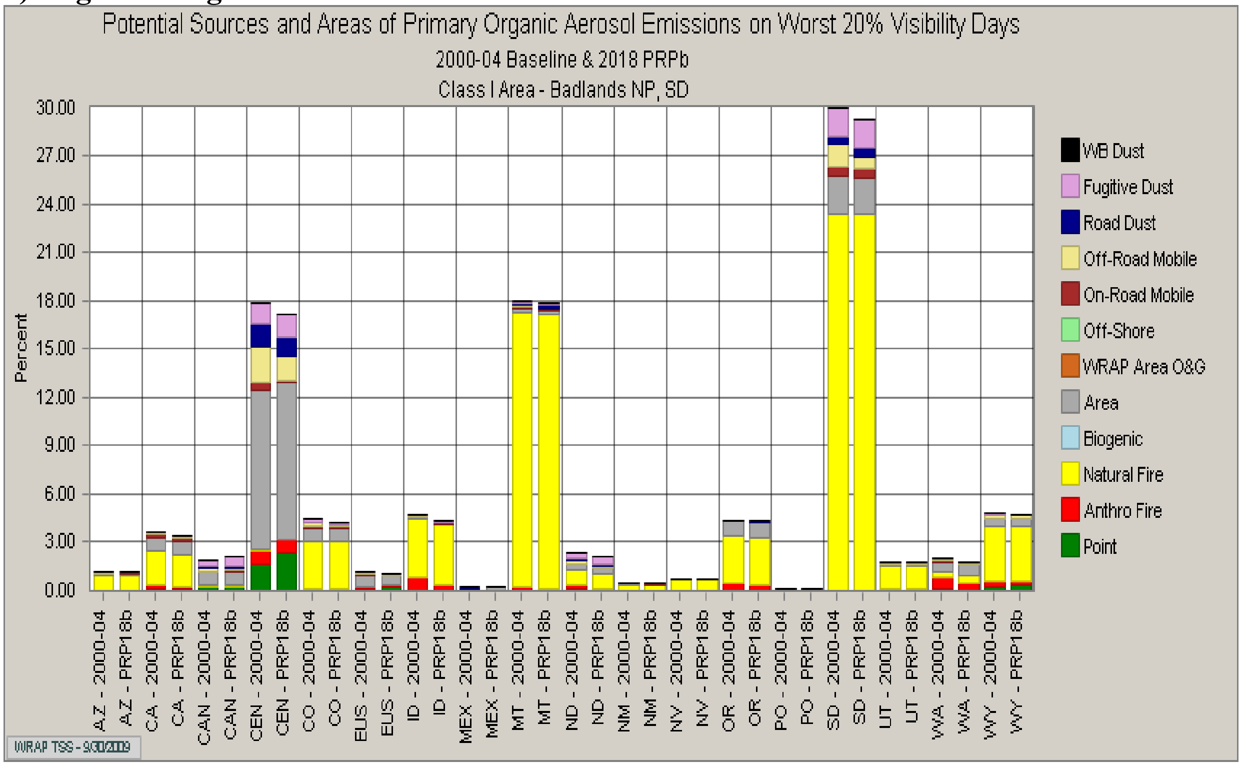
Based on the IMPROVE data, organic carbon mass also contributes to visibility impairment in both the Badlands and Wind Cave National Parks. At the Wind Cave National Park, organic carbon mass has the greatest impact and at the Badlands National Park it has the second greatest impact during the 20% most impaired days. Figure 5-3 and 5-4 illustrates the state and regional contribution of organic carbon mass during the 20% most and least impaired days in South Dakota's two Class I areas. The contributions are based on modeling of 2002 emission inventories of actual emissions and projected emissions in 2018. The bar chart identifies what state or region is contributing, the percentage of contribution, and what type of sources are contributing to organic carbon mass for the 2002 base year and 2018 projections. WRAP identified 12 source categories: 1) windblown dust; 2) fugitive dust; 3) road dust; 4) off-road mobile; 5) on-road mobile; 6) off-shore; 7) WRAP area oil and gas; 8) area; 9) biogenic; 10) natural fires; 11) anthropogenic fire; and 12) point sources.

The WRAP modeling indicates the greatest percentage of organic carbon mass contribution for the 20% most impaired days at the Badlands and Wind Cave National Park in 2002 and 2018 is generated from within South Dakota (see Figure 5-3). The percentage at the Badlands and Wind Cave National Park is approximately 30 and 41 percent, respectively. The CENRAP region contributes approximately 17 percent at the Badlands National Park; but only around eight percent at the Wind Cave National Park. Wyoming contributes approximately five percent at the Badlands National Park while up to eight percent at the Wind Cave National Park.

In all but the CENRAP region, the source of organic carbon mass contributions is generated from natural fires. For example, approximately 23 percent of South Dakota's 30 percent at the Badlands National Park is attributed to natural fires. South Dakota's natural fire percentage at the Wind Cave National Park is even greater at 33 percent. In the CENRAP region, organic carbon mass contributions are generated from area sources such as woodstoves or other urban related sources.

There appears to be slight decreases in organic carbon mass contributions from 2002 to 2018; but the reductions are minimal and mainly due to a decrease in off-road mobile and anthropogenic fires.

Figure 5-3 – Organic Carbon Mass Contribution for 20% Most Impaired Days
a) Regional Organic Carbon Mass Contributions at Badlands

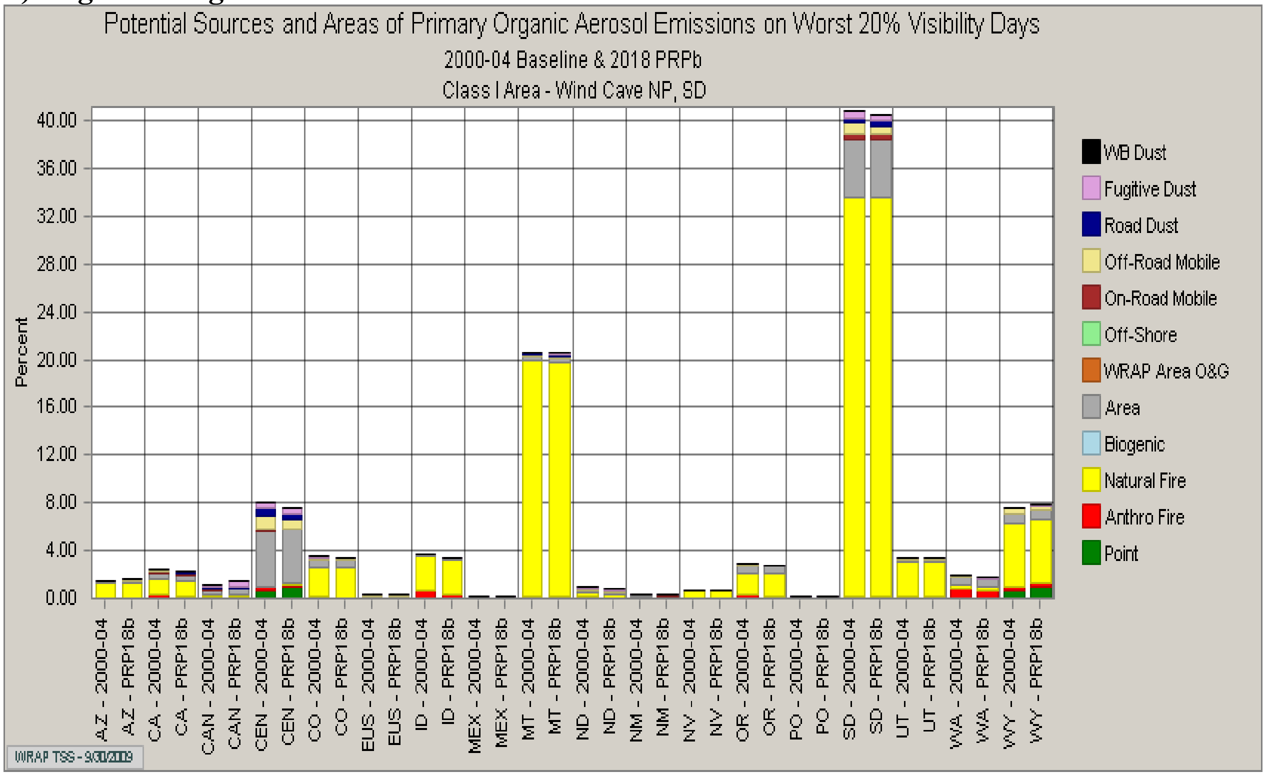


(WRAP TSS – http://vista.cira.colostate.edu/tss/)

It is interesting that the WRAP modeling indicates the greatest percentage of organic carbon mass contribution for the 20% least impaired days at the Badlands National Park in 2002 and 2018 is generated from Montana (see Figure 5-4(a)) at approximately 35 percent. South Dakota, Oregon, and Idaho contribute approximately 20 percent, 12 percent, and seven percent, respectively. The source of organic carbon mass contributions is generated mainly from natural fires. Natural fire generated organic carbon mass from Montana contributes approximately 34 percent of the organic carbon mass in the Badlands National Park. There appears to be slight decreases in organic carbon mass contributions from 2002 to 2018; but the reductions are minimal and mainly due to a decrease in off-road mobile and anthropogenic fire.

For the Wind Cave National Park, the WRAP modeling for the 20% least impaired days agrees better with the 20% most impaired days in that the greatest percentage of organic carbon mass contribution in 2002 and 2018 is generated from within South Dakota (see Figure 5-4(b)) at approximately 42 percent. Montana, Wyoming, Idaho, and Oregon all contribute over eight percent. The major source of organic carbon mass contribution is generated from natural fires. There appears to be slight decreases in organic carbon mass contributions from 2002 to 2018; but the reductions are minimal and mainly due to a decrease in off-road mobile and anthropogenic fire.

b) Regional Organic Carbon Mass Contributions at Wind Cave

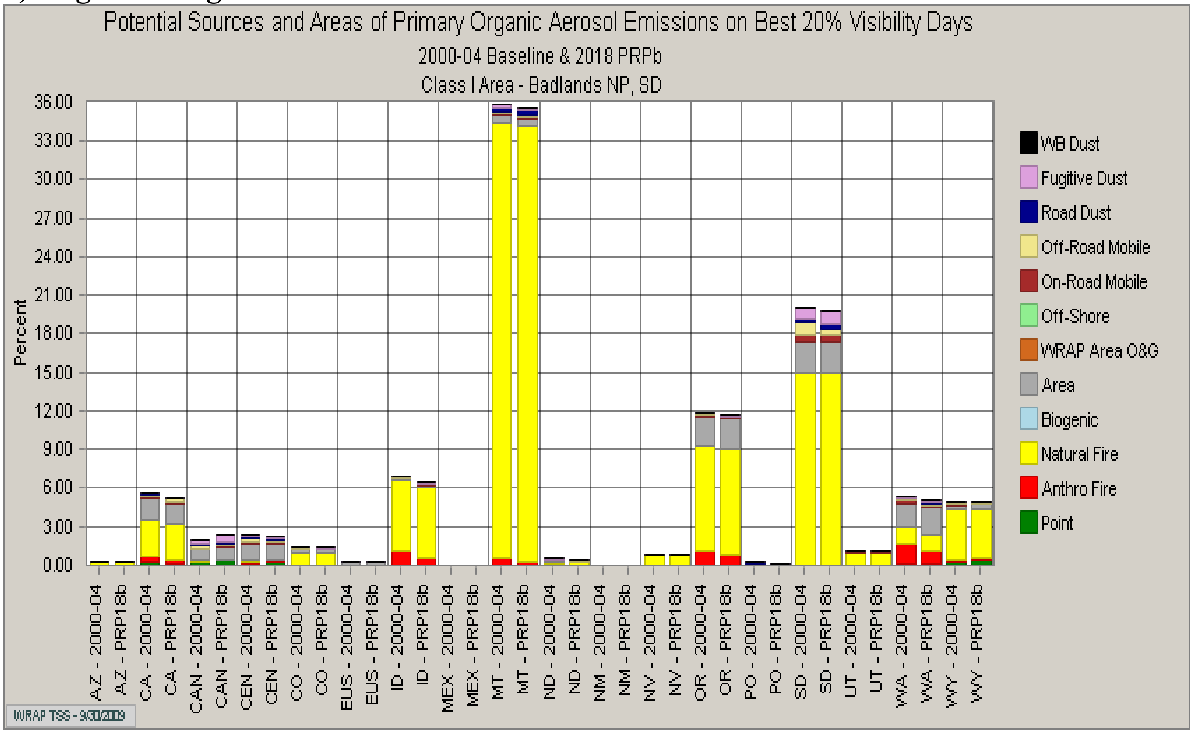


(WRAP TSS – http://vista.cira.colostate.edu/tss/)

It appears from this information that natural fires are the greatest contributor to visibility impairment from organic carbon mass in the two national parks. Based on South Dakota having the greatest contribution percentage for both the 20% most and least impaired days at the Wind Cave National Park, it appears natural fires within the Black Hills area have a greater impact on contributing to visibility impairment at the Wind Cave National Park then at the Badlands National Park. DENR believes this will have to be reviewed further to determine the best method for minimizing the impacts natural fires and prescribed fires have on South Dakota's two national parks.

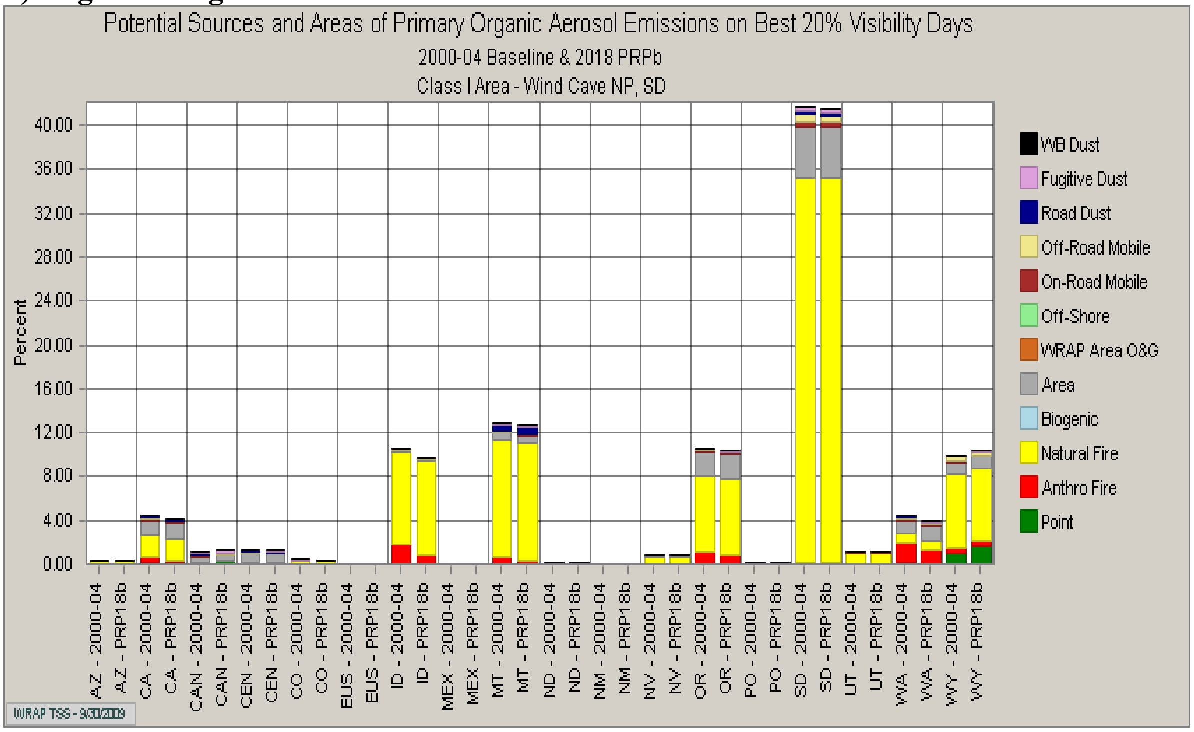
Figure 5-4 – Organic Carbon Mass Contribution for 20% Least Impaired Days

a) Regional Organic Carbon Mass Contributions at Badlands



(WRAP TSS – http://vista.cira.colostate.edu/tss/)

b) Regional Organic Carbon Mass Contributions at Wind Cave



(WRAP TSS – http://vista.cira.colostate.edu/tss/)

5.3.3 Nitrate Contributions

Based on the IMPROVE data, ammonia nitrate contributes to visibility impairment in both the Badlands and Wind Cave National Parks. Ammonia nitrate contributions are not as great as ammonia sulfate or organic carbon mass but are significant enough to determine where the nitrates are being generated. Figure 5-5 and 5-6 illustrates the state and regional contribution of sulfate during the 20% most and least impaired days in South Dakota's two Class I areas. The contributions are based on modeling of 2002 emission inventories of actual emissions and projected emissions in 2018. The pie chart in each figure displays the regional contribution to the total annual modeled nitrate mass at the respective sites for the 2002 base year and 2018 projections. The bar chart identifies what state or region is contributing, the amount of contribution, and what type of sources are contributing to nitrate concentrations in the 2002 base year and 2018 projections. There are five source categories listed: 1) point; 2) area; 3) mobile; 4) anthropogenic fires (controlled burns); and 5) natural fires and biogenic sources (mostly wildfire and windblown dust). In each figure, the first bar for each state and region is not labeled but represents the 2002 base year.

Based on the WRAP modeling, the nitrate concentrations for the 20% most impaired days (worst days) in the Badlands National Park will decrease from 1.3 micrograms per cubic meter in 2002 to 1.2 micrograms per cubic meter in 2018 (see Figure 5-5(a)). The decrease appears to be attributed to decreases of nitrate emission in the CENRAP region, South Dakota, Wyoming, and North Dakota from mobile sources.

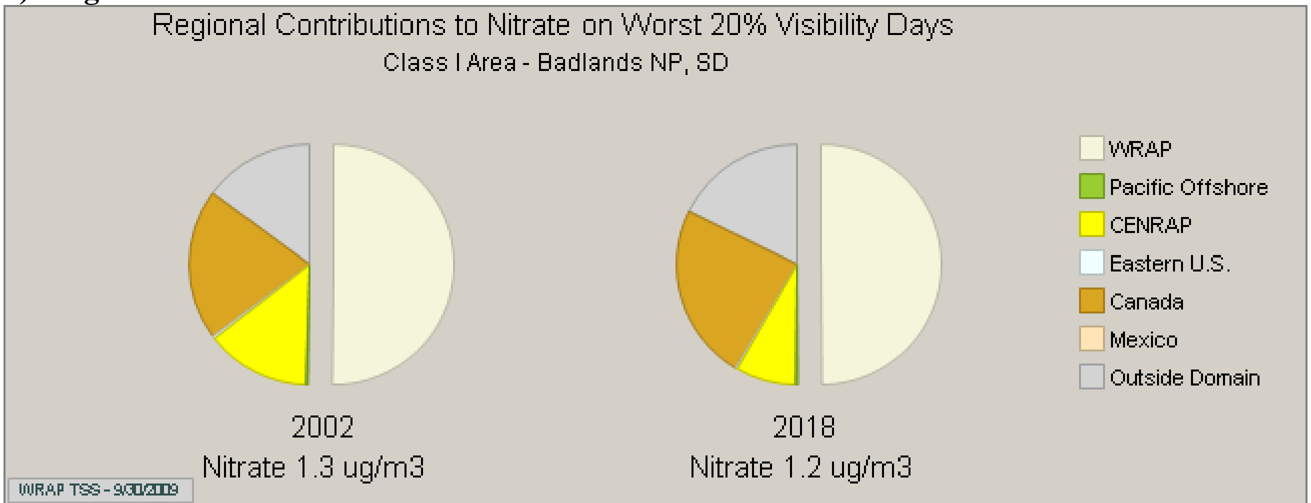
The WRAP modeling indicates the greatest nitrate contribution for the 20% most impaired days at the Badlands National Park in 2002 is generated from Canada followed by Outside the Domain, the CENRAP region, South Dakota, and Wyoming. If you exclude Outside the Domain because the source categories were not identified, a majority of the nitrate contribution is generated from point, area, and mobile sources in 2002 from influences outside of South Dakota; and in South Dakota the nitrate contribution is from mobile, natural fires and biogenic, and point sources.

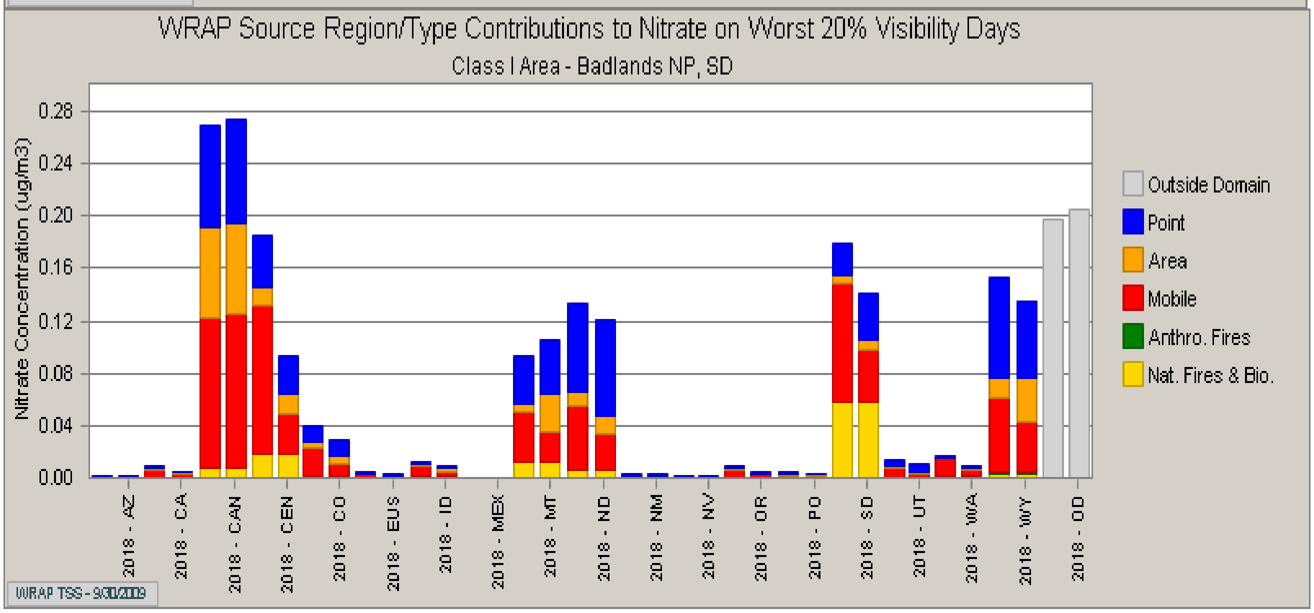
In 2018, the greatest nitrate contribution for the 20% most impaired days at the Badlands National Park remains from Canada followed by Outside the Domain, South Dakota, Wyoming, and North Dakota. The CENRAP region is no longer in the top five contributors because of nitrate decreases mainly due from mobile sources. The sources of nitrate contribution remain the same from 2002 to 2018.

South Dakota's nitrate contribution in 2002 at the Badlands National Park is approximately 0.18 micrograms per cubic meter. The sources of nitrates in South Dakota are generated from mobile, natural fires and biogenic, and point sources in 2002. In 2018, South Dakota's nitrate contribution drops to 0.14 micrograms per cubic meter due mainly to reduction in mobile contributions. The reduction in mobile source contributions is due to new changes in federal emission standards from mobile sources.

Figure 5-5 – Nitrate Contribution for 20% Most Impaired Days

a) Regional Nitrate Contributions at Badlands

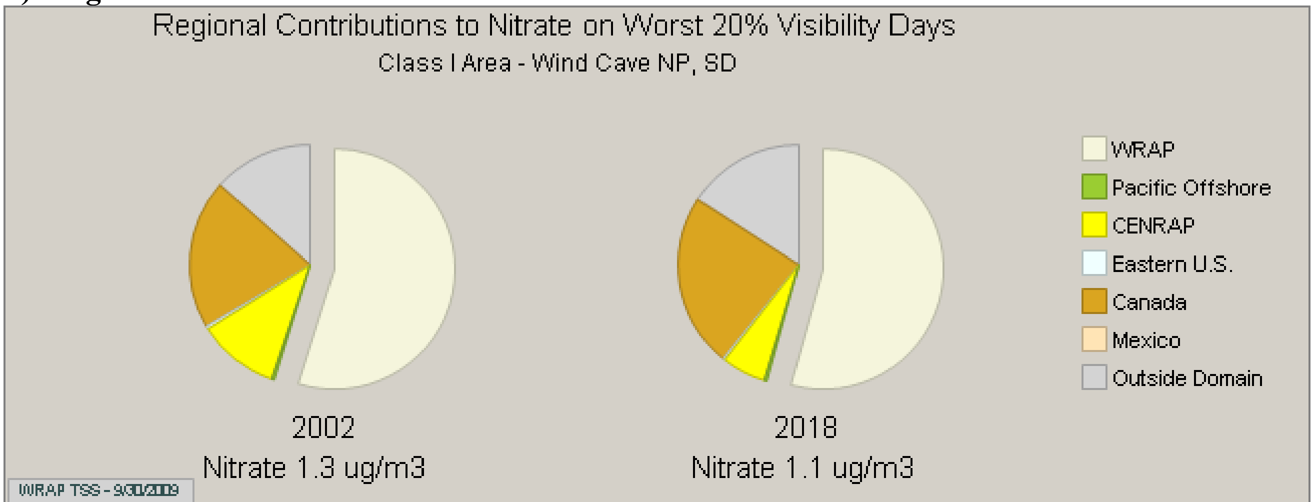


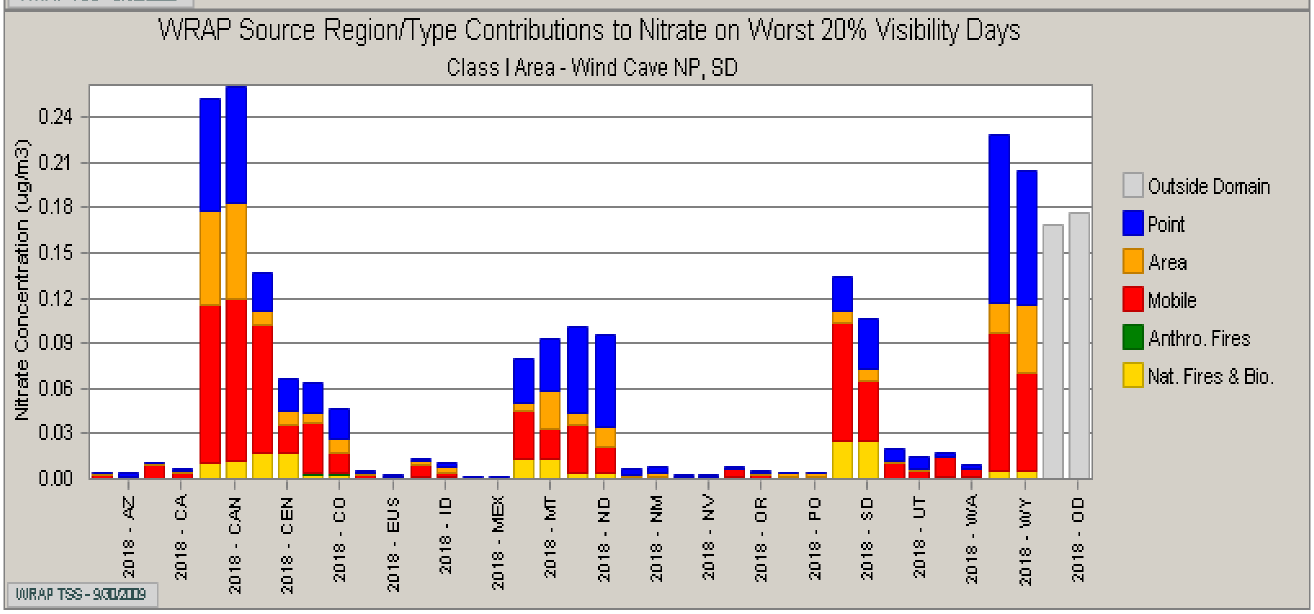


(WRAP TSS – http://vista.cira.colostate.edu/tss/)

Based on the WRAP modeling, the nitrate concentrations for the 20% most impaired days (worst days) in the Wind Cave National Park will decrease from 1.3 micrograms per cubic meter in 2002 to 1.1 micrograms per cubic meter in 2018 (see Figure 5-5(b)). The decrease appears to be attributed to decreases of nitrate emission in Wyoming, the CENRAP region, South Dakota, North Dakota and Colorado from mobile sources.

b) Regional Nitrate Contributions at Wind Cave





(WRAP TSS – http://vista.cira.colostate.edu/tss/)

The WRAP modeling indicates the greatest nitrate contribution for the 20% most impaired days at the Wind Cave National Park in 2002 is generated from Canada followed by Wyoming, Outside the Domain, the CENRAP region, and South Dakota. If you exclude Outside the Domain because the source categories were not identified, a majority of the nitrate contribution is generated from point, area, and mobile sources in 2002 from influences outside of South Dakota; and in South Dakota the nitrate contribution is from mobile, natural fires and biogenic, and point sources.

In 2018, the greatest nitrate contribution for the 20% most impaired days at the Wind Cave National Park remains from Canada followed by Wyoming, Outside the Domain, South Dakota, and North Dakota. The CENRAP region is no longer in the top five contributors because of nitrate decreases mainly due from mobile sources. The sources of nitrate contribution remain the same from 2002 to 2018.

South Dakota's nitrate contribution in 2002 at the Wind Cave National Park is approximately 0.13 micrograms per cubic meter. The sources of nitrates in South Dakota are generated mainly from mobile sources followed by natural fires, biogenic and point sources in 2002. In 2018, South Dakota's nitrate contribution drops to 0.10 micrograms per cubic meter due mainly to reduction in mobile contributions. The reduction in mobile source contributions is due to new changes in federal emission standards from mobile sources.

Based on the WRAP modeling, the nitrate concentrations for the 20% least impaired days (best days) in the Badlands National Park will decrease from 1.7 micrograms per cubic meter in 2002 to 1.5 micrograms per cubic meter in 2018 (see Figure 5-6(a)). The decrease appears to be attributed to decreases of nitrate emission in the states and regions is due to reductions from mobile sources.

The WRAP modeling indicates the greatest nitrate contribution for the 20% least impaired days at the Badlands National Park in 2002 is generated from Wyoming followed by Outside the Domain, Canada, Montana, and South Dakota. If you exclude Outside the Domain because the source categories were not identified, a majority of the nitrate contribution is generated from point, area, and mobile sources in 2002 from influences outside of South Dakota; and in South Dakota the nitrate contribution is from mobile, natural fires and biogenic, and point sources.

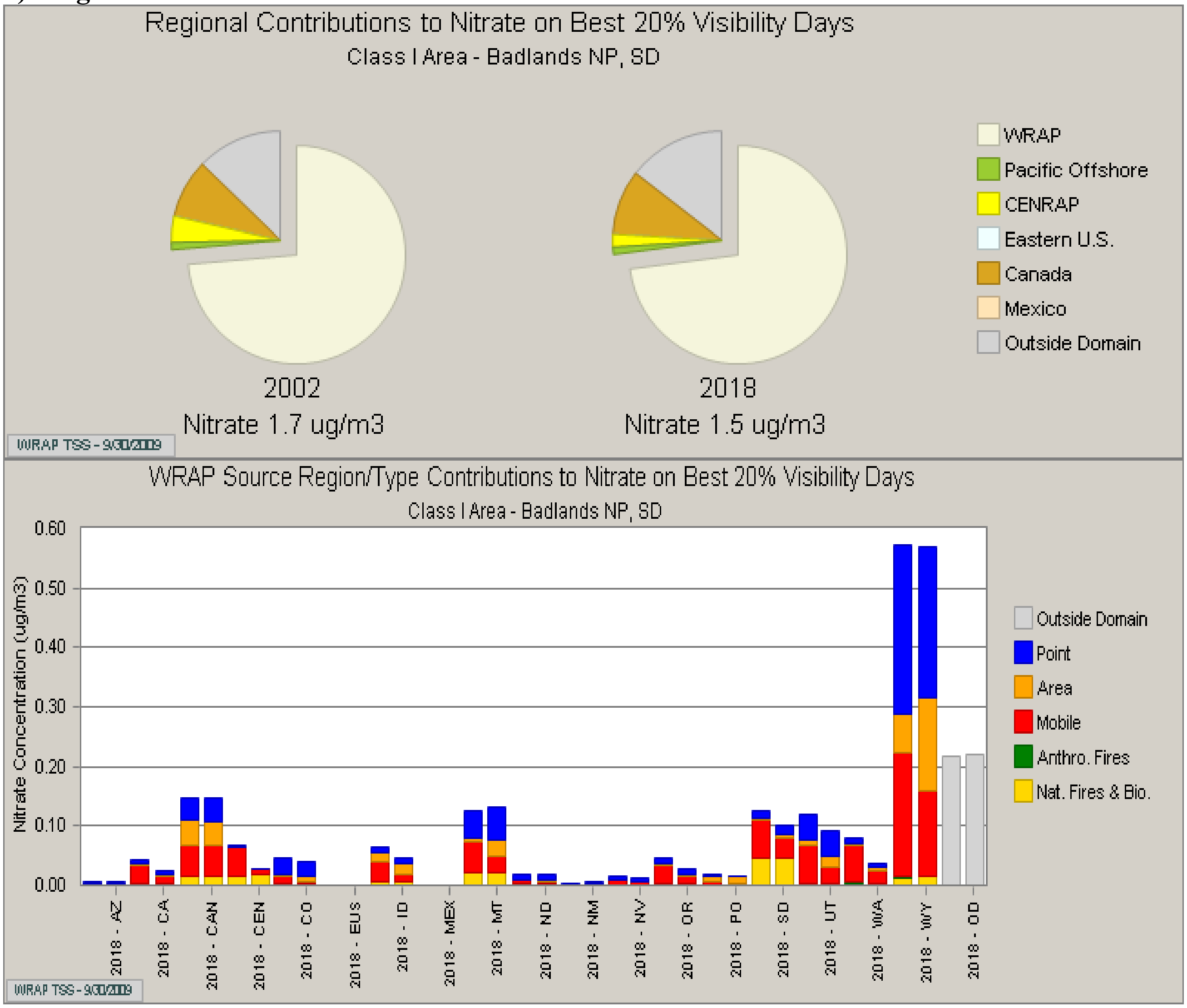
In 2018, the greatest nitrate contribution for the 20% most impaired days at the Badlands National Park remains from Wyoming followed by Outside the Domain, Canada, Montana, and South Dakota. The sources of nitrate contribution remain the same from 2002 to 2018.

South Dakota's nitrate contribution in 2002 at the Badlands National Park is approximately 0.11 micrograms per cubic meter. The sources of nitrates in South Dakota are generated mainly from mobile sources followed by natural fires, biogenic and point sources in 2002. In 2018, South Dakota's nitrate contribution drops to 0.10 micrograms per cubic meter due mainly to reduction in mobile contributions. The reduction in mobile source contributions is due to new changes in federal emission standards from mobile sources.

Based on the WRAP modeling, the nitrate concentrations for the 20% least impaired days (best days) in the Wind Cave National Park will decrease from 1.0 micrograms per cubic meter in 2002 to 0.9 micrograms per cubic meter in 2018 (see Figure 5-6(b)). The decrease appears to be attributed to decreases of nitrate emission in the states and regions is due to reductions from mobile sources.

Figure 5-6 – Nitrate Contribution for 20% Least Impaired Days

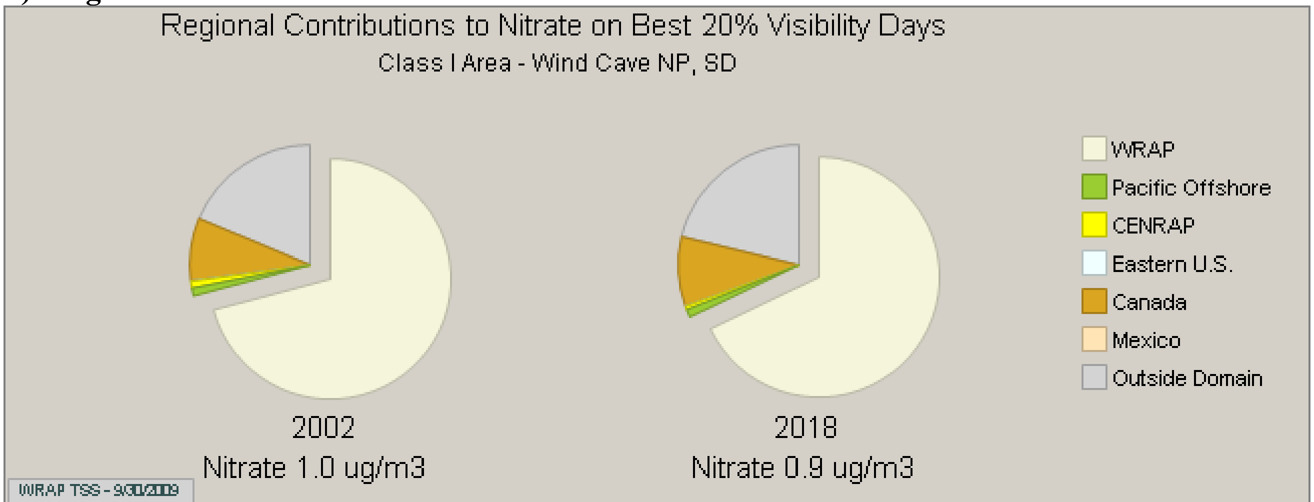
a) Regional Nitrate Contributions at Badlands

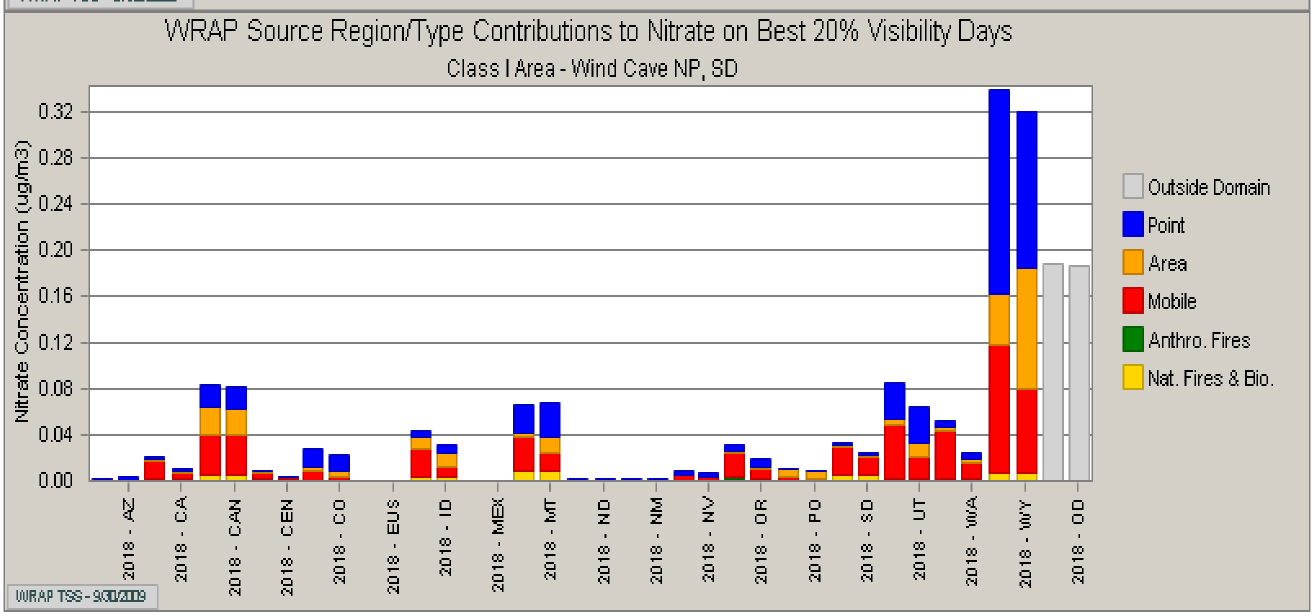


(WRAP TSS – http://vista.cira.colostate.edu/tss/)

The WRAP modeling indicates the greatest nitrate contribution for the 20% least impaired days at the Wind Cave National Park in 2002 is generated from Wyoming followed by Outside the Domain, Canada, Utah, and Montana. If you exclude Outside the Domain because the source categories were not identified, a majority of the nitrate contribution is generated from point, area, and mobile sources in 2002.

b) Regional Nitrate Contributions at Wind Cave





(WRAP TSS – http://vista.cira.colostate.edu/tss/)

In 2018, the greatest nitrate contribution for the 20% most impaired days at the Wind Cave National Park remains from Wyoming followed by Outside the Domain, Canada, Montana, and Utah. The sources of nitrate contribution remain the same from 2002 to 2018.

South Dakota's nitrate contribution in 2002 at the Wind Cave National Park is approximately 0.03 micrograms per cubic meter. The sources of nitrates in South Dakota are generated mainly from mobile sources in 2002. In 2018, South Dakota's nitrate contribution drops to 0.02 micrograms per cubic meter due mainly to reduction in mobile contributions. The reduction in mobile source contributions is due to new changes in federal emission standards from mobile sources.

5.3.4 Coarse Particulate Matter Contribution

Based on the IMPROVE data, coarse particulate matter contributes to visibility impairment in both the Badlands and Wind Cave National Parks. Coarse particulate matter contributions are not as great as ammonia sulfate or organic carbon mass but are significant enough to determine where the coarse particulate matter is being generated. Coarse particulate matter has the greater impact at the Badlands National Park then it does at the Wind Cave National Park during the 20% most impaired days. Figure 5-7 and 5-8 illustrates the state and regional contribution of coarse particulate matter during the 20% most and least impaired days in South Dakota's two Class I areas. The contributions are based on modeling of 2002 emission inventories of actual emissions and projected emissions in 2018. The bar chart identifies what state or region is contributing, the percentage of contribution, and what type of sources are contributing to coarse particulate matter for the 2002 base year and 2018 projections. WRAP identified 12 source categories: 1) windblown dust; 2) fugitive dust; 3) road dust; 4) off-road mobile; 5) on-road mobile; 6) off-shore; 7) WRAP area oil and gas; 8) area; 9) biogenic; 10) natural fires; 11) anthropogenic fire; and 12) point sources.

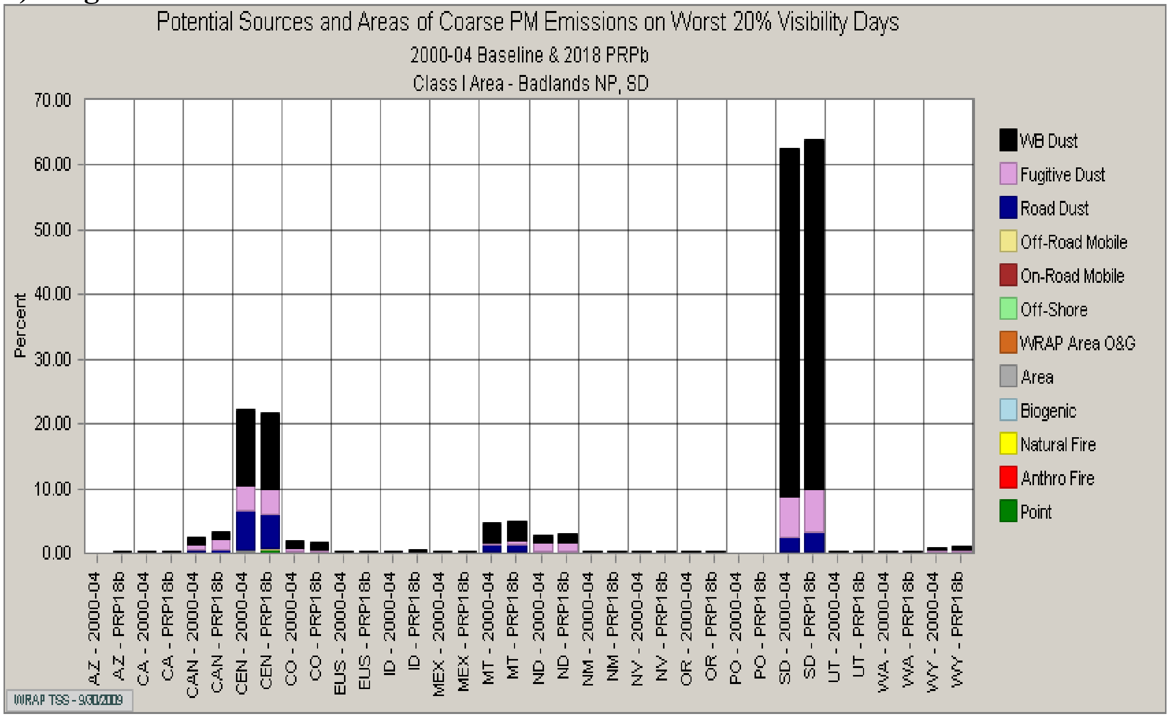
The WRAP modeling indicates the greatest percentage of coarse particulate matter contribution for the 20% most impaired days at the Badlands and Wind Cave National Park in 2002 and 2018 is generated from within South Dakota (see Figure 5-7). The percentage at the Badlands and Wind Cave National Park is approximately 62 and 44 percent, respectively. The CENRAP region contributes approximately 21 percent at the Badlands National Park; and almost 25 percent at the Wind Cave National Park. Montana contributes approximately four percent at the Badlands National Park while up to 12 percent at the Wind Cave National Park.

In all cases, the source of coarse particulate matter contributions is generated from windblown dust with some contribution from fugitive and road dust. For example, approximately 53 percent of South Dakota's 61 percent in 2002 at the Badlands National Park is attributed to windblown dust. South Dakota's windblown dust percentage at the Wind Cave National Park is less at 32 percent; but that is to be expected because of the dryer conditions and wide open areas in the Badlands National Park.

The WRAP modeling indicates the greatest percentage of coarse particulate matter contribution for the 20% least impaired days at the Badlands and Wind Cave National Park in 2002 and 2018 is also generated from within South Dakota (see Figure 5-8). The percentage at the Badlands and Wind Cave National Park is approximately 72 and 39 percent, respectively. The only other notable contributor at the Badlands National Park is Montana at approximately 12 percent. At the Wind Cave National Park, Montana's influence is greater at approximately 29 percent. Wyoming contributes approximately 11 percent at the Wind Cave National Park.

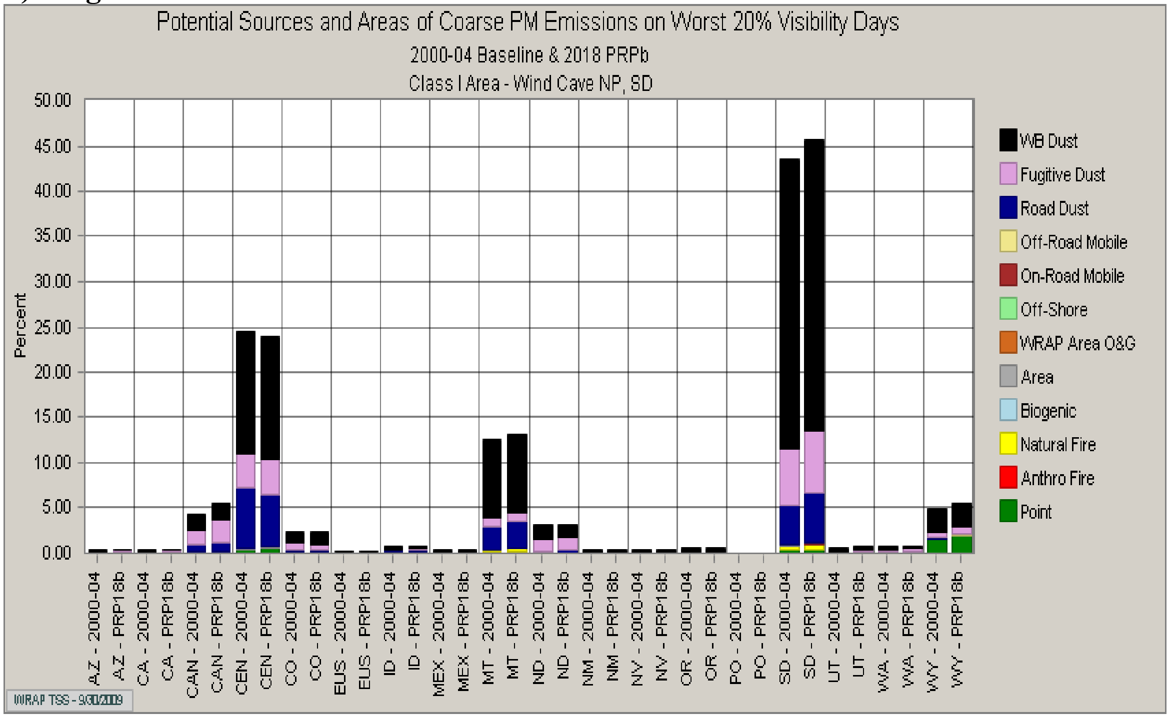
Figure 5-7 – Coarse Particulate Matter Contribution for 20% Most Impaired Days

a) Regional Coarse Particulate Matter Contributions at Badlands



(WRAP TSS – http://vista.cira.colostate.edu/tss/)

b) Regional Coarse Particulate Matter Contributions at Wind Cave

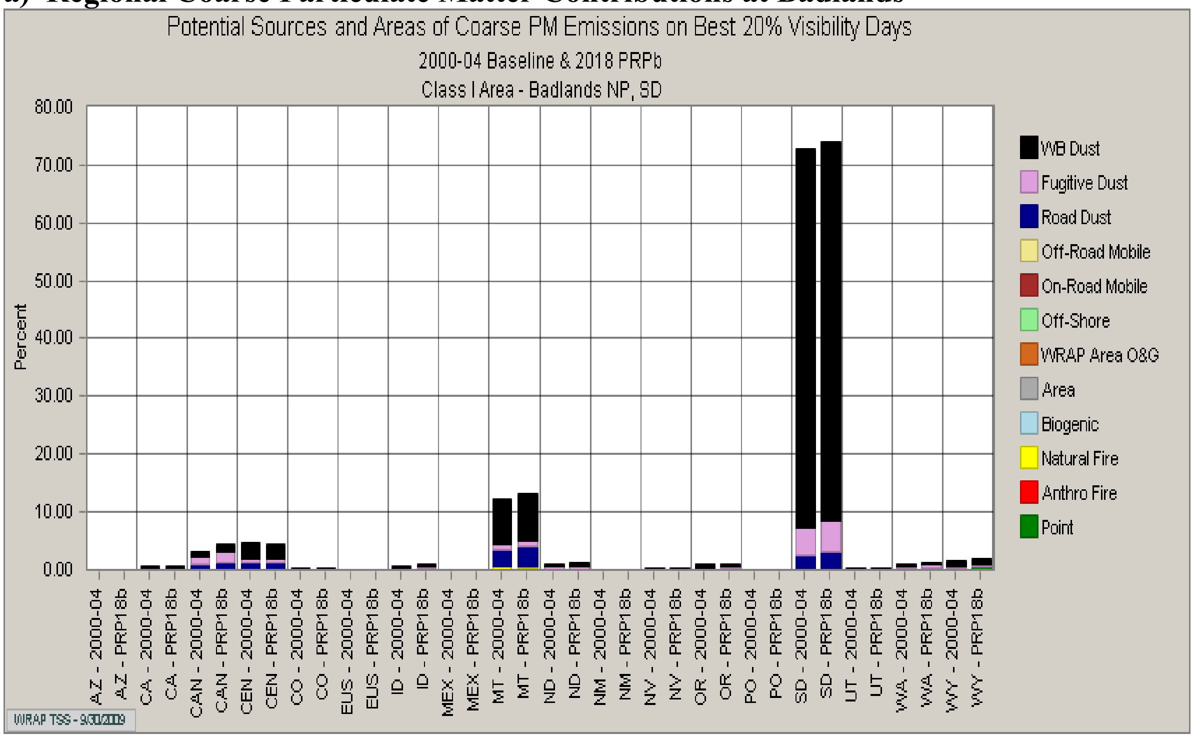


(WRAP TSS – http://vista.cira.colostate.edu/tss/)

In the Badlands National Park, the source of coarse particulate matter contributions is generated from windblown dust with some contribution from fugitive and road dust. For example, approximately 64 percent of South Dakota's 72 percent in 2002 at the Badlands National Park is attributed to windblown dust. At Wind Cave National Park, windblown dust is still the major contributor but fugitive and road dust have a greater role in South Dakota and Montana; while in Wyoming point sources have a greater role. South Dakota's windblown dust percentage at the Wind Cave National Park is less at 25 percent; but that is to be expected because of the dryer conditions and wide open areas in the Badlands National Park.

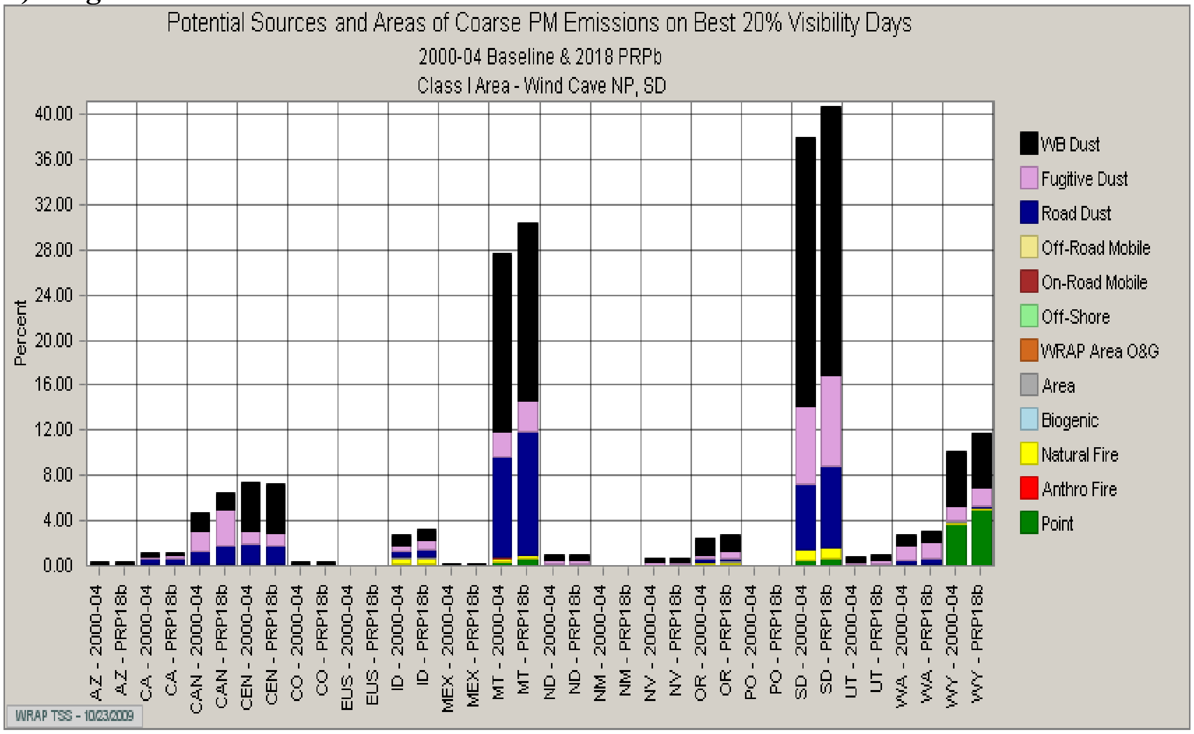
Figure 5-8 – Coarse Particulate Matter Contribution for 20% Least Impaired Days

a) Regional Coarse Particulate Matter Contributions at Badlands



(WRAP TSS – http://vista.cira.colostate.edu/tss/)

b) Regional Coarse Particulate Matter Contributions at Wind Cave



(WRAP TSS – http://vista.cira.colostate.edu/tss/)

6.0 Best Available Retrofit Technology (BART)

6.1 Bart-Eligible Sources

In accordance with 40 CFR § 51.308(e), South Dakota's State Implementation Plan is required to contain emission limitations representing BART and schedules for compliance with BART for each BART-eligible source that may reasonably be anticipated to cause or contribute to any impairment of visibility in any mandatory Class I area. A BART-eligible source is an existing stationary facility that is any of the following stationary sources of air pollutant that was not in operation prior to August 7, 1962, was in existence on August 7, 1977, and has the potential to emit 250 tons per year or more of any air pollutant. Fugitive emissions must be included in the potential to emit, to the extent quantifiable.

1. Fossil-fuel fired steam electric plants of more than 250 million British thermal units per hour heat input,
2. Coal cleaning plants (thermal dryers),
3. Kraft pulp mills,
4. Portland cement plants,
5. Primary zinc smelters,
6. Iron and steel mill plants,
7. Primary aluminum ore reduction plants,
8. Primary copper smelters,
9. Municipal incinerators capable of charging more than 250 tons of refuse per day,

10. Hydrofluoric, sulfuric, and nitric acid plants,
11. Petroleum refineries,
12. Lime plants,
13. Phosphate rock processing plants,
14. Coke oven batteries,
15. Sulfur recovery plants,
16. Carbon black plants (furnace process),
17. Primary lead smelters,
18. Fuel conversion plants,
19. Sintering plants,
20. Secondary metal production facilities,
21. Chemical process plants,
22. Fossil-fuel boilers of more than 250 million British thermal units per hour heat input,
23. Petroleum storage and transfer facilities with a capacity exceeding 300,000 barrels,
24. Taconite ore processing facilities,
25. Glass fiber processing plants, and
26. Charcoal production facilities.

In February 2004, DENR followed the procedures in 40 CFR Part 51, Appendix Y in identifying emission units at stationary facilities in South Dakota meeting the above categories, identifying the startup date of the emission units, comparing the potential emissions to the 250 tons per year cutoff, and identifying the emissions units and pollutants that constitute the BART-eligible sources. The following terms are defined below:

1. "In Operation" means engaged in activity related to the primary design function of the source. The date the unit is permitted is not important to meet this test because the focus is on actual operation of the unit;
2. "In Existence" means that the owner or operator has obtained all necessary preconstruction approvals or permits required by federal, state, or local air pollution emissions and air quality laws or regulations and either has (1) begun, or caused to begin, a continuous program of physical on-site construction of the facility or (2) entered into binding agreements or contractual obligations, which cannot be canceled or modified without substantial loss to the owner or operator, to undertake a program of construction of the facility to be completed in a reasonable time;
3. "Date of Reconstruction" must occur during the August 7, 1962 to August 7, 1977 time period; and
4. "Potential to Emit" means the maximum capacity of a stationary source to emit a pollutant under its physical and operational design. Any physical or operational limitation on the capacity of the source to emit a pollutant including air pollution control equipment and restrictions on hours of operation or on the type or amount of material combusted, stored, or processed, shall be treated as part of its design if the limitation or the effect it would have on emissions is federally enforceable. Secondary emissions do not count in determining the potential to emit of a stationary source. However, fugitive emissions, to the extent quantifiable, must be counted for the 26 categories.

In accordance with 40 CFR § 51.308(e)(1)(i), Table 6-1 provides a list of existing stationary facilities from the February 2004 analysis that may be considered a BART-eligible source and need further investigation to determine if they are subject to BART.

Table 6-1– List of BART-Eligible Sources [1]

Unit	Date	Maximum Capacity	Potential to Emit				BART Eligible
			TSP	SO_2	NOx	VOC	
Northern States Power Company – Sioux Falls							
#1 – Babcock boiler	1969	330 MMBtus/hr	7	1	795	2	Yes
#2 – Babcock boiler	1969	330 MMBtus/hr	7	1	795	2	Yes
#3 – Babcock boiler	1969	330 MMBtus/hr	7	1	795	2	Yes
Total =		**990 MMBtus/hr**	**21**	**3**	**2,385**	**6**	**Yes**
Pete Lien and Sons, Inc. – Rapid City							
#6 – Vertical kiln	1966	-	561	0	13	1	Yes
#7 – Pebble lime crusher	1970	-	1	0	0	0	Yes
#8 – Large hydrator	1965	-	97	0	0	0	Yes
#12 – Lime bagging	1963	-	48	0	0	0	Yes
Total =			707	0	13	1	**Yes**
Otter Tail Power Company – Big Stone I Power Plant							
#1 – Babcock boiler	1975	5,609 MMBtus/hr	300	19,863	17,179	125	**Yes**

[1] – "TSP" means total suspended particulate, "SO_2" means sulfur dioxide, "NOx" means nitrogen oxide, and "VOCs" means volatile organic compounds.

In accordance with 40 CFR Part 51, Appendix Y, the next step is to identify those BART-eligible sources that may "*emit any pollutant which may reasonably be anticipated to cause or contribute to any impairment of visibility*." For each source subject to BART, DENR is required to identify the best system of continuous emission control technology for each source after considering the following as specified in section 169A(g)(2) of the federal CAA:

1. Cost of compliance;
2. The energy and non-air quality environmental impacts of compliance;
3. Any existing pollution control technology in use at the source;
4. The remaining useful life of the source; and
5. The degree of visibility improvement which may reasonably be anticipated from the use of BART.

The results of the BART review are required to be submitted in the Regional Haze State Implementation Plan identifying the BART emission limitations and timeline for demonstrating compliance. The timeline for demonstrating compliance shall not exceed five years after EPA approves the Regional Haze State Implementation Plan. DENR may establish design, equipment, work practice or other operational standards when limitations on measurement technologies make emission standards infeasible.

6.1.1 Northern States Power Company – Sioux Falls

The three units at Northern States Power Company in Sioux Falls, South Dakota is considered fossil-fuel fired steam electric plant. The units were built in 1969 and have a maximum capacity greater than 250 million Btus per hour per unit. However, Northern States Power Company decommissioned these three units and they are no longer permitted to operate in Northern States Power Company's Title V air quality permit. Therefore, these three units at Northern States Power Company's Sioux Falls site are not subject to BART.

6.1.2 Pete Lien and Sons, Inc. – Rapid City

Pete Lien and Sons operates a limestone quarry operation and lime plant in northwest Rapid City. There are four operations that were identified in the February 2004 analysis, not in operation prior to August 7, 1962, and in existence on August 7, 1977. The four operations are a 1966 vertical kiln, 1970 pebble lime crusher, 1965 large hydrator, and 1963 lime bagging operation. Only the 1966 vertical kiln has the potential to emit over the 250 tons per year threshold.

As identified in Pete Lien and Sons' existing Title V air quality permit issued November 12, 2008, the 1970 pebble lime crusher was replaced with a 1982 pebble lime crusher and the 1963 bagging operation was replaced with a 2004 lime bagging operation. Therefore, these two units will not be evaluated further.

Pete Lien and Sons falls under the "lime plant" category listed above. DENR researched the definition of "lime plant" to determine if the large hydrator is included in the definition of a lime plant. DENR determined that typically the definition for the 26 categories coincides with the definitions under the New Source Performance Standards. Under 40 CFR Part 60, Subpart HH, a lime manufacturing plant means, "*…any plant which used a rotary lime kiln to produce lime product from limestone by calcinations.*" Based on this definition of a lime plant, Pete Lien and Sons would not be considered a lime plant because the kiln in question is a vertical kiln and not a rotary kiln. In addition, only the kiln would be considered a "lime plant".

DENR assumed the vertical kiln was considered a lime plant and on April 21, 2006, DENR requested that WRAP model Pete Lien and Sons emissions to determine if they would cause or contribute to any impairment of visibility in a Class I area. WRAP initiated this process by running CALMET/CALPUFF modeling using WRAP's "*CALMET/CALPUFF Protocol for BART Exemption Screening Analysis for Class I Areas in the Western United States*," August 15, 2006. The basic assumptions in the protocol are:

1. Use of three years of modeling consisting of calendar year 2001, 2002 and 2003;
2. Visibility impacts due to emissions of sulfur dioxide, nitrogen oxide and primary particulate matter emissions were calculated. Unless a state provided speciated particulate matter emissions, all PM emissions were modeled as $PM_{2.5}$. In this case all PM emissions were modeled as $PM_{2.5}$;
3. Visibility was calculated using the original IMPROVE equation and annual average natural conditions; and
4. CALPUFF version 6.112 was used in the analysis.

The CALPUFF modeling procedures are outlined in WRAP's BART Modeling Protocol, which can be reviewed at the following website:

http://pah.cert.ucr.edu/aqm/308/bart/WRAP_RMC_BART_Protocol_Aug15_2006.pdf.

Table 6-2 provides a summary of the modeling outputs based on annual sulfur dioxide and nitrogen oxide emissions of 0.4 and 277 tons per year, respectively.

Table 6-2– WRAP's Modeling Results for Pete Lien and Sons [1]

Class I Area	State	Minimum Distance	Max Delta (dv)	99th (dv)	Days >0.5	Annual 98th percentile 2001	2002	2003
Badlands	SD	73 km	0.267	0.140	0	0.120	0.160	0.105
Boundary Waters	MN	946 km	0.014	0.007	0	0.005	0.003	0.003
Bridger	WY	489 km	0.021	0.003	0	0.001	0.002	0.001
Fitzpatrick	WY	501 km	0.018	0.002	0	0.001	0.001	0.001
Grand Teton	WY	570 km	0.005	0.001	0	0.000	0.000	0.000
Lostwood	ND	509 km	0.040	0.009	0	0.006	0.005	0.007
Medicine Lake	MT	488 km	0.030	0.011	0	0.006	0.005	0.010
North Absaroka	WY	487 km	0.008	0.002	0	0.001	0.001	0.001
Teton	WY	513 km	0.009	0.001	0	0.001	0.001	0.000
Theodore Roosevelt	ND	311 km	0.049	0.023	0	0.014	0.016	0.015
Ul Bend	MT	516 km	0.024	0.006	0	0.005	0.003	0.005
Voyageurs	MN	921 km	0.012	0.006	0	0.004	0.002	0.003
Washakie	WY	461 km	0.019	0.003	0	0.001	0.002	0.001
Wind Cave	SD	52 km	0.366	0.203	0	0.128	0.137	0.139
Yellowstone	WY	524 km	0.008	0.002	0	0.001	0.001	0.001

[1] - "dv" means deciview and "km" means kilometers.

The modeling conducted by WRAP demonstrated that Pete Lien and Sons did not cause or contribute to visibility impairment at a Class I area. After reviewing the modeling inputs, DENR determined the vertical kiln should be modeled again because of errors in the UTM coordinates and emission rates. However, before the modeling could be re-run, the vertical kiln was shutdown and dismantled in 2009.

Although Pete Lien and Sons' existing Title V air quality permit still identifies the vertical kiln as a unit, permit condition 1.1 specifies in the footnote of Table 1-1 that Pete Lien and Sons is required to shutdown and dismantle the vertical kiln before the initial startup of Unit #45. Pete Lien and Sons fulfilled this commitment by notifying DENR on March 13, 2009, that the vertical kiln was shutdown and dismantled. Therefore, Pete Lien and Sons' shutdown and dismantled the unit subject to BART and DENR did not re-model the vertical kiln.

6.1.3 Otter Tail Power Company – Big Stone I

Unit #1 at the Big Stone I Power Plant was built in 1975, has a maximum capacity greater than 250 million Btus per hour, and has the potential to emit greater than 250 tons per year of any air pollutant. The next step in this analysis is to determine if Unit #1's emissions may reasonably be anticipated to cause or contribute to any impairment of visibility in a Class I area. On April 21, 2006, DENR requested that WRAP model Unit #1's emissions from Otter Tail Power Company's Big Stone I Power Plant.

WRAP initiated this process by running CALMET/CALPUFF modeling using WRAP's "CALMET/CALPUFF Protocol for BART Exemption Screening Analysis for Class I Areas in the Western United States," August 15, 2006. The basic assumptions in the protocol are:

1. Use of three years of modeling of 2001, 2002 and 2003;
2. The sulfur dioxide, nitrogen oxide and particulate emission rates represent the 24-hour average actual emission rate from the highest emitting day of the meteorological period modeled, not including periods of startup, shutdown, or malfunctions;
3. Visibility impacts due to emissions of sulfur dioxide, nitrogen oxide and primary particulate matter emissions were calculated. Unless a state provided speciated particulate matter emissions, all PM emissions were modeled as $PM_{2.5}$;
4. Visibility was calculated using the original IMPROVE equation and annual average natural conditions; and
5. CALPUFF version 6.112 was used in the analysis.

The CALPUFF modeling procedures are outlined in WRAP's BART Modeling Protocol and can be reviewed at the following website:

http://pah.cert.ucr.edu/aqm/308/bart/WRAP_RMC_BART_Protocol_Aug15_2006.pdf.

Table 6-3 provides a summary of the modeling outputs based on annual sulfur dioxide and nitrogen oxide emissions of 12,409 and 15,580 tons per year, respectively. The annual sulfur dioxide and nitrogen oxide emissions were derived from WRAP's BART protocol identified above.

Table 6-3– WRAP's Modeling Results for Otter Tail Power Company Big Stone I [1]

Class I Area	State	Min Distance	Max Delta (dv)	99th (dv)	Days >0.5	Annual 98th percentile 2001	2002	2003
Badlands	SD	470 km	3.047	1.076	21	0.364	0.417	**0.683**
Boundary Waters	MN	431 km	1.653	1.133	63	**0.951**	**0.659**	**1.034**
Bridger	WY	1,041 km	0.147	0.003	0	0.001	0.001	0.000
Fitzpatrick	WY	1,050 km	0.079	0.005	0	0.001	0.001	0.000
Grand Teton	WY	1,112 km	0.029	0.003	0	0.001	0.001	0.000
Lostwood	ND	585 km	0.779	0.370	7	0.263	0.175	0.204
Medicine Lake	MT	690 km	0.678	0.345	7	0.256	0.211	0.218
North Absaroka	WY	1,013 km	0.121	0.026	0	0.011	0.008	0.001
Teton	WY	1,052 km	0.049	0.008	0	0.004	0.002	0.001
Theodore Roosevelt	ND	555 km	2.061	0.840	27	**0.581**	0.443	**0.687**

Class I Area	State	Min Distance	Max Delta (dv)	99th (dv)	Days >0.5	Annual 98th percentile 2001	2002	2003
Ul Bend	MT	902 km	0.840	0.196	3	0.089	0.065	0.043
Voyageurs	MN	438 km	1.658	0.915	52	**0.666**	**0.703**	**0.729**
Washakie	WY	1,006 km	0.090	0.018	0	0.007	0.005	0.001
Wind Cave	SD	572 km	1.545	0.631	13	0.224	0.263	0.261
Yellowstone	WY	1,049 km	0.068	0.018	0	0.009	0.004	0.001

[1] - "dv" means deciview and "km" means kilometers.

WRAP had determined that Big Stone I would be reasonably anticipated to contribute to an impairment of visibility at the Badlands National Park in South Dakota, Theodore Roosevelt National Park in North Dakota, and Boundary Waters Wilderness and Voyageurs National Park in Minnesota.

6.2 Otter Tail Power Company's Modeling Results

Otter Tail Power Company was notified of the results and requested an opportunity to verify the results after identifying several errors in actual emission rates and stack parameters. The department allowed Otter Tail Power Company to re-run the models using the correct emission rates and stack parameters. On March 19, 2008, Otter Tail Power Company submitted an individual source analysis using CALMET/CALPUFF; but after review by the state, EPA, and federal land managers (U.S. Fish and Wildlife Service, U.S. Forest Service and National Park Service) it was determined that a BART modeling protocol should be submitted and approved by all parties, Otter Tail Power Company would run the model using the approved protocol, and submit before Otter Tail Power Company's results could be approved.

Otter Tail Power Company submitted the BART modeling protocol on January 16, 2009. After several conference calls and discussions, a revised protocol identified as June 2009, was submitted July 1, 2009. After several submittals and conference calls, Otter Tail Power Company committed to make the following changes to the protocol in an email dated August 31, 2009:

1. Although Otter Tail Power Company attached the CALMET switches it would use, it committed to using the CALMET switches recommended and approved by EPA and Federal Land Managers (FLMs) dated August 20, 2009. However, to ensure the most up-to-date CALMET switches are used, DENR is requiring Otter Tail Power Company to use the CALMET switches identified in EPA's memorandum dated August 31, 2009, from Tyler J Fox, Group Leader, Air Quality Modeling Group, to EPA Regional Modeling Contacts. The date on the listing of CALMET switches is August 28, 2009. The memorandum may be viewed in Attachment C.
2. Otter Tail Power Company committed to use the CALPUFF switches that Penny Shamblin, with Hunton and Williams, submitted to DENR by email on August 19, 2009. Although the document contains CALMET switches, only the CALPUFF switches (see Attachment D) in this email will be used by Otter Tail Power Company in the BART analysis. The CALMET switches mentioned above will be the ones used in the analysis.

3. Otter Tail Power Company proposes to revise the June 2009 modeling protocol by using a 12 kilometer MM5 grid and a 4 kilometer CALMET grid rather than the 4 kilometer MM5 grid and 4 kilometer CALMET grid identified in the June 2009 modeling protocol. DENR reviewed other acceptable modeling protocols and is acceptable to this change.
4. Although Otter Tail Power Company may run POSTUTIL option MNITRATE=2 for its own purposes, the modeling results DENR will accept for the BART analysis will be MNITRATE=1.

The CALPUFF switches Otter Tail Power Company is recommending contains five switches that are different than those recommended by EPA as defaults. The following identifies the variable, EPA's default, recommended default by Otter Tail Power Company, and DENR's response:

1. "NSPEC" – Identifies the number of species modeled. The EPA default is 5 and Otter Tail Power Company is proposing 11, which follows the FLM guidance on particle speciation and size. DENR is agreeable to this change.
2. "NSE" – Number of species emitted. The EPA default is 3 and Otter Tail Power Company is proposing 9.
3. "MSPLIT" – Allows puffing. The EPA default is 0 (No) and Otter Tail Power Company is proposing 1 (Yes). Puff splitting in necessary due to the distance from Big Stone I to a federal Class I area. DENR is agreeable to this change.
4. "MESHDN" – Grid receptor spacing. The EPA default is 1; however, Otter Tail Power Company is stating this is "Not Applicable". DENR is agreeable to this change.
5. "BCKNH3" – Ammonia background. The EPA default is 10 parts per billion and Otter Tail Power Company is recommending 1 part per billion. During the June 3, 2009, conference call, EPA stated it was okay with this change. DENR is agreeable to this change.

On September 18, 2009, the department determined that Otter Tail Power Company's BART modeling protocol as identified above. See Appendix A for the approval letter and the BART modeling protocol dated June 2009.

The modeling results identified that Otter Tail Power Company's Big Stone I Power Plant would be reasonably anticipated to contribute to an impairment of visibility at the Boundary Waters and Voyageurs federal Class I areas in northern Minnesota and the Isle Royale federal Class I area in Michigan. The reasonably anticipated to contribute to an impairment is based on visibility impacts greater than 0.5 deciview based on the 98^{th} percentile at the three federal Class I areas. See Appendix B for the modeling report dated October 2009, and Table 6-4 for a summary of the modeling results.

Table 6-4– Otter Tail Power Company's Modeling Results for Big Stone I [1]

Class I Area	State	Min Distance	Max Delta (dv)	99th (dv)	98th (dv)
Badlands	SD	470 km	2.202	0.698	**0.481 (0.5)**
Boundary Waters	MN	431 km	3.574	1.351	**1.079 (1.1)**
Lostwood	ND	585 km	1.110	0.722	0.409 (0.4)
Theodore Roosevelt	ND	555 km	2.232	0.772	**0.459 (0.5)**
Voyageurs	MN	438 km	2.162	1.376	**0.724 (0.7)**
Wind Cave	SD	572 km	1.671	0.591	0.325 (0.3)
Isle Royale	MI	1,049 km	1.806	0.789	**0.665 (0.7)**

[1] - "dv" means deciview and "km" means kilometers.

Otter Tail Power Company results did not match up entirely with the modeling conducted by WRAP. In particular, Otter Tail Power Company's modeling also showed that Big Stone I would reasonably contribute to impairment at the Isle Royale National Park in Michigan. DENR believes Otter Tail Power Company's modeling best represent the visibility impacts from Big Stone I since the original modeling did not have the correct emission rates and stack parameters and the CALPUFF modeling conducted by Otter Tail Power Company included puff splitting, which helps improve the accuracy of the model when used for great distances.

In accordance with the 40 CFR Part 51, Appendix Y, DENR used a contribution threshold of 0.5 deciviews for determining if Otter Tail Power Company's Big Stone I facility is subject to BART. The guideline provides the state the discretion to set a threshold below 0.5 deciviews if "the location of a large number of BART-eligible sources within the state and proximately to a Class I area justifies this approach. The discretion was based on the following factors:

1. It equates to the 5 percent extinction threshold for new sources under the PSD New Source Review rules;
2. It is consistent with the threshold selected by other states in the west, which all selected 0.5 deciviews; and
3. It represents the limit of perceptible change.

DENR chose the 0.5 deciview threshold because there is only one source that is BART-eligible and it is greater than 300 kilometers from any Class I area. Therefore, DENR will establish this threshold in its proposed ARSD Chapter 74:36:21 – Regional Haze Program. Otter Tail Power Company's Big Stone I power plant exceeded this threshold and is subject to BART. In accordance with 40 CFR § 51.308(e)(1)(i), the only source subject to BART in South Dakota is Otter Tail Power Company's Big Stone I facility.

In accordance with 40 CFR § 51.308(e)(1)(ii), DENR requested that Otter Tail Power Company complete a Case-by-Case BART analysis, which includes determining the visibility improvements expected at each of these Class I areas (see Appendix C).

6.3 Otter Tail Power Company's Case-by-Case BART Analysis

In accordance with 40 CFR 51.301, Best Available Retrofit Technology (BART) is defined as *"an emission limitation based on the degree of reduction achievable through the application of the best system of continuous emission reduction for each pollutant which is emitted by an existing stationary facility. The emission limitation must be established, on a case-by-case basis, taking into consideration the technology available, the costs of compliance, the energy and nonair quality environmental impacts of compliance, any pollution control equipment in use or in existence at the source, the remaining useful life of the source, and the degree of improvement in visibility which may reasonably be anticipated to result from the use of such technology."*

In accordance with 40 CFR § 51.308(e)(1)(ii)(B), the determination of BART for fossil fuel fired power plants having a total generating capacity greater than 750 megawatts must be made pursuant to the guidelines in Appendix Y of this part (Guidelines for BART Determinations under the Regional Haze Rule). Appendix Y identifies a five step process in determining BART. The five steps are as follows:

1. STEP 1—Identify All Available Retrofit Control Technologies: In identifying ''all'' options, one should identify the most stringent option and a reasonable set of options for analysis that reflects a comprehensive list of available technologies. It is not necessary to list all permutations of available control levels that exist for a given technology. The list is complete if it includes the maximum level of control each technology is capable of achieving. Where a New Source Performance Standard (NSPS), under 40 CFR Part 60, exists for a source category, one should include a level of control equivalent to the NSPS as one of the control options;
2. STEP 2—Eliminate Technically Infeasible Options: One evaluates the technical feasibility of the control options identified in Step 1. One should document a demonstration of technical infeasibility and should explain, based on physical, chemical, or engineering principles, why technical difficulties would preclude the successful use of the control option on the emissions unit under review. One may then eliminate such technically infeasible control options from further consideration in the BART analysis;
3. STEP 3—Evaluate Control Effectiveness of Remaining Control Technologies: One evaluates the control effectiveness of all the technically feasible control alternatives identified in Step 2 for the pollutant and emissions unit under review. Two key issues in this process include: (1) Make sure that you express the degree of control using a metric that ensures an ''apples to apples'' comparison of emissions performance levels among options; and (2) Give appropriate treatment and consideration of control techniques that can operate over a wide range of emission performance levels;
4. STEP 4—Evaluate Impacts and Document the Results: Once the available and technically feasible control technology options are identified, one should conduct the following analyses when you make a BART determination: (1) Impact analysis part 1 – costs of compliance; (2) Impact analysis part 2 – energy impacts, (3) Impact analysis part 3 – non-air quality environmental impacts; and (4) Impact analysis part 4 – remaining useful life; and
5. STEP 5—Evaluate Visibility Impacts: One should evaluate the net visibility improvement form the available and technically feasible control technology options.

This is accomplished by modeling the pre-control and post-control emission rates according to an accepted methodology.

In determining what is considered BART, Appendix Y identifies that the state should develop a chart (or charts) displaying each of the alternatives and include: (1) Expected emission rate (e.g., tons per year, pounds per hour); (2) Emissions performance level (e.g., percent pollutant removed, emissions per unit product, pounds per million Btus, parts per million); (3) Expected emissions reductions (e.g., tons per year); (4) Costs of compliance (e.g., total annualized costs in dollars, cost effectiveness (dollar per ton), incremental cost effectiveness (dollar per ton), any other cost-effectiveness measures (dollar per deciview)); (5) Energy impacts; (6) Non-air quality environmental impacts; and (7) Modeled visibility impacts.

Otter Tail Power Company's Big Stone I facility does not have a total generating capacity greater than 750 megawatts. Therefore, DENR is not required to follow these guidelines. As such, DENR will follow the steps identified in Appendix Y with some slight differences. For example, in identifying the available control technologies, DENR is not listing any of the permutations of the control levels for each identified control technology as suggested by EPA's guidance. DENR will use the initial step to identify control technologies without including the control levels. Step 3 is used to evaluate the control effectiveness or permutations of the control levels for those control technologies that are considered feasible to install or maintain as identified in Step 2.

6.3.1 Particulate BART Review

6.3.1.1 Particulate Control Technologies

Step 1 requires the identification of all available retrofit control technologies. The particulate matter emissions from fossil-fuel fired units can be categorized as either filterable or condensable particulate. The filterable particulate matter exists as a solid or liquid particle in the exhaust of a boiler as it leaves the stack. As such, the filterable particulate may be collected by placing a control device in the flue gas stream prior to the stack. Condensable particulates are emitted out the stack in a gaseous state but rapidly condense into particles when released into the atmosphere and cooled. Therefore, condensable particulates may not be readily collected by placing a control device in the stack.

Those control technologies being reviewed under Step 1 are those that would control the filterable particulate matter. Otter Tail Power Company identified the following control options for particulate matter.

1. Existing fabric filter (baghouse);
2. New fabric filter (baghouse);
3. Compact hybrid particulate collector; and
4. Electrostatic precipitator.

DENR also identified two more control technologies that may be used to control particulate emissions and are listed below:

1. Wet scrubber; and
2. Cyclone(s)/Multicyclone(s).

6.3.1.2 Technically Feasible Particulate Control Technologies

Step 2 requires the elimination of any control technologies identified in Step 1 that are technically infeasible. A compact hybrid particulate collector is a combination of an electrostatic precipitator and a baghouse in series. The compact hybrid particulate collector is generally operated with a higher air-to-cloth ratio than a typical baghouse. Since Otter Tail Power Company already has a baghouse installed at Big Stone I, Otter Tail did not further consider the compact hybrid particulate collector.

Even though Otter Tail Power Company identified a reason for not selecting the compact hybrid particulate collector, the reasoning does not identify that the technology is infeasible to install. Since both an electrostatic precipitator and a baghouse are both technically feasible options and without further evidence, DENR considers the compact hybrid particulate collector as a feasible control technology.

DENR determined that the following particulate control technologies were feasible for Otter Tail Power Company:

1. Existing fabric filter (baghouse);
2. New fabric filter (baghouse);
3. Compact hybrid particulate collector;
4. Electrostatic precipitator;
5. Wet scrubber; and
6. Cyclone(s)/Multicyclone(s).

6.3.1.3 Particulate Control Effectiveness

Step 3 requires the evaluation of control effectiveness for each control technology. DENR evaluated the control effectiveness by comparing the effectiveness in Table 6.5.

Table 6-5 – Comparison of Control Effectiveness for Particulate Controls

		Emission Rate		Control Efficiency	
		Otter Tail [1]	RBLC [3]	PFDR [4]	IEA [5]
Rank	**Control**	**(lbs/MMBtus) [2]**	**(lbs/MMBtus) [2]**	**(%)**	**(%)**
#1	**Baghouse**	0.015	0.010 to 0.03	95 to 99.9	>99 to >99.9999
#2	**Electrostatic Precipitator**	0.015	0.015 to 0.03	80 to 99.5	>99 to >99.99
#3	**COHPAC [6]**	Not Provided	0.015	Not Identified	Not Identified
#4	**Wet Scrubber(s)**	Not Provided	Not Identified	75 to 99	90 to 99.9
#5	**Cyclone(s)/ Multicyclone(s)**	Not Provided	Not Identified	50 to 95	75 – 99

[1] – The identified emission rates were identified in Otter Tail Power Company's BART analysis;
[2] – "lbs/MMBtus" means pounds per million British thermal units;
[3] – The identified emission rates were obtained from EPA's Reasonable Achievable Control Technology, Best Available Control Technology, and Lowest Achievable Emission Rate Clearinghouse (RBLC) considering data for permits issued after calendar year 2000;
[4] – The control efficiencies, in percent removal, are derived from page 473 of "Particulates and Fine Dust Removal Process and Equipment by Marshal Sittig";
[5] – The control efficiencies, in percent removal, are derived from the IEA Clean Coal Centre's Webpage at http://www.iea-coal.org.uk/site/ieacoal/home; and
[6] – "COHPAC" means Compact Hybrid Particulate Collector.

6.3.1.4 Particulate Control Technology Impacts

In Step 4, DENR looked at impacts associated with the control alternatives such as cost of compliance, energy impacts, non-air quality environmental impacts, and the remaining useful life of the project. These impacts are intended to provide rational in choosing between the alternative control options when determining what is considered BART. Otter Tail Power Company already has installed and is operating a baghouse, which is the top particulate control technology. Therefore, there is no additional compliance cost, energy impacts, etc. that Otter Tail Power Company would have to endure. As such, no additional impacts analysis will be conducted to determine the appropriate controls for particulate matter.

6.3.2 Sulfur Dioxide BART Review

6.3.2.1 Sulfur Dioxide Control Technologies

Step 1 requires the identification of all available retrofit control technologies. Otter Tail Power Company identified the following control options for sulfur dioxide:

1. Fuel switching;
2. Semi-dry flue gas desulfurization; and
3. Wet flue gas desulfurization.

DENR also identified the following control technologies that may be used to control sulfur dioxide emissions:

1. Coal cleaning;
2. Coal upgrading;
3. Hydrated lime injection; and
4. Emerging control technologies such as Enviroscrub, Electro catalytic oxidation, and Airborne process.

6.3.2.2 Technically Feasible Sulfur Dioxide Control Technologies

Fuel switching is a viable method to reduce sulfur dioxide emissions by switching to a fuel with lower sulfur content. Otter Tail Power Company's Big Stone facility's primary fuel source is subbituminous coal obtained from the Powder River Basin in Wyoming. Powder River Basin subbituminous coal has one of the lowest sulfur contents available in the United States. As such, Otter Tail Power Company has already implemented fuel switching.

Coal cleaning is typically performed by physical gravimetric separation which is capable of reducing sulfur, ash and impurities from the coal. The effectiveness of gravimetric separation is dependent on the ash content and the distribution of fuel bound sulfur between organic and inorganic. If the sulfur compounds are predominantly inorganic materials, then coal cleaning is fairly effective, but if the sulfur compounds are predominantly organic materials, then coal cleaning is not effective. Physical cleaning or gravimetric separation may be effective with bituminous coals that contain high levels of inorganic sulfur and ash. However, gravimetric coal cleaning is not technically feasible for low sulfur, low ash, and low inorganic-sulfur content coal such as the coal from the Powder River Basin in Wyoming. Otter Tail Power Company's Big Stone facility's primary fuel source is subbituminous coal obtained from the Powder River Basin in Wyoming. As such, coal cleaning is not a technical feasible option for Otter Tail Power Company.

Coal upgrading such as a process developed by Evergreen Energy (formerly KFx) called the K-Fuel process enriches the coal by utilizing high pressure and temperature conditions to reduce moisture and inorganic materials. Typically, the K-Fuel process is utilized to reduce the moisture content and increase the coal heating value, however, the process may remove some sulfur compounds. Evergreen Energy constructed a K-Fuel production facility in Gillette, Wyoming which may produce approximately 750,000 tons per year of K-Fuel. Otter Tail Power Company burned approximately 2,268,000 tons of coal in 2008. As such, coal upgrading is not a technically feasible option for Otter Tail Power Company because there is not enough being produced to supply Otter Tail Power Company's needs. In addition, based on Evergreen Energy's webpage, this facility has been idle since calendar year 2008.

Hydrated lime injection is a system that injects hydrated lime prior to the particulate collection system. The hydrated lime absorbs the sulfur dioxide and is collected in the particulate control device. Hydrated lime is also referred to as calcium hydroxide. The sulfur dioxide reacts with the calcium hydroxide to form calcium sulfate or calcium sulfite. Fly ash from the Powder River Basin has a calcium content of up to 30 percent. Since the Powder River Basin coal is already providing additional calcium to adsorb sulfur dioxide, the hydrated lime will not likely provide additional sulfur dioxide removal. Otter Tail Power Company's primary fuel source is subbituminous coal obtained from the Powder River Basin in Wyoming. As such, hydrated lime injection is not considered a technically feasible option for Otter Tail Power Company since the concept is already taking place by using Power River Basin coal.

Emerging control technologies such as Enviroscrub, Electro catalytic oxidation, and the Airborne process have not been commercially available and have not been demonstrated for long-term levels of performance. As noted in 40 CFR Part 51, Appendix Y, a control technology needs to be commercially available to be considered technically feasible. As such these emerging technologies are not considered technically feasible options for Otter Tail Power Company.

DENR determined that the following sulfur dioxide control technologies were feasible for Otter Tail Power Company:

1. Semi-dry flue gas desulfurization; and
2. Wet flue gas desulfurization.

6.3.2.3 Sulfur Dioxide Control Effectiveness

Step 3 requires the evaluation of control effectiveness for each control technology. DENR evaluated the control effectiveness by comparing the effectiveness in Table 6.6.

Table 6-6 – Comparison of Control Effectiveness for Sulfur Dioxide Controls

		Emission Rate			Control Efficiency
		Otter Tail [1]	**RBLC** [3]	**Basin** [4]	**EPA** [5]
Rank	**Control**	**(lbs/MMBtus)** [2]	**(lbs/MMBtus)** [2]	**(lbs/MMBtus)** [2]	**(%)**
#1	**Wet Flue Gas Desulfurization**	0.043 to 0.15	0.1 to 0.167	0.05	90 to 98
#2	**Semi-Dry Flue Gas Desulfurization**	0.09 to 0.15	0.038 to 0.16	0.07	80 to 90

[1] – The identified emission rates were identified in Otter Tail Power Company's BART analysis;
[2] – "lbs/MMBtus" means pounds per million British thermal units;
[3] – The identified emission rates were obtained from EPA's Reasonable Achievable Control Technology, Best Available Control Technology, and Lowest Achievable Emission Rate Clearinghouse (RBLC) considering data for permits issued after calendar year 2000;
[4] – The emission rates are based on the BACT analysis provided by Basin Electric Power Cooperative's proposed NextGen project in South Dakota; and
[5] – The control efficiencies, in percent removal, are from EPA's "Air Pollution Control Technology Fact Sheet on Flue Gas Desulfurization Systems".

6.3.2.4 Sulfur Dioxide Control Technology Impacts

Step 4 requires DENR to look at impacts associated with the control alternatives such as cost of compliance, energy impacts, non-air quality environmental impacts, and the remaining useful life of the project. These impacts are intended to provide rational in choosing between the alternative control options when determining what is considered BART.

Otter Tail Power Company identified cost estimates for each of the control options. In addition, Otter Tail Power Company identified cost estimated for two different operating scenarios for each of the two control alternatives. Table 6-7 summarizes Otter Tail Power Company's estimated costs.

In 40 CFR Part 51, Appendix Y – Guidelines for BART Determination Under the Regional Haze Rule, in the section titled "How should I determine visibility impacts in the BART determination" it notes that the model should use the 24-hour average actual emission rate from the highest emitting day of the meteorological period modeled (for the pre-control scenario). The 18,000 tons per year of sulfur dioxide is based on the highest average 24-hour average emission rate (4,832 pounds per hour) for calendar years 2001 through 2003 and operating 85% of the time or 7,746 hours per year. Based on the BART guidelines, the baseline emissions are 18,000 tons per year.

Table 6-7 – Comparison of Control Effectiveness for Sulfur Dioxide Controls

Control Option	Capital Cost	O&M [1]	Annual Cost [2]	Reduction [3]	Cost Effectiveness [4]
WFGD #1 [5]	$171,800,000	$9,600,000	$29,050,000	17,100	$1,699
WFGD #2 [6]	$171,800,000	$9,490,000	$28,900,000	14,870	$1,944
SDFGD #1 [7]	$141,300,000	$7,660,000	$23,570,000	16,120	$1,462
SDFGD #2 [8]	$141,300,000	$7,480,000	$23,330,000	14,870	$1,569

[1] – O&M represents the operational and maintenance cost estimate for the control alternative;
[2] – Annual cost is the annualized cost for each control alternative taking into account both the capital and operational and maintenance costs;
[3] – Reduction represents the amount of sulfur dioxide reduced in tons per year annual from the baseline level of 18,000 tons of sulfur dioxide per year;
[4] – Cost Effectiveness represents the annualized cost divided by the identified emission reductions (dollar per ton);
[5] – WFGD #1 represents a wet flue gas desulfurization system meeting an emission rate of 0.043 pounds per million British thermal units;
[6] – WFGD #2 represents a wet flue gas desulfurization system meeting an emission rate of 0.15 pounds per million British thermal units;
[7] – SDFGD #1 represents a semi-dry flue gas desulfurization system meeting an emission rate of 0.9 pounds per million British thermal units; and
[8] – SDFGD #2 represents a semi-dry flue gas desulfurization system meeting an emission rate of 0.15 pounds per million British thermal units.

Otter Tail Power Company did not identify the cost effectiveness on a dollar per visibility reduction. DENR considered this cost effectiveness in Step 5 of the analysis.

Otter Tail Power Company identified the energy impacts cost associated for each of the control options. Table 6-8 summarizes Otter Tail Power Company's estimated energy impacts.

Table 6-8 – Estimated Energy Impacts for Sulfur Dioxide Controls

Control	Energy Demand	Percent of Generation
Wet Flue Gas Desulfurization	9,500 kilowatts	2.0 percent
Semi-Dry Flue Gas Desulfurization	3,325 kilowatts	0.7 percent

The non-air quality environmental impacts of the two control alternatives include the solid and aqueous waste streams. The semi-dry flue gas desulfurization system would be installed upstream of the existing baghouse. The baghouse would be used to collect the injected lime and reacted sulfur dioxide emissions along with other existing particulate matter emissions. Otter Tail Power Company did not identify how much additional particulate matter would be collected by the baghouse due to the use of the semi-dry flue gas desulfurization system. At this time, it is assume the additional material collected in the baghouse is negligible compared to the existing collection. Otter Tail Power Company estimates that the wet flue gas desulfurization system would generate an additional 44,700 tons of gypsum solids which would need to be properly disposed.

In conducting its cost analysis, Otter Tail Power Company used 30 years as the life expectancy averaging period for the control alternatives. Since the useful life of Otter Tail Power Company's Big Stone I facility is expected to be longer than 30 years, there is no difference between the control options based on useful life.

6.3.3 Nitrogen Oxide BART Review

6.3.3.1 Nitrogen Oxide Control Technologies

Step 1 requires the identification of all available retrofit control technologies. Otter Tail Power Company identified the following control options for nitrogen oxide:

1. Low-nitrogen oxide burners (LNBs);
2. Over-fire air (OFA);
3. Separated over-fire air (SOFA);
4. Selective non-catalytic reduction (SNCR);
5. Rich reagent injection (RRI); and
6. Selective catalytic reduction (SCR).

DENR also identifies the following control technologies that may be used to control nitrogen oxide emissions:

1. Flue-gas recirculation;
2. Oxygen enhanced combustion;
3. Catalytic absorption/oxidation;
4. Gas reburn; and
5. Emerging control technologies such as Enviroscrub, Electro-catalytic oxidation, NOxStar, and Cascade processes.

6.3.3.2 Technically Feasible Nitrogen Oxide Control Technologies

Low-nitrogen oxide burners limit nitrogen oxide formation by controlling the stoichiometric and temperature profiles of the combustion process. Low-nitrogen oxide burners attempt to delay the complete mixing of fuel and air as long as possible within the constraints of the furnace design. This is the reason flames from low-nitrogen oxide burners are longer than conventional burners. Cyclone furnace's length and diameter are not designed with sufficient size to allow for low-nitrogen oxide burners to be installed allowing stable combustion. As such, low-nitrogen oxide burners are not considered a technically feasible option for Otter Tail Power Company.

Flue-gas recirculation reduces the formation of thermal nitrogen oxide emissions in a boiler by limiting the amount of oxygen available for oxidation in the fuel rich zone of the boiler. Flue-gas recirculation is not known to reduce nitrogen oxide emissions any further when added with an over-fire air system. Therefore, Otter Tail Power Company did not conduct any further review of flue-gas recirculation. However, this reasoning does not justify that flue-gas recirculation is not a feasible technology to consider. Therefore, DENR will consider the flue-gas recirculation as a feasible control technology.

Catalytic absorption/oxidation such as SCONOx or EMx systems is a nitrogen oxide control technology that utilizes a proprietary catalytic oxidation and absorption technology which oxidizes nitrogen oxide (NO) and carbon monoxide (CO) to nitrogen dioxide (NO2) and carbon dioxide (CO2), respectively. The nitrogen dioxide is then absorbed onto an absorption media while carbon dioxide is released to the atmosphere. Once the absorption media becomes saturated, the nitrogen dioxide is desorbed and treated by a proprietary catalyst. The SCONOx system is being considered as a cross over technology to coal-fired boilers, but to date has only been applied to "clean flue gas" systems such as natural-gas fired combustions turbines. The catalytic absorption/oxidation system requires a high operating temperature and low particulate loading. Therefore, the system would have to be installed after the particulate control device and require a flue gas reheater. DENR was unable to find a coal-fired system that was using a catalytic absorption/oxidation system or find that this system was being marketed commercially for coal fired boilers. As noted in 40 CFR Part 51, Appendix Y, a control technology needs to be commercially available to be considered technically feasible. As such the catalytic absorption/oxidation system is not considered a technically feasible option for Otter Tail Power Company.

Gas reburning is a nitrogen oxide control technology that uses a second combustion zone following the primary combustion zone in the boiler. In a cyclone boiler, such as the one being operated at Otter Tail Power Company's Big Stone I facility, burning the coal produces molten slag along the cyclone barrels. The molten slag catches subsequent coal until the combustion is complete. Generally, cyclone burners operate near the slag-tapping limits. Therefore, using natural gas or another fuel source as the reburn fuel may inhibit the molten slag formation. In addition, by trying to lower the air to fuel ratio more than achieved by the existing over-fire air systems may cause slag "freezing" at low load levels. As such gas reburn is not considered a technically feasible option for Otter Tail Power Company.

Oxygen enhanced combustion is a nitrogen oxide combustion control technology that reduces the formation of thermal nitrogen oxides in the boiler. Developed by Praxair Technology Inc., this method uses oxygen in the burner instead of air to achieve additional nitrogen oxide reductions. To date, the largest demonstration of this technology is a 30 megawatt pilot demonstration at Babcock and Wilcock's Clean Environmental Development facility in Alliance, Ohio. As noted on Babcock and Wilcock's website - http://www.babcock.com/, the project was a pilot test of the technology and the next step is to demonstrate the technology at a commercial scale. As noted in 40 CFR Part 51, Appendix Y, a control technology needs to be commercially available to be considered technically feasible. As such the oxygen enhanced combustion is not considered a technically feasible option for Otter Tail Power Company.

Emerging control technologies such as Enviroscrub, Electro catalytic oxidation, and the Airborne process have not been commercially available and have not been demonstrated for long-term levels of performance. As noted in 40 CFR Part 51, Appendix Y, a control technology needs to be commercially available to be considered technically feasible. As such these emerging technologies are not considered technically feasible options for Otter Tail Power Company.

DENR determined that the following nitrogen oxide control technologies were feasible for Otter Tail Power Company:

1. Over-fire air (OFA);
2. Separated over-fire air (SOFA);
3. Selective non-catalytic reduction (SNCR);
4. Rich reagent injection (RRI);
5. Selective catalytic reduction (SCR) ; and
6. Flue-gas recirculation.

6.3.3.3 Nitrogen Oxide Control Effectiveness

Step 3 requires the evaluation of control effectiveness for each control technology. DENR evaluated the control effectiveness by comparing the effectiveness in Table 6.9.

Table 6-9 – Comparison of Control Effectiveness for Nitrogen Oxide Controls

		Emission Rate			Control Efficiency	
		Otter Tail [1]	RBLC [3]	Basin [4]	EPA [5]	IEA [6]
Rank	Control	(lbs/MMBtus) [2]	(lbs/MMBtus) [2]	(lbs/MMBtus) [2]	(%)	(%)
#1	**SCR and SOFA [7]**	0.10	0.05 to 0.1	0.05	35 to 90	80 to 90
#2	**RRI, SNCR and SOFA [8]**	0.20	0.07 to 0.15	0.10	35 to 90	30 to 50
#3	**SNCR and SOFA [9]**	0.35	0.07 to 0.15	0.10	35 to 90	30 to 50
#4	**Separated over-fire air**	0.50	Not Identified	Not Identified	30 to 70	Not Identified
#5	**Over-fire air**	0.65	Not Identified	Not Identified	30 to 70	Not Identified
#6	**Flue Gas Recirculation**	Not Identified	Not Identified	Not Identified	30 to 70	Not Identified

[1] – The identified emission rates were identified in Otter Tail Power Company's BART analysis;
[2] – "lbs/MMBtus" means pounds per million British thermal units;
[3] – The identified emission rates were obtained from EPA's Reasonable Achievable Control Technology, Best Available Control Technology, and Lowest Achievable Emission Rate Clearinghouse (RBLC) considering data for permits issued after calendar year 2000;
[4] – The emission rates are based on the BACT analysis provided by Basin Electric Power Cooperative's proposed NextGen project in South Dakota which is for a new pulverized-fired boiler equipped with a low-NOx burner combustion technology. The emission rates were primarily based on if the system used selective catalytic reduction or selective non-catalytic reduction;
[5] – The emission rates are from page 27 of the EPA's Technical Bulletin – *"Nitrogen Oxides; Why and How they are Controlled"*.
[6] – The emission rates were obtained from the IEA Clean Coal Centre's Webpage - http://www.iea-coal.org.uk/site/ieacoal/home. The emission rates were primarily based on if the system used selective catalytic reduction or selective non-catalytic reduction.

[7] – SCR and SOFA refers to selective catalytic reduction and separated over-fire air;
[8] – RRI, SNCR, and SOFA refers to rich reagent injection, selective non-catalytic reduction and separated over-fire air, respectively; and
[9] – SNCR and SOFA refers to selective non-catalytic reduction and separated over-fire air.

6.3.3.4 Nitrogen Oxide Control Technology Impacts

Step 4 requires DENR to look at impacts associated with the control alternatives such as cost of compliance, energy impacts, non-air quality environmental impacts, and the remaining useful life of the project. These impacts are intended to provide rational in choosing between the alternative control options when determining what is considered BART.

Otter Tail Power Company identified cost estimates for five control options. Table 6-10 summarizes Otter Tail Power Company's estimated costs.

In 40 CFR Part 51, Appendix Y – Guidelines for BART Determination Under the Regional Haze Rule, in the section titled "How should I determine visibility impacts in the BART determination" it notes that the model should use the 24-hour average actual emission rate from the highest emitting day of the meteorological period modeled (for the pre-control scenario). The 18,000 tons per year of nitrogen oxide is based on the highest average 24-hour average emission rate (4,855 pounds per hour) for calendar years 2001 through 2003 and operating 85% of the time or 7,746 hours per year. Based on the BART guidelines, the baseline emissions are 18,000 tons per year.

Table 6-10 – Comparison of Control Effectiveness for Nitrogen Oxide Controls

Control Option	Capital Cost	O&M [1]	Annual Cost [2]	Reduction [3]	Cost Effectiveness [4]
SCR and SOFA [5]	$81,800,000	$4,110,000	$13,210,000	16,000	$825
RRI, SNCR and SOFA [6]	$16,200,000	$7,260,000	$11,390,000	13,910	$818
SNCR and SOFA [7]	$11,900,000	$2,120,000	$3,990,000	10,780	$197
SOFA [8]	$4,800,000	$152,000	$650,000	7,640	$85
Over-fired air	$0	$106,000	$140,000	4,510	$31

[1] – O&M represents the operational and maintenance cost estimate for the control alternative;
[2] – Annual cost is the annualized costs for each control alternative taking into account both the capital and operational and maintenance costs;
[3] – Reduction represents the amount of nitrogen oxide reduced in tons per year annual from the baseline level of 18,000 tons of nitrogen oxide per year;
[4] – Cost Effectiveness represents the annualized cost divided by the identified emission reductions (dollar per ton);
[5] – SCR and SOFA refers to selective catalytic reduction and separated over-fire air;
[6] – RRI, SNCR, and SOFA refer to rich reagent injection, selective non-catalytic reduction and separated over-fire air;
[7] – SNCR and SOFA refers to selective non-catalytic reduction and separated over-fire air; and
[8] – SOFA refers to separated over-fire air.

Otter Tail Power Company did not identify a cost effectiveness on a dollar per visibility reduction. DENR considered this cost effectiveness in Step 5 of the analysis.

Otter Tail Power Company identified the energy impacts cost associated for each of the control options. Table 6-11 summarizes Otter Tail Power Company's estimated energy impacts.

Table 6-11 – Estimated Energy Impacts for Nitrogen Oxide Controls

Control	Energy Demand	Percent of Generation
Selective catalytic reduction and Separated over-fire air	400 to 1,000 kilowatts	Less than 0.2 percent
Rich reagent injection, Selective non-catalytic reduction and Separated over-fire air	150 to 400 kilowatts	Less than 0.1 percent
Selective non-catalytic reduction and Separated over-fire air	150 to 400 kilowatts	Less than 0.1 percent
Separated over-fire air	1 kilowatt	Negligible
Over-fire air	1 kilowatt	Negligible

The over-fire air and the separated over-fire air will increase the amount of unburned carbon in the flyash, which will increase the amount of flyash that needs to be properly disposed. Otter Tail Power Company considers this increase negligible compared to the existing amount flyash being properly disposed.

The selective non-catalytic reduction and the selective catalytic reduction will generate a small amount of unreacted ammonia or urea to be emitted. Even though ammonia and urea are not considered regulated air pollutants, these emissions are involved in the formation of ammonium sulfates and ammonium nitrates, which contribute to the amount of visibility impairment.

In conducting its cost analysis, Otter Tail Power Company used 30 years as the life expectancy averaging period for the control alternatives. Since the useful life of Otter Tail Power Company's Big Stone I facility is expected to be longer than 30 years, there is no difference between the control options based on useful life.

6.3.4 Visibility Impact Evaluations

In accordance with 40 CFR Part 51, Appendix Y, a source that has an impact equal to or greater than 1.0 deciviews is considered to "cause" a visibility impairment and that establishing a threshold for what is considered to "contribute" to a visibility impairment should not be any higher than 0.5 deciviews. DENR is proposing to define "contribute" to visibility impairment as a change in visibility impairment in a mandatory Class I federal area of 0.5 deciviews or more, based on a 24-hour average, above the average natural visibility baseline. A source exceeds the threshold when the 98th percentile (eighth highest value) of the modeling results, based on one year of the three years of meteorological data modeled, exceeds the 0.5 deciviews.

Otter Tail Power Company modeled its existing operations impact on seven Class I areas that are located in Michigan, Minnesota, North Dakota, and South Dakota. Table 6-12 identifies the potential impact based on the 98th percentile for the existing Big Stone I facility has while emitting approximately 18,000 tons of sulfur dioxide, 18,000 tons of nitrogen oxides, and 300 tons of particulate matter per year.

Table 6-12 – Potential Impact of Existing Big Stone I (98th Percentile)

Class I Area	2002 [1,2]	2006 [1,2]	2007 [1,2]
Boundary Waters	0.574 (0.6)	0.790 (0.8)	1.079 (1.1)
Voyageurs	0.623 (0.6)	0.574 (0.6)	0.724 (0.7)
Wind Cave	0.305 (0.3)	0.120 (0.1)	0.325 (0.3)
Theodore Roosevelt	0.215 (0.2)	0.459 (0.5)	0.322 (0.3)
Lostwood	0.232 (0.2)	0.385 (0.4)	0.409 (0.4)
Badlands	0.452 (0.5)	0.481 (0.5)	0.471 (0.5)
Isle Royale	0.629 (0.6)	0.506 (0.5)	0.665 (0.7)

[1] – The modeling was conducted using the meteorological data for calendar years 2002, 2006, and 2007; and

[2] – The results are represented in deciviews. Otter Tail Power Company identified the deciview valued identified in the model to three decimal places which is consistent with how WRAP reported the visibility impacts in Table 6-3. The value in parentheses represents the value that is used to compare to the proposed contribution threshold of 0.5.

Based on the modeling results, Otter Tail Power Company's Big Stone I facility contributes to visibility impairment at Boundary Waters, Voyageurs, Theodore Roosevelt, Badlands, and Isle Royale because they have a deciview impact of 0.5 or greater.

Otter Tail Power Company conducted visibility modeling for 10 different control option scenarios and each scenario for three calendar years worth of meteorological data. The 10 different control option scenarios simultaneously considered the emissions of nitrogen oxide, sulfur dioxide, and particulate matter. Table 6-13 identifies the emission rates used in the modeling for each different control option.

Table 6-13 – Emission Rates for Each Control Option

Option	**Control Equipment**	**SO2** [11]	**NOx** [12]	**PM10** [13]
#1	OFA and Dry FGD #1 [1]	841.4	3645.9	84.1
#2	OFA and Wet FGD #1 [2]	841.4	3645.9	84.1
#3	OFA and Dry FGD #2 [3]	504.8	3645.9	84.1
#4	OFA and Wet FGD #2 [4]	241.2	3645.9	84.1
#5	SOFA and Dry FGD #1 [5]	841.4	2804.5	84.1
#5a	SOFA and Dry FGD #2 [6]	504.8	2804.5	84.1
#5b	SOFA and Wet FGD #2 [7]	241.2	2804.5	84.1
#6	SNCR, SOFA, and Dry FGD #1 [8]	841.4	1963.2	84.1
#7	RRI, SNCR, SOFA, and Dry FGD #1 [9]	841.4	1121.8	84.1
#8	SCR, SOFA, and Dry FGD #1 [10]	841.4	560.9	84.1

[1] – OFA and Dry FGD #1 refers to over-fire air and semi-dry flue gas desulfurization system meeting an emission rate of 0.15 pounds per million British thermal units;
[2] – OFA and Wet FGD #1 refers to over-fire air and wet flue gas desulfurization system meeting an emission rate of 0.15 pounds per million British thermal units;
[3] – OFA and Dry FGD #2 refers to over-fire air and semi-dry flue gas desulfurization system meeting an emission rate of 0.09 pounds per million British thermal units;
[4] – OFA and Wet FGD #2 refers to over-fire air and wet flue gas desulfurization system meeting an emission rate of 0.043 pounds per million British thermal units;
[5] – SOFA and Dry FGD #1 refers to separated over-fire air and semi-dry flue gas desulfurization system meeting an emission rate of 0.15 pounds per million British thermal units;
[6] – SOFA and Dry FGD #2 refers to separated over-fire air and semi-dry flue gas desulfurization system meeting an emission rate of 0.09 pounds per million British thermal units;
[7] – SOFA and Wet FGD #2 refers to separated over-fire air and wet flue gas desulfurization system meeting an emission rate of 0.043 pounds per million British thermal units;
[8] – SNCR, SOFA, and Dry FGD #1 refers to selective non-catalytic reduction, separated over-fire air, and semi-dry flue gas desulfurization system meeting an emission rate of 0.15 pounds per million British thermal units;
[9] – RRI, SNCR, SOFA, and Dry FGD #1 refers to rich reagent injection, selective non-catalytic reduction, separated over-fire air, and semi-dry flue gas desulfurization system meeting an emission rate of 0.15 pounds per million British thermal units;
[10] – SCR, SOFA, and Dry FGD #1 refers to selective catalytic reduction, separated over-fire air, and semi-dry flue gas desulfurization system meeting an emission rate of 0.15 pounds per million British thermal units;
[11] – SO2 represents the sulfur dioxide emission rate in pounds per hour;
[12] – NOx represents the nitrogen oxide emission rate in pounds per hour; and
[13] – PM10 represents the particulate matter less than 10 microns emission rate in pounds per hour.

Table 6-14 provides the results of the modeling (98^{th} percentile) using the different control options and emissions rates in Table 6-13. Again, Otter Tail Power Company identified the deciview valued identified in the model to three decimal places which is consistent with how WRAP reported the visibility impacts in Table 6-3. The value in parentheses represents the value that DENR used to compare to the proposed contribution threshold of 0.5.

Table 6-14 – Modeling Results for Each Control Option (98th Percentile – Deciviews)

Option	Control Equipment	Class I Area	2002	2006	2007
#1	OFA and Dry FGD #1 [1]	Boundary Waters	0.330 (0.3)	0.548 (0.5)	**0.657 (0.7)**
		Voyageurs	0.329 (0.3)	0.399 (0.4)	0.460 (0.5)
		Isle Royale	0.377 (0.4)	0.296 (0.3)	0.339 (0.3)
		Badlands	0.223 (0.2)	0.176 (0.2)	0.241 (0.2)
		Theodore Roosevelt	0.092 (0.1)	0.247 (0.2)	0.190 (0.2)
#2	OFA and Wet FGD #1 [2]	Boundary Waters	0.360 (0.4)	0.546 (0.5)	**0.667 (0.7)**
		Voyageurs	0.349 (0.3)	0.494 (0.5)	0.521 (0.5)
		Isle Royale	0.367 (0.4)	0.273 (0.3)	0.323 (0.3)
		Badlands	0.234 (0.2)	0.199 (0.2)	0.254 (0.3)
		Theodore Roosevelt	0.099 (0.1)	0.244 (0.2)	0.161 (0.2)
#3	OFA and Dry FGD #2 [3]	Boundary Waters	0.319 (0.3)	0.534 (0.5)	**0.620 (0.6)**
		Voyageurs	0.307 (0.3)	0.391 (0.4)	0.450 (0.5)
		Isle Royale	0.363 (0.4)	0.287 (0.3)	0.323 (0.3)
		Badlands	0.219 (0.2)	0.172 (0.2)	0.230 (0.2)
		Theodore Roosevelt	0.087 (0.1)	0.234 (0.2)	0.173 (0.2)
#4	OFA and Wet FGD #2 [4]	Boundary Waters	0.350 (0.4)	0.521 (0.5)	**0.611 (0.6)**
		Voyageurs	0.312 (0.3)	0.464 (0.5)	0.502 (0.5)
		Isle Royale	0.351 (0.4)	0.250 (0.3)	0.290 (0.3)
		Badlands	0.225 (0.2)	0.191 (0.2)	0.234 (0.2)
		Theodore Roosevelt	0.084 (0.1)	0.230 (0.2)	0.138 (0.1)
#5	SOFA and Dry FGD #1 [5]	Boundary Waters	0.264 (0.3)	0.433 (0.4)	0.524 (0.5)
		Voyageurs	0.263 (0.3)	0.314 (0.3)	0.364 (0.4)
		Isle Royale	0.298 (0.3)	0.235 (0.2)	0.272 (0.3)
		Badlands	0.169 (0.2)	0.137 (0.1)	0.191 (0.2)
		Theodore Roosevelt	0.076 (0.1)	0.199 (0.2)	0.156 (0.2)
#5a	SOFA and Dry FGD #2 [6]	Boundary Waters	0.250 (0.3)	0.419 (0.4)	0.493 (0.5)
		Voyageurs	0.249 (0.2)	0.306 (0.3)	0.354 (0.4)
		Isle Royale	0.285 (0.3)	0.226 (0.2)	0.256 (0.3)
		Badlands	0.165 (0.2)	0.133 (0.1)	0.180 (0.2)
		Theodore Roosevelt	0.069 (0.1)	0.186 (0.2)	0.141 (0.1)
#5b	SOFA and Wet FGD #2 [7]	Boundary Waters	0.274 (0.3	0.407 (0.4)	0.478 (0.5)
		Voyageurs	0.244 (0.2)	0.365 (0.4)	0.393 (0.4)
		Isle Royale	0.274 (0.3)	0.195 (0.2)	0.227 (0.2)
		Badlands	0.174 (0.2)	0.147 (0.1)	0.182 (0.2)
		Theodore Roosevelt	0.066 (0.1)	0.180 (0.2)	0.108 (0.1)
#6	**SNCR, SOFA, and Dry FGD #1 [8]**	**Boundary Waters**	**0.200 (0.2)**	**0.318 (0.3)**	**0.388 (0.4)**
		Voyageurs	**0.196 (0.2)**	**0.228 (0.2)**	**0.267 (0.3)**
		Isle Royale	**0.221 (0.2)**	**0.174 (0.2)**	**0.199 (0.2)**
		Badlands	**0.120 (0.1)**	**0.098 (0.1)**	**0.143 (0.1)**

Option	Control Equipment	Class I Area	2002	2006	2007
		Theodore Roosevelt	**0.063 (0.1)**	**0.150 (0.2)**	**0.121 (0.1)**
#7	**RRI, SNCR, SOFA, and Dry FGD #1 [9]**	**Boundary Waters**	**0.137 (0.1)**	**0.202 (0.2)**	**0.256 (0.3)**
		Voyageurs	**0.130 (0.1)**	**0.157 (0.2)**	**0.176 (0.2)**
		Isle Royale	**0.142 (0.1)**	**0.115 (0.1)**	**0.134 (0.1)**
		Badlands	**0.090 (0.1)**	**0.066 (0.1)**	**0.099 (0.1)**
		Theodore Roosevelt	**0.050 (0.1)**	**0.101 (0.1)**	**0.080 (0.1)**
#8	**SCR, SOFA, and Dry FGD #1 [10]**	**Boundary Waters**	**0.097 (0.1)**	**0.136 (0.1)**	**0.170 (0.2)**
		Voyageurs	**0.086 (0.1)**	**0.107 (0.1)**	**0.123 (0.1)**
		Isle Royale	**0.092 (0.1)**	**0.077 (0.1)**	**0.098 (0.1)**
		Badlands	**0.079 (0.1)**	**0.060 (0.1)**	**0.070 (0.1)**
		Theodore Roosevelt	**0.036 (0.0)**	**0.070 (0.1)**	**0.064 (0.1)**

[1] – OFA and Dry FGD #1 refers to over-fire air and semi-dry flue gas desulfurization system meeting an emission rate of 0.15 pounds per million British thermal units;
[2]- OFA and Wet FGD #1 refers to over-fire air and wet flue gas desulfurization system meeting an emission rate of 0.15 pounds per million British thermal units;
[3] - OFA and Dry FGD #2 refers to over-fire air and semi-dry flue gas desulfurization system meeting an emission rate of 0.09 pounds per million British thermal units;
[4] - OFA and Wet FGD #2 refers to over-fire air and wet flue gas desulfurization system meeting an emission rate of 0.043 pounds per million British thermal units;
[5] – SOFA and Dry FGD #1 refers to separated over-fire air and semi-dry flue gas desulfurization system meeting an emission rate of 0.15 pounds per million British thermal units;
[6] – SOFA and Dry FGD #2 refers to separated over-fire air and semi-dry flue gas desulfurization system meeting an emission rate of 0.09 pounds per million British thermal units;
[7] – SOFA and Wet FGD #2 refers to separated over-fire air and wet flue gas desulfurization system meeting an emission rate of 0.043 pounds per million British thermal units;
[8] – SNCR, SOFA, and Dry FGD #1 refers to selective non-catalytic reduction, separated over-fire air, and semi-dry flue gas desulfurization system meeting an emission rate of 0.15 pounds per million British thermal units;
[9] - RRI, SNCR, SOFA, and Dry FGD #1 refers to rich reagent injection, selective non-catalytic reduction, separated over-fire air, and semi-dry flue gas desulfurization system meeting an emission rate of 0.15 pounds per million British thermal units; and
[10] - SCR, SOFA, and Dry FGD #1 refers to selective catalytic reduction, separated over-fire air, and semi-dry flue gas desulfurization system meeting an emission rate of 0.15 pounds per million British thermal units.

Based on the modeling results in Table 6-14, Otter Tail Power Company would have to use Option #6, #7, or #8 to not reasonably contribute to visibility impairment in the Boundary Waters, Voyageurs, Isle Royale, Badlands, and Theodore Roosevelt National Parks.

Otter Tail Power Company did not provide a cost per deciview reduction for each of the proposed control options. DENR calculated a cost per deciview reduction by summing the annualized cost of each of the control alternatives associated with the control options and dividing by the visibility reduction identified by the modeling from the baseline condition. Table 6-15 provides a cost per deciview comparison.

Table 6-15 – Cost per Deciview Comparison ($/deciview)

Option	Control Equipment	Class I Area	2002	2006	2007
#1	OFA and Dry FGD #1 [1]	Boundary Waters	$ 96,188,525	$ 96,983,471	$ 55,616,114
		Voyageurs	$ 79,829,932	$ 134,114,286	$ 88,901,515
		Isle Royale	$ 93,134,921	$ 111,761,905	$ 71,993,865
		Badlands	$ 102,489,083	$ 79,950,820	$ 102,043,478
		Theodore Roosevelt	$ 190,813,008	$ 110,707,547	$ 177,803,030
		Cumulative	**$ 15,998,637**	**$ 16,108,442**	**$ 13,542,989**
#2	OFA and Wet FGD #1 [2]	Boundary Waters	$ 135,700,935	$ 119,016,393	$ 70,485,437
		Voyageurs	$ 105,985,401	$ 363,000,000	$ 143,054,187
		Isle Royale	$ 110,839,695	$ 124,635,193	$ 84,912,281
		Badlands	$ 133,211,009	$ 102,978,723	$ 133,824,885
		Theodore Roosevelt	$ 250,344,828	$ 135,069,767	$ 180,372,671
		Cumulative	**$ 20,625,000**	**$ 21,337,252**	**$ 17,224,199**
#3	OFA and Dry FGD #2 [3]	Boundary Waters	$ 92,980,392	$ 92,617,188	$ 51,655,773
		Voyageurs	$ 75,031,646	$ 129,562,842	$ 86,532,847
		Isle Royale	$ 89,135,338	$ 108,264,840	$ 69,327,485
		Badlands	$ 101,759,657	$ 76,731,392	$ 159,127,517
		Theodore Roosevelt	$ 185,234,375	$ 105,377,778	$ 98,381,743
		Cumulative	**$ 15,466,406**	**$ 15,588,429**	**$ 12,795,467**
#4	OFA and Wet FGD #2 [4]	Boundary Waters	$ 130,312,500	$ 108,513,011	$ 62,371,795
		Voyageurs	$ 93,858,521	$ 265,363,636	$ 131,486,486
		Isle Royale	$ 105,000,000	$ 114,023,438	$ 77,840,000
		Badlands	$ 128,590,308	$ 100,655,172	$ 123,164,557
		Theodore Roosevelt	$ 222,824,427	$ 127,467,249	$ 158,641,304
		Cumulative	**$ 19,140,984**	**$ 19,590,604**	**$ 15,617,978**
#5	SOFA and Dry FGD #1 [5]	Boundary Waters	$ 77,354,839	$ 67,170,868	$ 43,207,207
		Voyageurs	$ 66,611,111	$ 92,230,769	$ 66,611,111
		Isle Royale	$ 72,447,130	$ 88,487,085	$ 61,017,812
		Badlands	$ 84,734,392	$ 69,709,302	$ 85,642,857
		Theodore Roosevelt	$ 172,517,986	$ 92,230,769	$ 144,457,831
		Cumulative	**$ 13,411,633**	**$ 13,018,458**	**$ 11,045,601**
#5a	SOFA and Dry FGD #2 [6]	Boundary Waters	$ 74,753,086	$ 65,283,019	$ 41,331,058
		Voyageurs	$ 64,759,358	$ 90,373,134	$ 65,459,459
		Isle Royale	$ 70,406,977	$ 86,500,000	$ 59,217,604
		Badlands	$ 84,390,244	$ 69,597,701	$ 83,230,241
		Theodore Roosevelt	$ 165,890,411	$ 88,717,949	$ 133,812,155
		Cumulative	**$ 13,070,696**	**$ 12,727,273**	**$ 10,544,188**
#5b	SOFA and Wet FGD #2 [7]	Boundary Waters	$ 99,000,000	$ 77,545,692	$ 49,417,637
		Voyageurs	$ 78,364,116	$ 142,105,263	$ 89,728,097
		Isle Royale	$ 83,661,972	$ 95,498,392	$ 67,808,219
		Badlands	$ 106,834,532	$ 88,922,156	$ 102,768,166
		Theodore Roosevelt	$ 199,328,589	$ 106,451,613	$ 138,785,047

Option	Control Equipment	Class I Area	2002	2006	2007
		Cumulative	**$ 16,019,417**	**$ 15,730,932**	**$ 12,724,936**
#6	SNCR, SOFA, and Dry FGD #1 [8]	Boundary Waters	$ 73,048,128	$ 57,881,356	$ 39,536,903
		Voyageurs	$ 63,981,265	$ 78,959,538	$ 59,781,182
		Isle Royale	$ 66,960,784	$ 82,289,157	$ 58,626,609
		Badlands	$ 82,289,157	$ 71,331,593	$ 83,292,683
		Theodore Roosevelt	$ 179,736,842	$ 88,414,239	$ 135,920,398
		Cumulative	**$ 13,115,699**	**$ 12,262,118**	**$ 10,368,121**
#7	RRI, SNCR, SOFA, and Dry FGD #1 [9]	Boundary Waters	$ 79,450,801	$ 59,047,619	$ 42,187,120
		Voyageurs	$ 70,425,963	$ 83,261,391	$ 63,357,664
		Isle Royale	$ 71,293,634	$ 88,797,954	$ 65,386,064
		Badlands	$ 95,911,602	$ 83,662,651	$ 93,333,333
		Theodore Roosevelt	$ 210,424,242	$ 96,983,240	$ 143,471,074
		Cumulative	**$ 14,711,864**	**$ 13,467,804**	**$ 11,280,052**
#8	SCR, SOFA, and Dry FGD #1 [10]	Boundary Waters	$ 76,603,774	$ 55,871,560	$ 40,198,020
		Voyageurs	$ 68,044,693	$ 78,244,111	$ 60,798,669
		Isle Royale	$ 68,044,693	$ 85,174,825	$ 64,444,444
		Badlands	$ 97,962,466	$ 86,793,349	$ 91,122,195
		Theodore Roosevelt	$ 204,134,078	$ 93,933,162	$ 141,627,907
		Cumulative	**$ 14,329,412**	**$ 13,101,470**	**$ 10,900,955**

[1] – OFA and Dry FGD #1 refers to over-fire air and semi-dry flue gas desulfurization system meeting an emission rate of 0.15 pounds per million British thermal units;
[2]- OFA and Wet FGD #1 refers to over-fire air and wet flue gas desulfurization system meeting an emission rate of 0.15 pounds per million British thermal units;
[3] - OFA and Dry FGD #2 refers to over-fire air and semi-dry flue gas desulfurization system meeting an emission rate of 0.09 pounds per million British thermal units;
[4] - OFA and Wet FGD #2 refers to over-fire air and wet flue gas desulfurization system meeting an emission rate of 0.043 pounds per million British thermal units;
[5] – SOFA and Dry FGD #1 refers to separated over-fire air and semi-dry flue gas desulfurization system meeting an emission rate of 0.15 pounds per million British thermal units;
[6] – SOFA and Dry FGD #2 refers to separated over-fire air and semi-dry flue gas desulfurization system meeting an emission rate of 0.09 pounds per million British thermal units;
[7] – SOFA and Wet FGD #2 refers to separated over-fire air and wet flue gas desulfurization system meeting an emission rate of 0.043 pounds per million British thermal units;
[8] – SNCR, SOFA, and Dry FGD #1 refers to selective non-catalytic reduction, separated over-fire air, and semi-dry flue gas desulfurization system meeting an emission rate of 0.15 pounds per million British thermal units;
[9] - RRI, SNCR, SOFA, and Dry FGD #1 refers to rich reagent injection, selective non-catalytic reduction, separated over-fire air, and semi-dry flue gas desulfurization system meeting an emission rate of 0.15 pounds per million British thermal units; and
[10] - SCR, SOFA, and Dry FGD #1 refers to selective catalytic reduction, separated over-fire air, and semi-dry flue gas desulfurization system meeting an emission rate of 0.15 pounds per million British thermal units.

Based on the cost per deciview reduction numbers in Table 6-15, the most cost effective controls options are #5A, #6 and #8. The cost effective control costs are generally within 10 percent of each other.

6.3.5 BART Emissions Limits for Big Stone I

EPA identifies in 40 CFR Part 51, Appendix Y that in determining the "best" available retrofit technology, the state has discretion to determine the order in which the state should evaluate control options for BART. The state should provide a justification for adopting the technology that is selected as the ''best'' level of control, including an explanation of the Clean Air Act factors that led the state to choose that option over other control levels.

To complete the BART process, the state should establish enforceable emission limits that reflect the BART requirements and require compliance within a given period of time. In particular, the state should establish an enforceable emission limit for each subject emission unit at the source and for each pollutant subject to review that is emitted from the source. In addition, the state should require compliance with the BART emission limitations no later than five years after EPA approves South Dakota's State Implementation Plan for regional haze. If technological or economic limitations in the application of a measurement methodology to a particular emission unit make a conventional emissions limit infeasible, the state may instead prescribe a design, equipment, work practice, operation standard, or combination of these types of standards.

6.3.5.1 Particulate Matter BART Recommendation

Otter Tail Power Company already installed and is operating a baghouse, which is the top particulate control technology. Therefore, there is no additional compliance cost, energy impacts, etc. that Otter Tail Power Company would have to endure. As such, DENR considers the continual use of the baghouse as BART for particulate matter.

Otter Tail Power Company proposes an emission limit of 84.1 pounds per hour which they based on an emission rate of 0.015 pounds per million Btu and a maximum fuel heat input of 5,609 million Btus per hour. Otter Tail Power Company proposes to comply with the pounds per hour limit using a 30-day rolling average. Each day, Otter Tail Power Company will multiply the emission rate, in pounds per million Btus as determined by the most recent annual performance test, by the heat input to the boiler, as determined by a continuous emission monitoring system, and dividing by the number of hours the boiler operated that day.

In the December 11, 2006, application, Otter Tail Power Company proposed to replace the advanced hybrid particulate collector control system with the current day baghouse. In that application, Otter Tail Power Company noted that the baghouse would have a maximum filterable particulate matter emission rate of 0.012 pounds per million Btu of fuel heat input. The emission rate equates to 67.3 pounds per hour at 5,609 million Btus per hour heat input In May 2009, Otter Tail Power Company conducted a performance test on the baghouse. The test results noted an average filterable particulate matter emission rate of 0.011 pounds per million Btus and 57.6 pounds per hour.

DENR considers the emission limit representing BART as 67.3 pounds per hour. The hourly emission limit includes periods of startup and shutdown. DENR is also establishing a BART emission limit of 0.012 pounds per million Btus, which includes periods of startup and shutdown. Compliance with both emission limits shall be based on an annual stack performance test using the average of three 1-hour test runs.

6.3.5.2 Sulfur Dioxide BART Recommendation

Otter Tail Power Company is proposing the second ranked control option (semi-dry flue gas desulfurization system) to control sulfur dioxide emissions. Since control options #6, #7, and #8, which were the only three options that reduced the visibility less than the contribution level of 0.5 deciviews, did not include the top ranked sulfur dioxide control alternative an analysis of the visibility impacts of the other control alternatives was considered. Even though the top ranked control option (wet flue gas desulfurization system) reduces the sulfur dioxide emissions more than the second ranked control option, neither of the two control options is considered a better control option when considering the visibility impacts. For example, Table 6-16 displays the comparison of the visibility impacts for control option #3 to control option #4 and control option #5a to control option #5b. These options were chosen because the emission rates for nitrogen oxide and particulate matter were constant, while the sulfur dioxide emissions varied as noted by the two different control alternatives.

Table 6-16 – Visibility Comparison between Wet and Dry Scrubbers

	Control Option	Class I Area	2002	2006	2007
#3	OFA and Dry FGD #2 [1]	Boundary Waters	0.319	0.534	0.620
		Voyageurs	0.307	0.391	0.450
		Isle Royale	0.363	0.287	0.323
		Badlands	0.219	0.172	0.230
		Theodore Roosevelt	0.087	0.234	0.173
#4	OFA and Wet FGD #2 [2]	Boundary Waters	0.350	0.521	0.611
		Voyageurs	0.312	0.464	0.502
		Isle Royale	0.351	0.250	0.290
		Badlands	0.225	0.191	0.234
		Theodore Roosevelt	0.084	0.230	0.138
	Comparison Review	Boundary Waters	↑	↓	↓
		Voyageurs	↑	↑	↑
		Isle Royale	↓	↓	↓
		Badlands	↑	↑	↑
		Theodore Roosevelt	↓	↓	↓
#5a	SOFA and Dry FGD #2 [3]	Boundary Waters	0.250	0.419	0.493
		Voyageurs	0.249	0.306	0.354
		Isle Royale	0.285	0.226	0.256
		Badlands	0.165	0.133	0.180
		Theodore Roosevelt	0.069	0.186	0.141
#5b	SOFA and Wet FGD #2 [4]	Boundary Waters	0.274	0.407	0.478
		Voyageurs	0.244	0.365	0.393

	Control Option	Class I Area	2002	2006	2007
		Isle Royale	0.274	0.195	0.227
		Badlands	0.174	0.147	0.182
		Theodore Roosevelt	0.066	0.180	0.108
	Comparison Review	Boundary Waters	↑	↓	↓
		Voyageurs	↓	↑	↑
		Isle Royale	↓	↓	↓
		Badlands	↑	↑	↑
		Theodore Roosevelt	↓	↓	↓

[1] - OFA and Dry FGD #2 refers to over-fire air and semi-dry flue gas desulfurization system meeting an emission rate of 0.09 pounds per million British thermal units;
[2] - OFA and Wet FGD #2 refers to over-fire air and wet flue gas desulfurization system meeting an emission rate of 0.043 pounds per million British thermal units;
[3] – SOFA and Dry FGD #2 refers to separated over-fire air and semi-dry flue gas desulfurization system meeting an emission rate of 0.09 pounds per million British thermal units; and
[4] – SOFA and Wet FGD #2 refers to separated over-fire air and wet flue gas desulfurization system meeting an emission rate of 0.043 pounds per million British thermal units.

As noted in the table, approximately 40 percent of the modeling, the top ranked control option generated a higher visibility impact than the second ranked control option. Whereas, approximately 60 percent of the modeling, the second ranked control option generated a higher visibility impact than the top ranked control option. Therefore, based on the visibility modeling there is no discernable difference between these two control options. As such, DENR considers that the semi-dry flue gas desulfurization system is considered BART.

Otter Tail Power Company proposes an emission limit of 505 pounds per hour based upon a 30-day rolling average, which is based on the emission rate of 0.09 pounds per million Btu of fuel heat input at 5,609 million Btus per hour heat input.

The presumptive emission limit established by EPA for scrubber systems is 0.15 pounds per million Btus of fuel heat input. The limit proposed by Otter Tail Power Company is more stringent than the presumptive limit identified by EPA. DENR considers the emission limit representing BART should be 505 pounds per hour and 0.09 pounds per million Btus, which would include periods of startup, shutdown and malfunction. Compliance with these emission limits shall be based on the continuous emission monitoring system and on a 30-day rolling average.

6.3.5.3 Nitrogen Oxide BART Recommendation

Otter Tail Power Company is proposing the fourth ranked control option (separated over-fire air) to control nitrogen oxide emissions. In reviewing the higher ranked control options, each option reduces the amount of nitrogen oxide emissions and the visibility impacts more than the fourth ranked control option (separated over-fire air). However, each of these higher ranking control options comes with a higher financial cost.

In establishing the nitrogen oxide presumptive BART requirements, EPA identified that $1,500 per ton of nitrogen oxide removed was considered cost effective. (Federal Register Volume 70 Number 128 on pages 39134 and 39135). EPA considers this threshold cost effective for a coal fired unit greater than 200 megawatts existing at a facility with a combined capacity greater than 750 megawatts.

Otter Tail Power Company's Big Stone I facility does not have a capacity greater than 750 megawatts and is not applicable to the established nitrogen oxide presumptive BART requirements. However, Otter Tail Power Company's Big Stone I's coal fired unit is greater than the 200 megawatt. As noted in Table 6-10, the cost of the control options on a $ per ton basis are all less than $900 per ton. As such DENR considers all the identified control options as cost effective on a $ per ton basis.

As noted in Table 6-15, the cost on a $ per deciview basis indicates that control options #5a, #6 and #8 are the most cost effective. Options #5a, #6 and #8 consider the operation of separated over-fire air, selective non catalytic reduction and selective catalytic reduction. It should be noted that the $ per deciview includes the cost for both sulfur dioxide and nitrogen oxide.

As noted in Table 6-14, control options #6, #7, #8, were the only options that resulted in modeling less than 0.5 deciviews of visibility impairment. Again, it should be noted the modeling results includes the emissions of particulate matter, sulfur dioxide, and nitrogen oxide.

None of the nitrogen oxide control alternatives have identified energy, non-air environmental, or have issues with the current life expectancy of the Big Stone I coal fire unit to preclude the use of any of the control options. As such DENR considers all the identified control options as being acceptable options based on impacts to energy, non-air environmental and life expectancy.

Based on the visibility modeling, the first ranked control option (selective catalytic reduction) reduces the visibility more than any other control option. The selective catalytic reduction system also reduces the visibility an additional 34 percent over the second ranked control option and an additional 65 percent over the fourth ranked control option. The selective catalytic reduction is also considered cost effective on a $ per ton basis, is represented as part of the control option #8 that is one of the most cost effective options on a $ per deciview reduction basis and one of the options that modeling demonstrates less than 0.5 deciviews of visibility impairment. DENR considers selective catalytic reduction and separate over-fire air system as BART.

The presumptive emission limit established by EPA for a selective catalytic reduction system installed on a cyclone coal fired unit is 0.10 pounds per million Btus of fuel heat input (Federal Register Volume 70 Number 128 on page 39172). DENR considers the emission limit representing BART should be 561 pounds per hour and 0.10 pounds per million Btus, which would include periods of startup, shutdown and malfunction. Compliance with the emission limits shall be based on the continuous emission monitoring system and on a 30-day rolling average.

6.4 BART Requirements

Otter Tail Power Company's Big Stone I reasonably contributes to visibility impairment at Class I areas and is considered a BART-eligible source subject to BART. Therefore, DENR is adopting BART requirements in its Administrative Rules of South Dakota under Chapter 74:36:21 – Regional Haze Program.

These requirements will be part of South Dakota's Regional Haze State Implementation Plan and will be enforceable because they will establish emission limits representing BART; in accordance with 40 CFR § 51.308(e)(1)(v), the BART control equipment will be required to be properly operated and maintained; and testing, monitoring, recordkeeping, and reporting requirements will be established to ensure compliance with BART. One method of determining if control equipment is being properly operated and maintained is through monitoring the emissions from the unit. In Otter Tail Power Company's case, continuous emission monitoring sulfur dioxide and nitrogen oxide is already required in their existing permit. The minimum requirements for the operation, maintenance, and monitoring requirements will be established in ARSD 74:36:21:07. In accordance with 40 CFR § 51.308(e)(1)(iv), DENR will require BART to be installed and operating as expeditiously as practicable, but no later than 5 years from EPA's approval of South Dakota's Regional Haze Program. The deadline for installing BART will be established in ARSD 74:36:21:06.

In accordance with 40 CFR § 51.308(e)(5), once the requirements of BART are achieved, Otter Tail Power Company will be subject to the requirements of South Dakota's State Implementation Plan in the same manner as other sources.

7.0 Reasonable Progress

In accordance with 40 CFR § 51.308(d)(1), for each mandatory Class I area located within the state, the state must establish goals, expressed in deciviews, that provide reasonable progress towards achieving natural visibility conditions by 2064. The reasonable progress goals must provide improvement in visibility for the 20% most impaired days over the period of the implementation plan and ensure no degradation in visibility for the 20% least impaired days over the same period. In accordance with 40 CFR § 51.308(d)(1)(v), the reasonable progress goals established by the state are not directly enforceable but will be considered in the evaluation of the adequacy of the measures a state would implement to achieve natural conditions by 2064. In accordance with 40 CFR § 51.308(d)(1)(vi), the state may not adopt a reasonable progress goal that represents less visibility improvement than is expected to result from implementation of other requirements of the federal Clean Air Act during the applicable planning period.

The EPA published the *Guidance for Setting Reasonable Progress Goals under the Regional Haze Rule, 2007*, for setting reasonable progress goals. The basic steps include:

1. Establish baseline and natural visibility conditions;
2. Determine the glide path or uniform rate of progress;
3. Identify and analyze the measures aimed at achieving the uniform rate of progress using the following approaches:

a. Identify the key pollutants, sources and/or source categories that are contributing to visibility impairment at each Class I area. The sources of impairment for the most impaired and least impaired days may differ;
b. Identify the control measures and associated emission reductions that are expected to result from compliance with existing rules and other available measurements for the sources and source categories that contribute significantly to visibility impairment;
c. Determine what additional control measures would be reasonable based on the statutory factors and other relevant factors for the sources and/or source categories you have identified;
d. Estimate through the use of air quality models the improvement in visibility that would result from implementation of the control measures you have found to be reasonable and compare this to the uniform rate of progress; and

4. Establish the reasonable progress goals.

DENR determined natural visibility conditions (see Table 3-7) and the uniform slope of reduction for each Class I area (see Figure 3-5).

7.1 State and Federal Rules

South Dakota's current air quality rules under Administrative Rules of South Dakota (ARSD) article 74:36 – Air Pollution Control Program, currently protects and improves visibility in Class I areas. Examples of existing rules that protect and improve visibility in Class I areas are listed below:

1. ARSD § 74:36:01:05 – Applicable requirements of Clean Air Act defined: Subsection (12) states "*Any national ambient air quality standard or increment or visibility requirement under Part C of Title I of the Clean Air Act, but only as it would apply to temporary sources permitted pursuant to § 504(e) of the Clean Air Act*";
2. ARSD § 74:36:01:10 – Modification defined: Subsection (3) states "*The change requires or changes a case-by-case determination of an emission limit or other standard, a source-specific determination for temporary sources of ambient impacts, or a visibility or increment analysis*";
3. ARSD § 74:36:02:01 – Air quality goals: Subsection (3) states one of the goals is "*optimization of visibility*";
4. ARSD § 74:36:04 – Operating permits for minor sources and § 74:36:05 – Operating permits for Part 70 sources: The permits issued under these chapters require sources to meet all applicable emission limits, demonstrate compliance, monitoring, recordkeeping and reporting requirements to ensure compliance with all applicable requirements of the Clean Air Act;
5. ARSD §§ 74:36:06 – Regulated Air Pollutant Emissions; 74:36:07 – New Source Performance Standards; 74:36:08 – National Emission Standards for Hazardous Air Pollutants, and ARSD § 74:36:12 – Control of Visible Emissions: These chapters restrict air emissions from regulated entities that contribute to visibility impairment and prohibits certain open burning practices such as open burning waste oil, rubber, waste tires, asphalt shingles, railroad ties, etc.;

6. ARSD § 74:36:09 – Prevention of Significant Deterioration: This chapter requires a visibility analysis to prevent sources subject to these requirements from contributing to visibility impairment in Class I Areas;
7. ARSD § 74:36:10 – New Source Review: This chapter requires a visibility analysis to prevent sources subject to these requirements from contributing to visibility impairment in Class I Areas; and
8. ARSD § 74:36:18 – Regulations for State Facilities in the Rapid City Area: This chapter restricts visible emissions from fugitive sources.

The chapters and sections listed above are included in South Dakota's State Implementation Plan.

DENR adopted rules that will establish BART emission limits, recordkeeping requirements, monitoring requirements, and reporting requirements for BART-eligible sources that will reduce their impacts on Class I areas. In addition, DENR adopted rules that will require new major sources and a modification to an existing major source that are not subject to New Source Review to conduct a visibility impact analysis to ensure the proposal will not contribute to adverse impact on visibility in an mandatory Class I area.

On the federal side, gains in visibility should have already occurred from the implementation of the Acid Rain Program and future gains will occur from the implementation of federal emission standards established for mobile sources and federal fuel standards.

7.2 2018 Projected Visibility Conditions

The reasonable progress goals are interim goals that represent incremental improvement in visibility over time and are compared to the uniform rate of progress for achieving natural visibility by 2064. The first year in determining if states are meeting their reasonable progress goals is 2018. WRAP gathered the reductions that will occur through this timeframe from states and federal regulations and modeled the results to project where states will be at in 2018.

The information WRAP gathered was entered into a CMAQ model for the Class I areas in the WRAP region to project visibility improvements. The CMAQ model was used to estimate 2018 visibility conditions in South Dakota and all Western Class I areas. DENR relied on the results of the CMAQ modeling in determining the reasonable progress achieved by South Dakota, surrounding states, and federal regulations in South Dakota's Class I areas. DENR originally used the modeling results from "Plan02d" to calculate its reasonable progress for the 20% most impaired days and to show no degradation on the 20% least impaired days. WRAP discovered an error in the modeling runs for some of the Class I area, including the Badlands National Park which resulted in a "Plan02d_rev" modeling run. The corrected version, "Plan02d_rev" was used in the final results in Table 7-1 and Figure 7-1.

Table 7-1 provides a summary of WRAP's modeling results and compares the results to the deciview level needed to achieve the 2018 uniform rate of progress for the 20% most impaired days and determine if there is any degradation in the 20% least impaired days in South Dakota's Class I areas. The modeling results indicate the 2018 uniform rate of progress goal for the 20%

most impaired days will not be achieved; but there will be no degradation of the 20% least impaired days.

Table 7-1– 2018 Reasonable Progress Summary for South Dakota's Class I Areas
(a) 20% Most Impaired Days

Class I Area	Baseline [1]	Uniform Progress [2]	Reasonable Progress [3]	Uniform Progress Achieved
Badlands	17.14 deciview	15.02 deciview	16.30 deciview	38%
Wind Cave	15.84 deciview	13.94 deciview	15.28 deciview	33%

(b) 20% Least Impaired Days

Class I Area	Baseline [1]	Reasonable Progress [3]	Degradation?
Badlands	6.91 deciview	6.64 deciview	No
Wind Cave	5.16 deciview	5.02 deciview	No

[1] – Baseline values derived from Table 3-7;
[2] – Uniform progress derived from Figure 3-5; and
[3] – Reasonable progress derived from WRAP's modeling results.

7.3 Key Pollutants Contributing to Visibility Impairment

As indicated by the 2018 visibility projections using CMAQ modeling, the Class I areas in South Dakota are projected to not meet the uniform rate of progress goal for 2018 for the 20% most impaired days. The CMAQ modeling is conservative in several respects. The CMAQ modeling does not include the BART emissions limits for Otter Tail Power Company's Big Stone I facility. In addition, the CMAQ modeling includes Big Stone II and NextGen emissions, which are two new coal-fired power plants. The Big Stone II facility will no longer be constructed and the NextGen facility is on hold.

In order to determine if there are other contributors to not meeting the reasonable progress goals, it is necessary to break down these results to identify individual pollutants. Figures 7-1 provides a breakdown of individual pollutant contribution (measured by extinction) by showing the glide slope of each pollutant in South Dakota's Class I area from the baseline to 2018, and 2064, for the 20% most impaired days. Below each figure is a table that shows the 2018 projections for each pollutant, and whether the projection is under the 2018 uniform rate of progress goal and the percent improvement toward the 2018 uniform rate of progress goal.

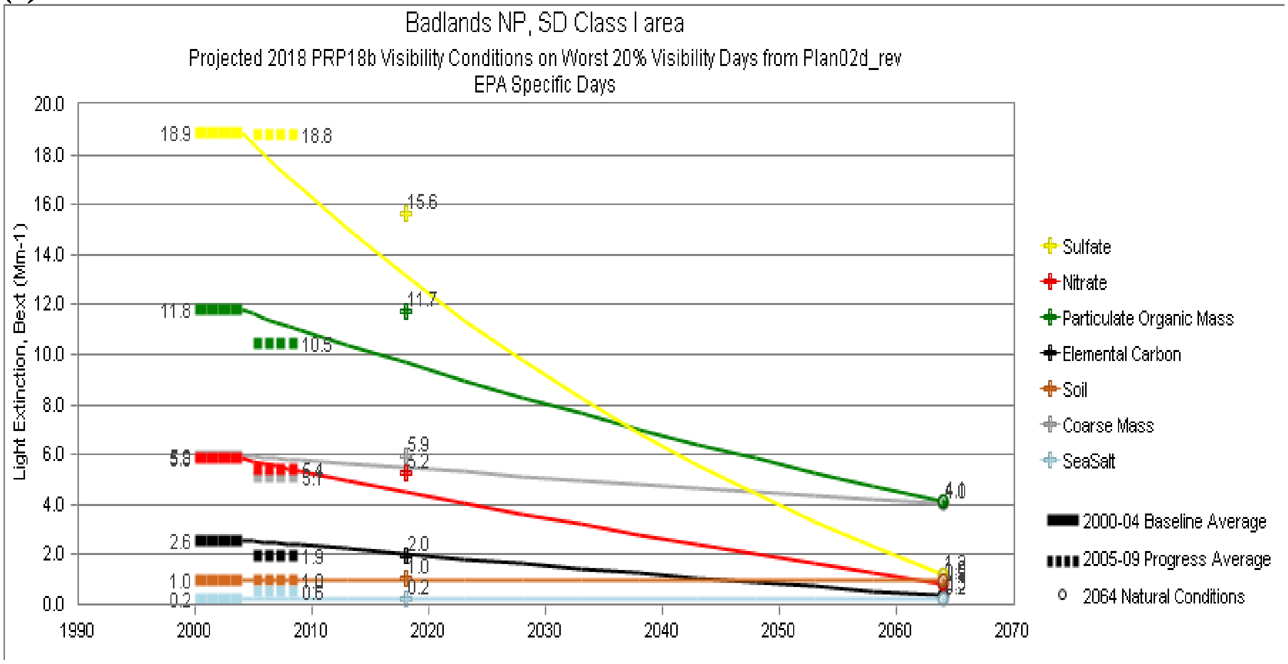
The glide path for the Badlands National Park indicates the air pollutants not achieving the necessary levels for the 2018 uniform progress goal to be achieved are organic carbon mass, ammonia sulfate, ammonia nitrate, and coarse mass. However, ammonia nitrate and coarse mass are very close to the 2018 goal. Organic carbon mass and ammonia sulfate appear to be the pollutants of most concern in reaching the 2018 goal.

The glide path for the Wind Cave National Park indicates the air pollutants not achieving the necessary levels for the 2018 uniform progress goal to be achieved are organic carbon mass, ammonia sulfate, and ammonia nitrates. At the Wind Cave National Park, it appears organic carbon mass and ammonia sulfate are the greatest concern since the extinction value for both are the furthest from where they need to be to achieve the uniform rate of progress goal for 2018.

Next, DENR reviewed WRAP's attribution analysis to determine the major contributors of ammonia sulfate, organic carbon mass, and ammonia nitrate in South Dakota's two Class I areas. For the Badlands and Wind Cave National Parks, the major contributors of ammonia sulfate are from sources not in South Dakota. South Dakota's ammonia sulfate contribution for 2002 and 2018 is minimal at both national parks at approximately 0.04 micrograms per cubic meter. South Dakota's contribution represents 3% of the ammonia sulfate concentrations for 2018 at both national parks. Of the 3%, approximately 1.5% is generated from point sources and 1.5% is generated from mobile and other sources.

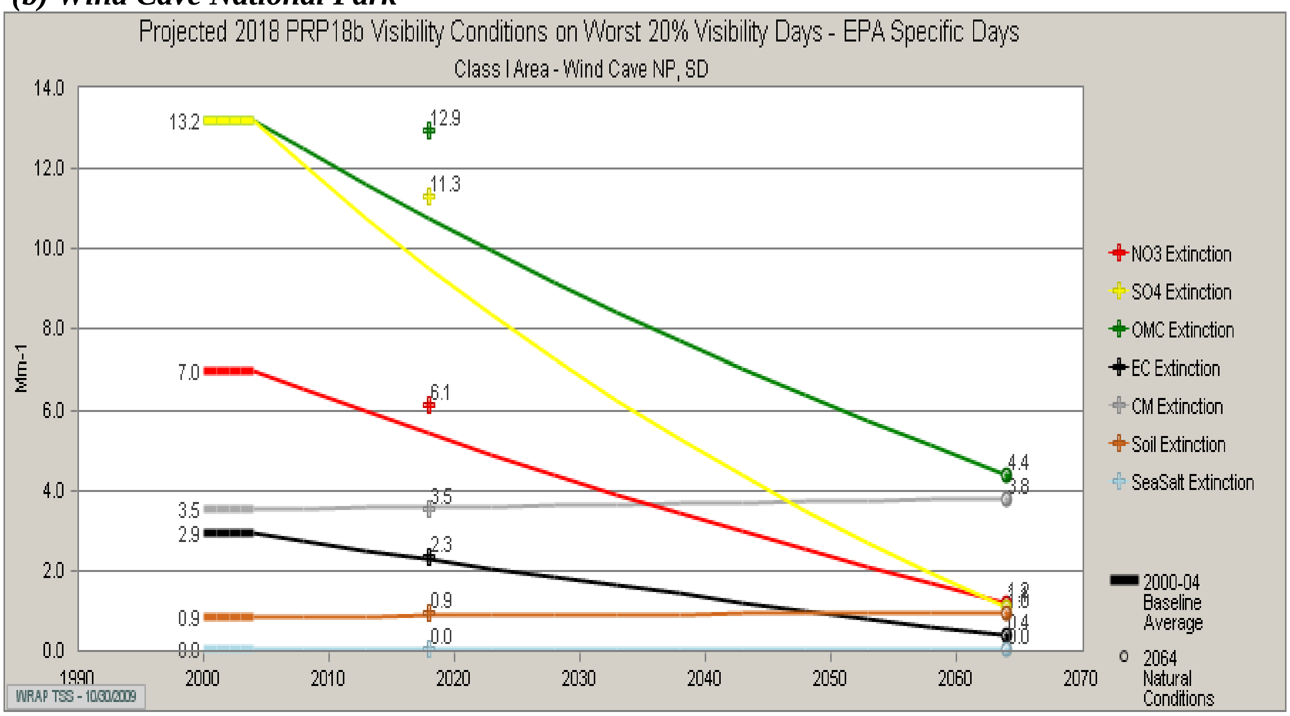
The major contributor of organic carbon mass in both national parks is natural fires with point source contributions being minimal. Organic carbon mass emissions from natural and prescribed fires will be evaluated as part of a smoke management plan which is part of DENR's long term strategy.

Figure 7-1 – Glide Slope by Pollutant for 20% Worst Visibility Days (Extinction) [1]
(a) Badlands National Park



(WRAP TSS – http://vista.cira.colostate.edu/tss/)

(b) Wind Cave National Park



(WRAP TSS – http://vista.cira.colostate.edu/tss/)

[1] – "NO_3" means nitrates, "SO_4" means sulfates, "OMC" means organic mass carbon, "EC" means elemental carbon, and "CM" means coarse mass.

Ammonia nitrate was only a concern for the Wind Cave National Park since it was on the glide path at the Badlands National Park. The major contributors to ammonia nitrate at the Wind Cave National Park are Canada followed by Wyoming, Outside the Domain, and South Dakota. South Dakota's ammonia nitrate contribution for 2002 and 2018 is approximately 0.135 and 0.105 micrograms per cubic meter, respectively. South Dakota's contribution represents 10% of the ammonia nitrate concentration for 2018 at the Wind Cave National Park. Of the 10%, approximately 4% is generated from point sources and 6% is generated from mobile and other sources.

South Dakota's contribution of ammonia sulfate, organic carbon mass, and ammonia nitrate concentrations is approximately 1.5% for ammonia sulfate, minimal for organic carbon mass, and 4% for ammonia nitrate. Therefore, minimal gain would be encountered from reduction in sulfur dioxide, organic carbon mass, and nitrogen oxide emissions from point sources within South Dakota.

7.4 Four Factor Analysis

In accordance with 40 CFR § 51.308(d)(1)(ii), if the state establishes a reasonable progress goal that provides for a slower rate of improvement in visibility than the rate that would be needed to attain natural conditions by 2064, the state must demonstrate based on the four factor analysis that the rate of progress for the state's implementation plan to attain natural conditions by 2064 is not reasonable; and the progress goal adopted by the state is reasonable. DENR looked at the air pollutants being emitted from point sources that were not meeting the glide path for each national park. Based on Figure 7-1(a), the air pollutant not meeting the glide path at the Badlands National Park is ammonia sulfate and organic carbon mass. Based on Figure 7-1(b), the air pollutant not meeting the glide path at the Wind Cave National Park is ammonia sulfate, organic carbon mass, and ammonia nitrate.

In accordance with 40 CFR § 51.308(d)(1)(i)(A), in establishing the reasonable progress goals for each mandatory Class I federal area within the state the state must consider the costs of compliance, the time necessary for compliance, the energy and non-air quality environmental impacts of compliance, and the remaining useful life of any potential affected sources. This consideration is also known as the four factor analysis. The four factor analysis must also include a demonstration showing how these factors were taken into consideration in selecting the goal.

There are three facilities in the Rapid City area which EPA indicates require a four factor analysis and they are: 1) GCC Dacotah; 2) Black Hills Corporation (Ben French); and 3) Pete Lien and Sons, Inc. The four factor analysis will be conducted for sulfur dioxide and nitrogen oxide.

7.4.1 Four Factor Analysis – GCC Dacotah

WRAP conducted a four factor analysis for GCC Dacotah's two wet kilns at DENR's request and finalized the document on May 9, 2009 (see Appendix F). After reviewing the calculations in Table 4-2 of the document, DENR determined some of the cost effectiveness values for GCC Dacotah are incorrect. Table 7-2 provides a corrected version of the cost effectiveness of the feasible control options using the emission reduction listed in the document.

WRAP's analysis did not include the analysis of a selective non-catalytic reduction (SNCR) system because at the time, SNCR were not a proven technology for wet kilns at Portland cement plants. EPA commented after the analysis was completed that the review should include a SNCR because the SNCR is being used a wet kilns in Europe and at the Ash Grove Cement plant in Midlothian, Texas. Although DENR does not agree that one plant in the Nation operating a SNCR on a wet kiln for several months constitute the system is capable of using a SNCR, DENR agreed to conduct a four factor analysis for SNCRs. DENR used EPA's November 2007 "Alternative Control Techniques Document Update – NOx Emissions from New Cement Kilns", EPA-453/R-07-006 to estimate the cost of a SNCR system even though this document was developed for the review of dry kilns and not wet kiln.

The "Capital Cost ($1,000)" column represents the capital investment for purchasing the control equipment. The "Annual Cost ($1,000)" is the amortized cost of the capital investment plus the annual cost to operate the control equipment. WRAP based the amortized cost of the capital investment on the control device and/or wet kiln operating 30 years and a 7% interest rate. EPA's cost numbers for a SNCR system was based on 2005 dollars. WRAP's cost numbers were based on 2007 dollars. Therefore, EPA's 2005 cost numbers were updated to 2007 cost numbers by using a 3% annual inflationary rate. The "Cost per Ton" column is based on the "Annual Cost" divided by the "Reductions".

Table 7-2– Four Factor Analysis for GCC Dacotah

Pollutant	Control Option	2002 tpy	Control Efficiency %	%	Reductions tpy	tpy	Capital Cost ($1000)	Annual Cost ($1000)	Cost per Ton Range $/ton	$/ton
Wet Kiln #4										
NOx	**LNB (indirect)**	707	30	40	212	283	$526	$129	$608	$456
	LNB (direct)	707	-	40		283	$1873	$331	-	$1,170
	Biosolids Injection	707	-	23		163	-	-	[1]	[1]
	CemStar	707	20	60	141	424	$1,599	$299	$2,121	$705
	Mid-Kiln	707	20	50	141	354	$2,748	-$315	[2]	[2]
	LoTOx™	707	80	90	566	636	-	-	[1]	[1]
	SCR	707		80		566	$14,813	$4,137		$7,309
	SNCR	707	30	40	212	283	-	$878 [3]	$4,142	$3,102
SO_2	**Wet FGD**	26	90	99	23	26	$9,133	$1,370	$59,565	$52,692
Wet Kiln #5										
NOx	**LNB (indirect)**	388	30	40	116	155	$526	$129	$1,112	$832
	LNB (direct)	388		40	-	155	$1873	$331	-	$2,135
	Biosolids Injection	388		23	-	89	-	-	[1]	[1]
	CemStar	388	20	60	78	233	1599	299	$3,833	$1,283
	Mid-Kiln	388	20	50	78	194	$2,748	-$315	[2]	[2]
	LoTOx™	388	80	90	310	349	-	-	[1]	[1]
	SNCR	388	30	40	116	155	-	$878 [3]	$7,569	$5,665
	SCR	388		80		310	$14,813	$4,137		$13,345
SO_2	**Wet FGD**	431	90	99	388	427	$9,133	$1,370	$3,531	$3,208

[1] – The document did not list a cost per ton because they did not identify any capital or annual costs;
[2] – DENR did not list a cost per ton because the annual cost was a negative number; and
[3] – EPA's November 2007 update indicates the average annualized cost of an SNCR to an SCR is approximately 1/5 the cost. (Average annualized cost of facility numbers 1, 2, 3, 4, 5, 6, 18, 19, 20, and 31, divided by average annualized cost of facility numbers 36, 37, 40, 43, and 46). Using this ratio, WRAP's estimated annualized cost of $4,137,000, and the inflationary rate, the annualized cost is estimated to be $878,000 ($4,137,000 x 0.2 x 1.0609 = $878,000).

Based on the cost per ton estimates, DENR determined a wet flue gas desulfurization unit for controlling sulfur dioxide emissions from Wet Kiln #4 and a selective catalytic reduction system for controlling nitrogen oxide emissions from Wet Kiln #5 is not cost effective. DENR looked at a biosolids injection system and determined a cheap supply of biosolids was not available in Rapid City and shipping biosolids to GCC Dacotah would make this option economically infeasible especially when looking at only a 23 percent reduction in nitrogen oxide emissions. Based on DENR's research, the CemStar and LoTOx™ options have not been demonstrated to work for wet cement kilns and the low-NOx burners will not work since the wet kilns are direct fired. Therefore, DENR does not believe these options are a viable option. That leaves the Mid-Kiln and SNCR as a viable option for controlling nitrogen oxide emissions from both wet kilns, a selective catalytic reduction system for controlling nitrogen oxide emissions from Wet Kiln #4, no viable options for controlling sulfur dioxide emissions from Wet Kiln #4, and a wet flue gas desulfurization system for controlling sulfur dioxide emissions from Wet Kiln #5.

The cost per ton analysis is based on calendar year 2002 air emissions for the two wet kilns which operated on average approximately 8,282 hours per year. In the last five years, the two wet kiln have operated an average of 4,160 hours per year with the last two years not operating. To determine if these control options are still cost effective if the two wet kilns are only operated 4,160 hours per year, DENR calculated the cost per ton for those controls that are viable for each wet kiln and pollutant. The results may be viewed in Table 7-3.

Table 7-3– Four Factor Analysis for GCC Dacotah at 4,160 Hours per Year

	Control	Annual	Control Efficiency		Reductions		Capital Cost	Annual Cost	Cost per Ton Range	
Pollutant	**Option**	**tpy**	**%**	**%**	**tpy**	**tpy**	**($1000)**	**($1000)**	**$/ton**	**$/ton**
Wet Kiln #4										
SO_2	**Wet FGD**	14	90	99	13	14	$9,133	$1,370	$105,385	$97,857
NOx	**SCR**	370	-	80	-	296	$14,813	$4,137	-	$13,976
	SNCR	370	30	40	111	148	-	$878	7,910	5,932
Wet Kiln #5										
SO_2	**Wet FGD**	208	90	99	187	206	$9,133	$1,370	$7,326	$6,650
NOx	**SCR**	187	-	80	-	150	$14,813	$4,137	-	$27,580
	SNCR	208	30	40	62	83	-	$878	14,161	10,578

Based on operating approximately 50% of the time the wet kilns operated in 2002, the wet flue gas desulfurization system for Wet Kiln #5 and the SNCR for Wet Kiln #4 are on the border of being a viable option.

DENR modeled GCC Dacotah's two wet kilns to determine if the emissions reasonably contribute to visibility impairment in the Badlands and Wind Cave national Park. The modeling analysis is based on 2002 actual emissions. The modeling report is located in Appendix G and a summary of the modeling results is displayed in Table 7-4. The modeling results represent the 8th highest reading (deciviews) per year.

Table 7-4– Visibility Impacts from GCC Dacotah (8th Highest)

Year	Badlands	Wind Cave
2002	0.32 deciviews	0.36 deciviews
2006	0.32 deciviews	0.36 deciviews
2007	0.31 deciviews	0.46 deciviews

Based on the modeling results, the current air emissions from GCC Dacotah's wet kilns do not reasonably contribute to visibility impairment in the Badlands and Wind Cave National Parks.

DENR believes the cost of reductions is not reasonable for either wet kiln when considering GCC Dacotah's visibility impact and the remaining useful life used in the analysis is suspect when considering GCC Dacotah has not operated the two wet kilns in the last two years. In addition, EPA promulgated new standards on September 9, 2010, for Portland Cement Manufacturing (Federal Register Volume 75, #174, page 54970) and DENR is unsure what impacts that will have on the useful life of the wet kiln(s).

7.4.2 Four Factor Analysis – Black Hills Corporation (Ben French)

WRAP conducted a four factor analysis for the 25 megawatt subbituminous coal-fired electric power plant at Black Hills Corporation's Ben French facility and finalized the document on May 9, 2009 (see Appendix F). After reviewing the calculations in Table 4-2 of the document, DENR determined that some of the cost effectiveness values for Black Hills Corporation are incorrect. Table 7-5 provides a corrected version of the cost effectiveness of the feasible control options using the emission reduction listed in the document.

The "Capital Cost ($1,000)" column represents the capital investment for purchasing the control equipment. The "Annual Cost ($1,000)" is the amortized cost of the capital investment plus the annual cost to operate the control equipment. WRAP based the amortized cost of the capital investment on the control device and/or the coal fired electric power plant operating 30 years and a 7% interest rate. The "Cost per Ton" column is based on the "Annual Cost" divided by the "Reductions".

Table 7-1– Four Factor Analysis for Black Hills Corporation Based on 30 Year Life

	Control	2002	Control Efficiency		Reductions		Capital Cost	Annual Cost	Cost per Ton Range	
Pollutant	**Option**	**tpy**	**%**	**%**	**tpy**	**tpy**	**($1000)**	**($1000)**	**$/ton**	**$/ton**
NOx	**LNB**	907	30	75	272	680	$1,250	$195	$717	$287
	LNB w/OFA	907	50	65	454	590	$1,780	$298	$656	$505
	SNCR	907	30	75	272	680	$1,290	$770	$2,831	$1,132
	SCR	907	40	90	363	816	$3,000	$754	$2,077	$924
							$4,250	$1,068	$2,942	$1,309
SO_2	**Dry Sorbent Injection**	785	10	40	79	314	$4,300	$1,700	$21,519	$5,414
	Spray Dryer Absorber	785		90		707	$11,600	$2,670		$3,777
	Wet FGD	785		90		707	$14,600	$2,760		$3,904

It appears the WRAP analysis is usable in a general sense. However, Black Hills Corporation identified the WRAP report as highly generalized without consideration of physical site constraints and expected life of the plant. According to Black Hills Corporation, the expected life of the Ben French facility is 10 years with current regulations. This may change as EPA's regulations change.

DENR conducted a cost per ton analysis based on operating for 10 years instead of 30 years as assumed by WRAP. DENR assumed the difference between the amortized cost of the capital investment and the annual cost is the annual operation and maintenance cost. Table 7-6 provides the results for this analysis.

Table 7-2– Four Factor Analysis for Black Hills Corporation Based on 10 Year Life

	Control	2002	Control Efficiency		Reductions		Capital Cost	Annual Cost	Cost per Ton Range	
Pollutant	**Option**	**tpy**	**%**	**%**	**tpy**	**tpy**	**($1000)**	**($1000)**	**$/ton**	**$/ton**
NOx	**LNB**	907	30	75	272	680	$1,250	$272	$1,000	$400
	LNB w/OFA	907	50	65	454	590	$1,780	$408	$899	$692
	SNCR	907	30	75	272	680	$1,290	$850	$3,125	$1,250
	SCR	907	40	90	363	816	$3,000	$939	$2,587	$1,151
							$4,250	$1,331	$3,667	$1,631
SO_2	**Dry Sorbent Injection**	785	10	40	79	314	$4,300	$1,966	$24,886	$6,261
	Spray Dryer Absorber	785		90		707	$11,600	$3,387		$4,791
	Wet FGD	785		90		707	$14,600	$3,662		$5,180

The 10 year evaluation does not change the outcome of the analysis. It appears from both evaluations the control equipment would be economical to install based on a cost per ton basis, except for the dry sorbent injection system if the anticipated sulfur dioxide emission reductions are at the lower level (e.g., 10% efficiency).

DENR modeled Black Hills Corporation's coal-fired electric power plant to determine if the emissions reasonably contribute to visibility impairment in the Badlands and Wind Cave national Park. The modeling analysis is based on 2002 actual emissions. The modeling report is located in Appendix H and a summary of the modeling results is displayed in Table 7-7. The modeling results represent the 8th highest reading (deciviews) per year.

Table 7-3– Visibility Impacts from Black Hills Corporation (8th Highest)

Year	Badlands	Wind Cave
2002	0.21 deciviews	0.22 deciviews
2006	0.23 deciviews	0.23 deciviews
2007	0.20 deciviews	0.30 deciviews

Based on the modeling results, the current air emissions from Black Hills Corporation's coal-fired electric power plant does not reasonably contribute to visibility impairment in the Badlands and Wind Cave National Parks.

7.4.3 Four Factor Analysis – Pete Lien and Sons

WRAP did not conduct a four factor analysis on Pete Lien and Sons operations. Pete Lien and Sons' sulfur dioxide emissions are less than one ton per year and will have no impact on visibility in any Class I area. In 2002, nitrogen oxide emissions were approximately 272 tons per year which has not changed much over the years based on the 2009 nitrogen oxide emissions at approximately 287 tons per year.

On May 12, 2008, Pete Lien and Sons submitted a PSD application for a new preheater-type rotary lime kiln and ancillary equipment for its facility in Rapid City. A Best Available Control Technology (BACT) analysis for nitrogen oxide was included in the application which indicated that post control options such as non-selective catalytic reduction and selective catalytic reduction systems were found to be technically infeasible because of temperatures, location of injection nozzles, etc. The PSD application also looked at low-NOx burners and determined they were also not technically feasible since the rotary kiln is a direct-fired lime kiln. DENR reviewed the application at the time and agreed with the conclusion that BACT for a lime rotary kiln was good combustion practices.

DENR reviewed EPA's RACT/BACT/LAER Clearinghouse (RBLC) to determine if any new rotary lime kilns had been permitted since Pete Lien and Sons' PSD application had been submitted. There were three entries. One occurred in Texas, Ohio, and Wisconsin. The one for Texas only involved carbon monoxide. In Ohio and Wisconsin, the BACT analysis for nitrogen oxide determined that no control technologies were cost effective and good combustion practices were considered BACT.

DENR conducted a modeling analysis to determine if the emissions from Pete Lien and Sons' lime kiln contribute to visibility impairment at the Badlands and Wind Cave National Parks. The impact is based on 2002 actual emissions. The modeling report is located in Appendix I and a summary of the modeling results is displayed in Table 7-8. The modeling results represent the 8^{th} highest reading (deciviews) per year.

Table 7-4– Visibility Impacts from Pete Lien and Sons (8^{th} Highest)

Year	Badlands	Wind Cave
2002	0.05 deciviews	0.06 deciviews
2006	0.06 deciviews	0.05 deciviews
2007	0.07 deciviews	0.05 deciviews

Based on the modeling results, the air emissions from Pete Lien and Sons's lime kiln does not reasonably contribute to visibility impairment in the Badlands and Wind Cave National Parks.

7.4.4 Four Factor Analysis – Summary

DENR conducted a four factor analysis on GCC Dacotah's two wet kilns, Black Hills Corporation's coal-fired electric power plant, and Pete Lien and Sons' lime kiln. As part of the analysis, DENR modeled the actual emissions from these units at each facility to determine if they reasonably contribute to visibility impairment in the Badlands and Wind Cave National Parks.

DENR does not plan on requiring controls on these three facilities at this time because the visibility modeling indicates the units at these facilities do not reasonably contribute to visibility impairment in the national parks. The results of the visibility modeling is substantiated by the results of WRAP's attribution analysis which concluded South Dakota's contribution to ammonia sulfate and ammonia nitrate is minimal.

DENR will continue to review these three facilities and others facilities as the goal of achieving natural visibility conditions in our national parks by 2064 is evaluated on a periodic basis.

8.0 Long Term Strategy

In accordance with 40 CFR § 51.308(d)(3), each state must submit a long term strategy to address regional haze visibility impairments for each Class I area within the state and for each Class I area outside the state which may be affected by emissions from the state. The long term strategy must include enforceable emission limitations, compliance schedules, and other measures as necessary to achieve the reasonable progress goals established by the state for each Class I area.

The long term strategy must meet the following requirements:

1. Where the state has emissions that are reasonably anticipated to contribute to visibility impairment in any Class I area located in another state or states, the state must consult with the other state(s) in order to develop coordinated emission management strategies. The state must also consult with any other state having emissions that are reasonably anticipated to contribute to visibility impairment in any mandatory Class I area within the state;
2. Where other states cause or contribute to impairment in a Class I area, the state must demonstrate that it has included in its implementation plan all measures necessary to obtain its share of the emission reductions needed to meet the progress goal for the area. If the state has participated in a regional planning process, the state must ensure it has included all measures needed to achieve its apportionment of emission reduction obligations agreed upon through that process;
3. The state must document the technical basis, including modeling, monitoring and emissions information, on which the state is relying to determine its apportionment of emission reduction obligations necessary for achieving reasonable progress in each mandatory Class I area it affects. The state may meet this requirement by relying on technical analyses developed by the regional planning organization and approved by all state participants. The state must identify the baseline emissions inventory on which its

strategies are based. The baseline emissions inventory year is presumed to be the most recent year of the consolidate periodic emissions inventory;

4. The state must identify all anthropogenic sources of visibility impairment considered by the state in developing its long term strategy. The state should consider major and minor stationary sources, mobile sources, and area sources; and
5. The state must consider, at a minimum, the following factors in developing its long term strategy:
   a. Emission reductions due to ongoing air pollution control programs, including measures to address reasonably attributable visibility impairment;
   b. Measures to mitigate the impacts of construction activities;
   c. Emissions limitations and schedules for compliance to achieve the reasonable progress goal;
   d. Source retirement and replacement schedules;
   e. Smoke management techniques for agricultural and forestry management purposes including plans as currently exist within the state for these purposes;
   f. Enforceability of emissions limitations and control measures; and
   g. The anticipated net effect on visibility due to projected changes in point, area, and mobile source emissions over the period addressed by the long-term strategy.

8.1 Class I Areas in Other States Impacted by South Dakota

In accordance with 40 CFR § 51.308(d)(3)(i), the long term strategy for each state that causes or contributes to impairment in a Class I area is required to demonstrate that it has included in its State Implementation Plan all measures necessary to obtain its share of the emission reductions needed to meet the progress goals for the Class I area. If the state has participated in a regional planning process, the state must ensure it has included all measures needed to achieve its apportionment of emission reduction obligations agreed upon through that process.

DENR participated in WRAP and worked with other states that are not members of WRAP in developing its State Implementation Plan. Otter Tail Power Company's Big Stone I facility is the only source in South Dakota that is reasonable anticipated to contribute to visibility impairment at the Badlands National Park in South Dakota; Theodore National Park in North Dakota; Boundary Waters and Voyageurs Class I areas in northern Minnesota and the Isle Royale federal Class I area in Michigan. Otter Tail Power Company developed a case-by-case BART analysis which DENR reviewed to establish the BART emission limits for Big Stone I. The case-by-case BART analysis and DENR's review was submitted to the appropriate states for their comments.

DENR will establish the BART procedures in the Administrative Rules of South Dakota that are equivalent to federal regulation in 40 CFR Part 51, adopt the BART emission limits applicable to BART-eligible coal fired power plants (which includes Big Stone I) in the rule, and adopt the BART emission limits in an air quality construction permit and eventually in Otter Tail Power Company's Title V air quality operating permit for the Big Stone I facility. DENR believes the BART requirements represents South Dakota's emission reductions for those Class I areas impacted by Big Stone I.

8.2 States Impacting South Dakota's Class I Areas

In accordance with 40 CFR § 51.308(d)(3)(ii), the long term strategy for each state that causes or contributes to impairment in a Class I area is required to demonstrate that it has included in its State Implementation Plan all measures necessary to obtain its share of the emission reductions needed to meet the progress goals for the Class I area. If the state has participated in a regional planning process, the state must ensure it has included all measures needed to achieve its apportionment of emission reduction obligations agreed upon through that process.

DENR has worked with states contributing to visibility impairment in South Dakota's Class I areas through WRAP and also with those states that are not part of WRAP. DENR believes at this time that the controls they are adopting under their BART analysis, State Implementation Plan, and other measures states are taking will minimize their impacts on South Dakota's Class I areas. Based on WRAP's emission inventory for 2002 and 2018, these control measures will reduce sulfur dioxide emissions by 26%, nitrogen oxide emissions by 29%, organic carbon mass by 6% and elemental carbon by 31% (derived from Table 5-6 and 5-7).

8.3 Technical Basis for Modeling, Monitoring and Emissions Information

In accordance with 40 CFR § 51.308(d)(3)(iii), as part of the long term strategy, each state is required to document the technical basis, including modeling, monitoring and emissions information, on which the state is relying to determine its apportionment of emission reduction obligations necessary for achieving reasonable progress in each mandatory Class I area it affects. The state may meet this requirement by relying on technical analyses developed by the regional planning organization and approved by all state participants. The state must identify the baseline emissions inventory on which its strategies are based. The baseline emissions inventory year is presumed to be the most recent year of the consolidated periodic emissions inventory.

South Dakota is a member of WRAP and relied on the modeling, monitoring and emissions information and technical analyses developed by WRAP to accomplish this requirement. DENR relied on the use of CALPUFF for single source BART screening modeling and WRAP's CMAQ and Particulate Matter Source Apportionment Technology modeling in its cumulative impact analyses. The BART modeling conformed to the requirements of the BART guidelines. The WRAP CMAQ and Particulate Matter Source Apportionment Technology modeling conformed with EPA's modeling guidelines. On the monitoring side, DENR used the IMPROVE monitoring data available on the IMPROVE website for its Class I areas.

DENR used WRAP's Plan02d emissions inventory for the baseline emissions year 2002 which reflects a composite interpretation of emissions for the base 2000-2004 period; and WRAP's CMAQ PRP18b (Preliminary Reasonable Progress 2018 Scenario A) emissions inventory which reflects projected year 2018 emissions. The projected year 2018 emissions represents base period emissions projected to 2018, accounting for estimates of the effect of BART controls and assuming other growth and control factors.

Currently, WRAP is maintaining this documentation at the following website:

http://vista.cira.colostate.edu/TSS/Results/HazePlanning.aspx

DENR will continue to work with WRAP in its effort to update emission inventories and run models to determine if South Dakota is meeting its reasonable progress and long term strategy goals.

8.4 Identification of Anthropogenic Sources of Visibility Impairment

In accordance with 40 CFR § 51.308(d)(3)(iv), as part of the long term strategy, each state must identify all anthropogenic sources of visibility impairment considered by the state in developing its long term strategy. The state should consider major and minor stationary sources, mobile sources and area sources.

DENR worked through WRAP and through a BART analysis to identify major and minor stationary sources. WRAP was also used to consider mobile and area source emissions. One item that does appear to be the greatest contributor is activities contributing to organic mass carbon emissions such as wild fires and prescribed fires.

8.5 Factors in Developing Long Term Strategy

In accordance with 40 CFR § 51.308(d)(3)(v), states must consider, at a minimum, the following factors in developing its long term strategy:

1. Emission reductions due to ongoing air pollution control programs, including measures to address reasonably attributable visibility impairment;
2. Measures to mitigate the impacts of construction activities;
3. Emissions limitations and schedules for compliance to achieve the reasonable progress goal;
4. Source retirement and replacement schedules;
5. Smoke management techniques for agriculture and forestry management purposes including plans as currently exist within the state for these purposes;
6. Enforceability of emissions limitations and control measures; and
7. The anticipated net effect on visibility due to projected changes in point, area, and mobile source emissions over the period addressed by the long-term strategy.

It is expected that for some areas of the country, such as parts of the eastern United States, emission reductions achieved for the acid rain program and for meeting the PM2.5 NAAQS, will lead to substantial improvements in visibility as well. Subsection 1 in this section makes clear that states must take these other emission reductions into account in developing their long-term strategies for regional haze.

8.5.1 Emission Reductions from Ongoing Air Pollution Control Programs

In accordance with 40 CFR § 51.308(d)(3)(v)(A), an assessment of emission reductions due to ongoing air pollution control programs is required. Existing air pollution control programs in place which assist in reducing air emissions and help achieve reasonable progress toward the national visibility goal include the following South Dakota air quality rules under ARSD § 74:36 – Air Pollution Control Program are listed below:

1. ARSD § 74:36:01:05 – Applicable requirements of Clean Air Act defined: Subsection (12) states "*Any national ambient air quality standard or increment or visibility requirement under Part C of Title I of the Clean Air Act, but only as it would apply to temporary sources permitted pursuant to § 504(e) of the Clean Air Act*";
2. ARSD § 74:36:01:10 – Modification defined: Subsection (3) states "*The change requires or changes a case-by-case determination of an emission limit or other standard, a source-specific determination for temporary sources of ambient impacts, or a visibility or increment analysis*";
3. ARSD § 74:36:02:01 – Air quality goals: Subsection (3) states one of the goals is "*optimization of visibility*";
4. ARSD § 74:36:04 – Operating permits for minor sources and § 74:36:05 – Operating permits for Part 70 sources: The permits issued under these chapters require sources to meet all applicable emission limits, demonstrate compliance, monitoring, recordkeeping and reporting requirements;
5. ARSD §§ 74:36:06 – Regulated Air Pollutant Emissions; 74:36:07 – New Source Performance Standards; 74:36:08 – National Emission Standards for Hazardous Air Pollutants, and ARSD § 74:36:12 – Control of Visible Emissions: These chapter restricts air emissions from regulated entities that cause visibility impairment and prohibits certain open burning practices such as open burning waste oil, rubber, waste tires, asphalt shingles, railroad ties, etc.;
6. ARSD § 74:36:09 – Prevention of Significant Deterioration: This chapter requires a visibility analysis to prevent sources subject to these requirements from contributing to visibility impairment in Class I Areas;
7. ARSD § 74:36:10 – New Source Review: This chapter requires a visibility analysis to prevent sources subject to these requirements from contributing to visibility impairment in Class I Areas; and
8. ARSD § 74:36:18 – Regulations for State Facilities in the Rapid City Area: This chapter restricts visible emissions from fugitive sources.

The chapters and sections listed above are included in South Dakota's State Implementation Plan.

In addition, EPA implemented a reasonably attributable visibility impact (RAVI) protection program in 1987 with a Federal Implementation Plan (FIP) for South Dakota to meet the general visibility plan requirements and long-term strategies of 40 CFR §§ 51.302 and 51.306, respectively. The existing federal RAVI program is compatible with the regional haze program and no revisions are needed at this time. DENR will coordinate with EPA to conduct joint periodic reviews and revisions of the long-term RAVI strategy as required by 40 CFR § 51.306(c). DENR may consider incorporation of the RAVI program into South Dakota's State Implementation Plan in the future.

8.5.2 Measures to Mitigate Impacts of Construction Activities

In accordance with 40 CFR § 51.308(d)(3)(v)(B), states are required to consider measures to mitigate the impacts of construction activities. States, for example, should include these activities in emission inventories used for long-term strategy development. South Dakota regulates fugitive emissions by rule in ARSD § 74:36:18 – Regulations for State Facilities in the Rapid City Area. This chapter restricts visible emissions from fugitive sources in the Rapid City area.

In addition, as part of South Dakota's State Implementation Plan, DENR is proposing rules that will require new major sources and modifications to major sources to conduct a visibility analysis. A new major source or modification to a major source will have to determine what controls will be necessary to maintain emissions at a level that will not cause visible emission equal to or greater than 0.5 deciviews at a Class I area. The new major source or modification to a major source will be required to install the control equipment, establish emission limits, recordkeeping requirements, and reporting requirements.

8.5.3 Emission Limitations and Schedules to Achieve Reasonable Progress Goals

In accordance with 40 CFR § 51.308(d)(3)(v)(C), states are required to consider air emissions limitations and schedules for compliance to achieve the reasonable progress goal in developing its long terms strategy. This requirement impacts South Dakota's only BART-eligible source (Otter Tail Power Company's Big Stone I). The BART requirements, BART emission limits, and compliance deadlines for Otter Tail Power Company's Big Stone I facility will be established in South Dakota's rules. The evaluation of non-BART sources as part of the long term strategy will be reviewed in the next planning period since WRAP's attribution analysis indicates South Dakota's sources have minimal impact on our Class I areas.

8.5.4 Retirement and Replacement Schedules

In accordance with 40 CFR § 51.308(d)(3)(v)(D), states are required to consider any source retirement and replacement schedules in developing its long term strategy, particularly, where these schedules would have a significant impact on regional emission loadings and on a state's ability to achieve reasonable progress.

DENR is not aware of any anticipated major source retirements or replacements that would have a significant impact on regional emissions loadings and on a state's ability to achieve reasonable progress. The replacement of existing units at facilities will be managed in conformance with the state's existing State Implementation Plan.

The 2018 modeling conducted by WRAP included two new coal-fired electric power plants and one oil refinery to be located in South Dakota. Although the PSD permit has been issued for one of the new coal-fired electric power plants, the applicant notified DENR that it is no longer going to build the plant. The second coal-fired power electric power plant requested that DENR put its application on hold until further notice. Therefore, the next modeling exercise for determining visibility in 2018 will need to be adjusted to reflect this development and the current modeling results for 2018 are probably conservative.

8.5.5 Smoke Management

In accordance with 40 CFR § 51.308(d)(3)(v)(E), states are required to consider smoke management techniques for agriculture and forestry management purposes including plans as currently exist within the state for these purposes in developing its long term strategy. As part of the long term strategy, DENR will investigate the impacts a smoke management plan for wild fires and prescribed burns will have on the 20% most impaired days within the first planning period of 2013.

Currently very little agricultural burning takes place in South Dakota and the majority of agricultural land lies in the eastern two-thirds of the state, while both Class I areas are in the western third. In addition, DENR did not observe any of the 20% most impaired days that were attributed to agricultural burning in the eastern half of South Dakota. Therefore, agricultural burning does not appear to have much of an impact at our Class I areas. However, there is some burning of grass in and around the Class I areas which will be investigated to determine if this practice warrants being covered under a smoke management plan.

Over the years the National Park Service and U.S. Forest Service have conducted planned prescribed burns on federal lands at both Class I areas, which have affected the air quality in both parks. The last prescribed burn at the Wind Cave National Park is one example in which the smoke from the fire had a negative impact on DENR's air monitoring equipment. DENR is currently waiting to review the IMPROVE data for those days to see what kind of impact the fire had on the organic carbon mass concentration and to some extent the ammonia sulfide and ammonia nitrate levels. In addition, DENR has observed there is evidence that large fires contribute to the 20% most impaired days during the baseline period.

DENR has taken the initial steps in developing a smoke management plan by contacting those groups that DENR believes would need to be involved, including the South Dakota Department of Agriculture, National Park Service and U.S. Forest Service, among others. The response from these agencies has been positive and all have offered to assist in developing a smoke management plan for South Dakota. More recently, DENR has been in contact with the South Dakota Division of Wildland Fire Suppression, which maintains a prescribed fire database of fires throughout South Dakota and along our borders in neighboring states. DENR will use this database to track fires and compare the fire data (e.g., size of fire, material being burned, distance from the Class I areas, dates) to the IMPROVE data from our Class I areas to see what the impacts are to the visibility.

It is DENR's intention to investigate these prescribed burns as well as other wildfires and planned prescribed burns to determine at what level (e.g., size of burn, distance from the Class I areas, combustible material) should a wildfire or prescribed fire be included in the smoke management plan and what best management practices can be used to minimize their impacts on the 20% most impaired days in the Class I areas. The results of this analysis will be adopted in the Regional Haze State Implementation Plan as part of our long term strategy. DENR will work with the federal land managers, other state agencies, and local governments during the development and implementation of the smoke management plan.

8.5.6 Enforceable Emission Limits and Control Measures

In accordance with 40 CFR § 51.308(d)(3)(v)(F), states are required to consider the enforceability of emission limits and control measures in developing its long term strategy. In developing enforceable emissions limits and control measures, the state should ensure they are written in a way that EPA and citizens may enforce them as a practical matter.

The BART requirements, including the BART emission limits for Big Stone I, will be established in South Dakota's rules and adopted into South Dakota's State Implementation Plan. This will allow states, the public, and any interested party to comment on the rules to ensure the BART requirements are enforceable in a practical matter. In addition, the BART emission limits and specific control measures that will be established in Otter Tail Power Company's Big Stone I air quality permit will be open to states, the public, and any interested party for comment and ensure the BART permit requirements are enforceable in a practical matter.

Currently, DENR developed a Title V air quality permit program which is required prior to construction for new sources and modifications to existing sources. DENR established a construction permit program that separates the construction permit from the Title V air quality permit program. The construction permit program was submitted to EPA to be included in South Dakota's State Implementation Plan. The BART emission limits and control measures will be included in a construction permit and eventually in the Title V air quality permit.

DENR is also establishing requirements under the Regional Haze Program to require new major sources and modifications to major sources to demonstrate through a visibility analysis that the new major source or modification to a major source will not contribute to visibility impairment in any mandatory Class I area. Contribute to visibility impairment is defined by a change in visibility impairment in a mandatory Class I area of 0.5 deciviews or more, based on a 24-hour average, above the average natural visibility baseline. A source exceeds the threshold with the 98^{th} percentile (eighth highest value) of the modeling results based on one year of the three years of meteorological data modeled exceeds the 0.5 deciviews. The emission limits and control measures used in the visibility analysis are required to be included in the sources permit which will include an opportunity for states, the public, and any interested party to comment on to ensure the requirements are enforceable in a practical matter. The rules will assist DENR in ensuring the sources in South Dakota will not contribute to visibility impairment in any Class I area.

8.5.7 Anticipated Net Effect on Visibility Due to Projected Changes

In accordance with 40 CFR § 51.308(d)(3)(v)(G), when developing its long term strategy states are required to consider the anticipated net effect on visibility due to projected changes in point, area, and mobile source emissions over the period addressed by the long term strategy. WRAP projected the net effect on visibility from emission reductions and increases by point, area and mobile sources throughout the WRAP region through 2018. The first emission projection inventory was compiled in 2006. The inventory was revised in 2007 to make preliminary evaluations of reasonable progress towards Class I areas visibility goals. The 2007 inventory focused on the most significant point and area sources of visibility impairing pollution. This effort included updating projections of electric generating units and incorporating known and presumed BART emission levels.

During the spring of 2009, the WRAP once again updated emission inventory projections for point and area sources in the WRAP region to give the most current assessment of reasonable progress towards visibility goals. Again, the updated projection inventory reflected new information about BART determinations and projection of future fossil fuel plants needed to achieve 2018 federal electrical generation demands.

The results of the CMAQ modeling which has already been discussed shows anthropogenic emissions sources generally declining across the West through 2018. However, natural sources such as wildfires and dust, international sources in Mexico and Canada, global transport of emissions and off shore shipping in the Pacific Ocean all appear to offset improvements in visibility from controls on manmade sources. In spite of the large number of growing uncontrollable sources in the WRAP region, however, South Dakota does see a net visibility improvement at the South Dakota Class I areas through 2018. The net effect of all of the reductions in the WRAP region, known at the time of the most recent model run is demonstrated in the WRAP Class I Summary Tables shown below for each of the Class I areas in South Dakota. Table 8-1 provides a summary of the results for each Class I area for the 20% most impaired days.

Table 8-1– CMAQ Modeling Visibility Summary for 20% Most Impaired Days
(a) Badlands National Park

	RRF Calculations Method: Specific Days (EPA) Emissions Scenarios: 2000-04 Baseline (plan02d_rev) and 2018 PRPb (prp18b)						
	Monitored	Estimated		Projected			
	2000-04 Baseline Conditions (Mm-1) [1]	2064 Natural Conditions (Mm-1) [2]	2018 Uniform Rate of Progress Target (Mm-1) [3]	2018 Visibility Conditions (Mm-1)	Baseline to 2018 Change In Statewide Emissions (tons/%)	Baseline to 2018 Change In Upwind Weighted Emissions [4] (%)	Baseline to 2018 Change In Anthropogenic Upwind Weighted Emissions [4] (%)
Sulfate	18.85	1.19	13.13	15.61	-8,115 -36%	-30%	-30%
Nitrate	5.85	0.86	4.51	5.23	-26,347 -18%	-27%	-37%
Organic Carbon	11.78	4.10	9.68	11.73	-555 -6%	-3%	-7%
Elemental	2.59	0.34	2.02	2.13	-2,404	-30%	-45%

	RRF Calculations Method: Specific Days (EPA) Emissions Scenarios: 2000-04 Baseline (plan02d_rev) and 2018 PRPb (prp18b)						
	Monitored	Estimated		Projected			
	2000-04 Baseline Conditions (Mm-1) [1]	2064 Natural Conditions (Mm-1) [2]	2018 Uniform Rate of Progress Target (Mm-1) [3]	2018 Visibility Conditions (Mm-1)	Baseline to 2018 Change In Statewide Emissions (tons/%)	Baseline to 2018 Change In Upwind Weighted Emissions [4] (%)	Baseline to 2018 Change In Anthropogenic Upwind Weighted Emissions [4] (%)
Carbon					-51%		
Fine Soil	0.98	0.95	0.97	0.94	1,837 6%	3%	9%
Coarse Material	5.94	4.04	5.48	Not Applicable [5]	25,873 16%	2%	8%
Sea Salt	0.19	0.19	0.19	Not Applicable [5]	Not Applicable	Not Applicable	Not Applicable
Total Light Extinction	57.18	22.67	45.98	52.73	Not Applicable	Not Applicable	Not Applicable
Deciview	17.14	8.06	15.02	16.32	Not Applicable	Not Applicable	Not Applicable

[1] – Baseline values derived from Table 4.3(b), except for the deciview values. The deciview value was derived from Table 3-7;
[2] – Deciview value derived from Table 3-7;
[3] – 2018 Uniform Rate of Progress Target for Best 20% Days is not defined. The Deciview value was derived from Figure 3-5(a);
[4] – Results based on Weighted Emissions Potential analysis using the 2000-04 Baseline (plan02d_rev) & 2018 PRPb (prp18b) emissions scenarios; and
[5] – Visibility projections not available due to model performance issues.

(b) Wind Cave National Park

	RRF Calculations Method: Specific Days (EPA) Emissions Scenarios: 2000-04 Baseline (plan02d) and 2018 PRPb (prp18b)						
	Monitored	**Estimated**		**Projected**			
	2000-04 Baseline Conditions (Mm-1) [1]	**2064 Natural Conditions (Mm-1)** [2]	**2018 Uniform Rate of Progress Target (Mm-1)** [3]	**2018 Visibility Conditions (Mm-1)**	**Baseline to 2018 Change In Statewide Emissions (tons/%)**	**Baseline to 2018 Change In Upwind Weighted Emissions** [4] **(%)**	**Baseline to 2018 Change In Anthropogenic Upwind Weighted Emissions** [4] **(%)**
Sulfate	13.32	1.09	9.53	11.33	-8,115 -36%	-21%	-22%
Nitrate	7.07	1.21	5.41	6.12	-26,347 -18%	-24%	-30%
Organic Carbon	13.39	4.4	10.77	12.93	-555 -6%	-1%	-5%
Elemental Carbon	2.96	0.4	2.28	2.32	-2,404 -51%	-21%	-41%
Fine Soil	0.86	0.97	0.88	0.93	1,837 6%	8%	16%
Coarse Material	3.53	3.8	3.59	Not Applicable [5]	25,873 16%	5%	13%
Sea Salt	0.00	0.03	0.03	Not Applicable [5]	Not Applicable	Not Applicable	Not Applicable
Total Light Extinction	51.18	21.90	41.71	47.19	Not Applicable	Not Applicable	Not Applicable
Deciview	15.84	7.41	13.94	15.12	Not Applicable	Not Applicable	Not Applicable

[1] – Baseline values derived from Table 4.4(b), except for Deciview. The Deciview value was derived from Table 3-7;
[2] – Deciview value derived from Table 3-7;
[3] – 2018 Uniform Rate of Progress Target for Best 20% Days is not defined. The Deciview value was derived from Figure 3-5(b);
[4] – Results based on Weighted Emissions Potential analysis using the 2000-04 Baseline (plan02d) & 2018 PRPb (prp18b) emissions scenarios; and
[5] – Visibility projections not available due to model performance issues.

9.0 Monitoring Strategy

In accordance with 40 CFR § 51.308(d)(4), the State Implementation Plan for the Regional Haze Program is required to include a monitoring strategy for measuring, characterizing and reporting of regional haze visibility impairment that is representative of all Class I areas within the state.

The monitoring strategy must be coordinated with the monitoring strategy required in 40 CFR § 51.305. In accordance with 40 CFR § 51.305, the monitoring strategy must take into account current and anticipated visibility monitoring research, the availability of appropriate monitoring techniques, and such guidance as provided by EPA. In addition, the monitoring strategy must provide for the consideration of available visibility data and must provide a mechanism for its use in decisions making. Compliance with this requirement may be met through the participation in the IMPROVE network.

DENR has been and will continue to participate in the IMPROVE network for both of its Class I areas. The IMPROVE network currently collects and reports aerosol monitoring data which will be used to track long term reasonable progress. Because the long term tracking program with an implementation period nominally set for 60 years, the state expects that the IMPROVE network will provide data based on the following goals:

1. Maintain a stable configuration of the individual monitors and sampling sites and stability in network operations for the purpose of continuity in tracking reasonable progress trends;
2. Assure sufficient data capture at each site of all visibility-impairing species;
3. Comply with EPA quality control and assurance requirements; and
4. Prepare and disseminate periodic reports on IMPROVE network operations.

DENR is relying on the IMPROVE network to meet these monitoring operation and data collection goals, with the fundamental assumption that network data collection operations will not change, or if changed, will remain directly comparable to those operated by the IMPROVE network during the 2000 to 2004 baseline period. Technical analyses and reasonable progress goals in this implementation plan are based on data from these sites. As such, DENR will work with EPA and the Federal Land Managers to ensure these monitors continue to operate and any changes to the IMPROVE network will not jeopardize the use of the data in the monitoring strategy.

The state of South Dakota depends on the following IMPROVE program-operated monitors at the following sites listed in Table 9-1 for tracking reasonable progress:

Table 9-1*– IMPROVE *Monitoring Sites at Class I areas in South Dakota

IMPROVE Monitoring Sites	Class I Area
BAD1	Badlands National Park
WICA1	Wind Cave National Park

In accordance with 40 CFR § 51.308(d)(4)(i), DENR will also operate additional non-IMPROVE monitors that may be used in assessing if reasonable progress goals in South Dakota's Class I areas are being met. These may include PM2.5 speciation or Federal Reference Methods, and/or more portable monitoring systems than operated at an IMPROVE site. This data is collected throughout the state but the ambient air quality monitoring sites of particular interest are the ones located next to the IMPROVE sites in the Class I areas in South Dakota. The data collected by these sites, along with data from the others sites throughout the state are reported to EPA's AIRS database. Table 9-2 provides a summary of what DENR is currently monitoring next to the IMPROVE sites in the Class I area in South Dakota.

Table 9-2– Ambient Air Monitoring Site Parameters Next to IMPROVE Sites

Monitoring Site	Parameter	Sampling &Analysis Method	Operating Schedule
Badlands National Park AQS#	Sulfur Dioxide	Instrumental pulsed florescent	Continuous
	Nitrogen Dioxide	Instrumental chemiluminescence	Continuous
	Ozone	Instrumental ultra violet	Continuous
	$PM_{2.5}$	Met One BAM – 1020 Very Sharp Cut Cyclone Gravimetric	Continuous
	PM_{10}	Thermal Anderson Series FH62 C14 BETA Gravimetric	Continuous
	Wind Speed	Electronic signal	Continuous
	Wind Direction	Electronic signal	Continuous
	Ambient Temperature	Electronic signal	Continuous
	Delta Temperature	Electronic signal	Continuous
	Ambient Pressure	Barometric pressure transducer	Continuous
	Solar Radiation	Pyranometer	Continuous
	Relative Humidity	Hygroscopic Plastic Film	Continuous
Wind Cave National Park AQS#	Sulfur Dioxide	Instrumental Pulsed Florescent	Continuous
	Nitrogen Dioxide	Instrumental Chemiluminescence	Continuous
	Ozone	Instrumental Ultra Violet	Continuous
	$PM_{2.5}$	Met One BAM – 1020 Very Sharp Cut Cyclone Gravimetric	Continuous
	PM_{10}	Thermal Anderson Series FH62 C14 BETA Gravimetric	Continuous
	Wind Speed	Electronic signal	Continuous
	Wind Direction	Electronic signal	Continuous
	Ambient Temperature	Electronic signal	Continuous
	Ambient Pressure	Barometric Pressure	Continuous

Monitoring Site	Parameter	Sampling &Analysis Method	Operating Schedule
		Transducer	
	Relative Humidity	Hygroscopic Plastic Film	Continuous

In accordance with 40 CFR § 51.308(d)(4)(ii), DENR will use data reported by the IMPROVE program as part of the regional technical support analysis tools found at the Visibility Information Exchange Web System (VIEWS), as well as other analysis tools that are available. DENR will participate in the ongoing regional analysis activities to collectively assess and verify the progress toward reasonable progress goals, also supporting interstate consultation as the regional haze rules are implemented and collaborate with EPA, states, tribes, and federal land managers to ensure the continued operation of these technical support analysis tools and systems .

In accordance with 40 CFR § 51.308(d)(4)(iv), DENR will depend on the routine timely reporting of haze monitoring data by the IMPROVE program for the reasonable progress tracking sites to the EPA air quality data system and VIEWS. DENR will collaborate with EPA, states, tribes, and federal land managers to ensure the continued operation of these technical support analysis tools and systems.

In accordance with 40 CFR § 51.308(d)(4)(vi), DENR will track data related to the regional haze plan implementation for sources for which the state has regulatory authority and will depend on the IMPROVE program and working with states and other organizations to collect and analyze efforts and data support systems for monitoring and emissions inventory data, respectively. To ensure the availability of data and analyses to report on visibility conditions and progress toward Class I area visibility goals, the state of South Dakota will collaborate with EPA, states, tribes, and FLMs to ensure the continued operation of the IMPROVE program.

10.0 Consultation Requirements

10.1 Federal Land Manager Consultation

In accordance with 40 CFR § 51.308(i)(1), a state is required to provide written notification to the federal land managers the title of the official to which the federal land managers of any Class I area can submit any recommendations on the implementation of the state’s Regional Haze Program. DENR provided the state’s contact to the federal land managers through its involvement with WRAP.

WRAP represents a conglomeration of stakeholders representing federal land managers, industry, states, tribes, environmental groups and the general public. Through participation in this process, a significant portion of the consultation process with federal land managers and other states has been met. In the WRAP process these stakeholders participated in various forums to help develop a coordinated emissions inventory and analysis of the impacts sources have on regional haze in the west. Coordination and evaluation of monitoring data and modeling processes were also overseen by WRAP participants. Through these coordinated technical evaluations, a regional haze oriented evaluation of South Dakota's Class I areas was constructed.

South Dakota has been a participating member of the WRAP since its inception. The WRAP completed a long-term strategic plan in 2003. The Strategic Plan provides the overall schedule and objectives of the annual work plans and may be revised as appropriate. Among other things, the Strategic Plan (1) identifies major products and milestones; (2) serves as an instrument of coordination; (3) provides the direction and transparency needed to foster stakeholder participation and consensus-based decision making, which are key features of the WRAP process; and (4) provides guidance to the individual plans of WRAP forums and committees.

Much of the WRAP's effort is focused on regional technical analysis that serves as the basis for developing strategies to meet the regional haze rule requirements to demonstrate reasonable progress towards natural visibility conditions in Class I areas. This includes the compilation of emission inventories, air quality modeling, and ambient monitoring and data analysis. The WRAP is committed to using the most recent and scientifically acceptable data and methods. The WRAP does not sponsor basic research, but WRAP committees and forums interact with the research community to refine and incorporate the best available tools and information pertaining to western haze.

In accordance with 40 CFR § 51.308(i)(2), a state is required to provide the federal land managers with an opportunity for consultation, in person and at least 60 days prior to holding any public hearing on the state's regional haze program or revisions to the program. The consultation shall include an opportunity to discuss the following:

1. Assessment of impairment of visibility in any mandatory Class I area; and
2. Recommendations on the development of the reasonable progress goal and on the development and implementation of strategies to address visibility impairment.

DENR is committed to providing the federal land managers opportunities to provide input as South Dakota' State Implementation Plan for the regional haze program is developed and implemented. This includes providing the federal land managers with at least 60 days prior notice to any public hearing. On January 15, 2010, DENR fulfilled this obligation and submitted South Dakota's draft Regional Haze Program to the following Federal Land Managers:

1. Tim Allen, U.S. Fish & Wildlife Service, Lakewood, Colorado;
2. Trent Wickman, USDA Forest Service, Great Lakes National Forests – Eastern Region;
3. John Bunyak, National Park Service, Air Resources Division, Lakewood, Colorado;
4. John Notar, National Park Service, Air Resources Division, Lakewood, Colorado;
5. Brian Kenner, National Park Service, Badlands National Park; and
6. Ken Hyde, National Park Service, Wind Cave National Park.

In addition, DENR took this opportunity to solicit comments from the following:

1. Laurel Dygowski, EPA Region VIII;
2. Amy Platt, EPA Region VIII;
3. Monica Morales, EPA Region VIII;
4. Catherine Nueschler and Anne Jackson, State of Minnesota;

5. Teresa Cooper and Asad Khan, State of Michigan;
6. Shelley Schneider and Katryna Schaf, State of Nebraska;
7. Dana Mount and Tom Bachman, State of North Dakota;
8. Curtis Taipale, State of Colorado;
9. Dave Klemp, State of Montana;
10. Tina Anderson, State of Wyoming;
11. Jim Strain, South Dakota Department of Agriculture;
12. Gene Nelson, GCC Dacotah, Rapid City, SD;
13. Tim Rogers, Black Hills Corporation, Rapid City, SD;
14. Danielle Weibers, Pete Lien and Sons, Rapid City, SD;
15. Clint Allen, Hills Materials Company, Rapid City, SD; and
16. Terry Graumann, Otter Tail Power Company, Big Stone I.

DENR requested comments by March 16, 2010. DENR received comments from the United States Department of Agriculture – Forest Service, United States Department of Interior – National Park Service, Otter Tail Power Company, and the United States Environmental Protection Agency (EPA) – Region 8.

10.1.1 Addressing Federal Land Manager Recommendations

In accordance with 40 CFR § 51.308(i)(3), in developing any implementation plan or revision, the state must include a description of how it addressed any comments provided by federal land managers. The comments from the federal land managers, Otter Tail Power Company, and EPA and DENR response to those comments may be reviewed in Appendix D.

10.1.2 Continued Consultation with Federal Land Managers

In accordance with 40 CFR § 51.308(i)(4), DENR must provide procedures for continuing consultation between the state and federal land managers on the implementation of the visibility protection program including the development and review of implementation plan revisions and 5-year progress reports and on the implementation of other programs having the potential to contribute to impairment of visibility in a Class I area. DENR is committed to working with the federal land managers to protect the Class I areas in South Dakota and in neighboring states. This will be accomplished with our continued involvement in regional organizations and through our contacts with the federal land managers.

DENR has already involved the federal land managers on other programs that may impact visibility in a Class I area through our PSD air quality permit program. Again, DENR has an open door policy in which the federal land managers can submit recommendations in an ongoing basis.

10.2 Consultation with Other States

In accordance with 40 CFR § 51.308(d)(1)(iv), in developing reasonable progress goals the state must consult with those states which may reasonably be anticipated to cause or contribute to visibility impairment in a Class I area within the state. In accordance with 40 CFR §

51.308(d)(3)(i), where a state's emissions are reasonably anticipated to cause or contribute to impairment in a Class I area located in another state or states, that state must consult with the other state or states in order to develop coordinated emission management strategies. DENR accomplished these requirements through WRAP and by contacting and working with states that are not part of WRAP.

As noted previously, DENR has been a participant in WRAP since its inception and considers its involvement as fulfilling part of the requirements for consultation. Within WRAP, the Implementation Work Group (IWG) was formed to address states' issues regarding Regional Haze and conducted numerous face-to-face meetings and monthly calls. All western states, EPA, Tribes and Federal Land Managers participated in the WRAP activities and were involved throughout the process.

DENR accomplished the requirement of working with states impacting Class I areas in South Dakota through WRAP and by contacting and working with states that are not part of WRAP to develop emission reductions. WRAP gathered information from what states were doing to reduce air emissions that contribute to visibility impairment and provided that information to other states. The same information was used by WRAP in the 2018 projection models to determine the impacts those reductions will have on each Class I area.

Beyond WRAP, South Dakota was involved with the Northern Class I Areas workgroup which had monthly conference calls and included Minnesota, Michigan, Iowa, along with other Midwestern states. In addition, South Dakota consulted with Minnesota directly starting in August of 2007 through emails and phone calls, which continued through December of 2009 when Minnesota submitted its Regional Haze State Implementation Plan to EPA. DENR also consulted directly with the State of Nebraska over the past few years through email and phone calls, mostly in regards to impacts the Gerald Gentleman Power Plant has on visibility impairment in Class I areas in South Dakota and their plans to control emissions from the Gerald Gentlemen Power Plant. As noted in a Public Notice dated May 28, 2009, the Nebraska Department of Environmental Quality determined BART shall be the replacement of the existing burner equipment system on Unit 2, a coal-fired electric generating unit, with a new Low NOx burner equipment system including overfire air ports.

Otter Tail Power Company's Big Stone I facility is the only source in South Dakota that is reasonably anticipated to contribute to visibility impairment of a Class I area in another state. Otter Tail Power Company's BART analysis for Big Stone I demonstrated that its air emissions were reasonably anticipated to contribute to impairment at the Badlands National Park in South Dakota; Theodore National Park in North Dakota; Boundary Waters and Voyageurs Class I areas in northern Minnesota and the Isle Royale federal Class I area in Michigan. DENR notified these states and submitted Otter Tail Power Company's case-by-case BART analysis and DENR's review of the BART analysis for their comments. DENR did not receive any comments from Minnesota or Michigan.

DENR reviewed the BART analysis and determined the proper air emission limits for the regulated air pollutants that are reasonably anticipated to contribute to impairment in the Class I areas. DENR will established the BART procedures in the Administrative Rules of South

Dakota that are equivalent to federal regulation in 40 CFR Part 51 and will adopt the BART emission limits in an air quality construction permit and eventually in Otter Tail Power Company's Title V air quality operating permit for the Big Stone I facility. DENR believes the BART requirements for Big Stone I meets South Dakota's obligation for emission reductions for those Class I areas impacted by Big Stone I.

As stated above, DENR also sent South Dakota's draft Regional Haze State Implementation Plan to the following states on January 15, 2010:

1. Catherine Nueschler and Anne Jackson, State of Minnesota;
2. Teresa Cooper and Asad Khan, State of Michigan;
3. Shelley Schneider and Katryna Schaf, State of Nebraska;
4. Dana Mount and Tom Bachman, State of North Dakota;
5. Curtis Taipale, State of Colorado;
6. Dave Klemp, State of Montana; and
7. Tina Anderson, State of Wyoming.

DENR did not receive any comments from these states.

DENR did not experience any situation in which we disagreed with another state on a reasonable progress goal. DENR will continue to work with states to ensure South Dakota's Class I areas achieve natural conditions by 2064 and air emissions from within South Dakota do not impair other state's progress in achieving natural condition in their Class I areas by 2064.

10.3 Public Input

In accordance with 40 CFR § 51.308(d)(1)(ii), if the state establishes a reasonable progress goal that provides a slower rate of improvement in visibility than the rate that would be needed to attain natural condition by 2064, the state must provide the public an opportunity to review as part of the implementation plan an assessment of the number of years it would take to attain natural conditions if visibility improvement continues at the rate of progress selected by the state as reasonable.

Based on the modeling analysis WRAP conducted on visibility improvement in 2018, the reasonable progress goal will not be met for organic carbon mass, ammonia nitrates, ammonia sulfates, and coarse particulates. The major contributor of ammonia sulfates and ammonia nitrates emissions at the two national parks is transported in from out of state. DENR has worked with other states through WRAP or individually to ensure their contribution in South Dakota is minimized. However, until all of the states implement their approved regional haze rules it is hard to determine if the modeling assumptions used by WRAP in the analysis are correct. For instance, the WRAP analysis does not reflect the BART emission limits that will be implemented by Big Stone I or the BART emission limits other states are still developing for their BART sources. DENR believes as states start implementing the Regional Haze Programs, the ammonia sulfate and ammonia nitrate concentrations will be reduced to meet the glide path sometime between now and 2018. Therefore, DENR believes that South Dakota can still meet its reasonable progress goals and achieve natural conditions by 2064. DENR will evaluate the progress on a periodic basis.

Although DENR believes it will still achieve natural conditions by 2064, EPA states DENR must include a projection of when WRAP's modeling projects natural conditions will be achieved. Based on WRAP's modeling results, which as stated above does not represent the final reductions in each state's regional haze program, natural conditions in South Dakota may not be achieved in the Badlands and Wind Cave National Parks until 2265 and 2236, respectively. DENR believes this is unrealistic and will continue to evaluate the projection as states begin implementing their Regional Haze State Implementation Plans.

DENR has also committed through this document to develop and implement a Smoke Management Plan by 2013. DENR will use the time from now until then to evaluate wildfires and prescribed fires to determine which size, distance, fuel material, etc. needs to be included in the Smoke Management Plan and the Best Management Practices for minimizing the impacts of wildfires and prescribed fires on South Dakota's two Class I areas.

DENR is also required to provide public input when adopting rules. DENR will provide the public an opportunity to comment on the proposed regional haze program and provide testimony at a public hearing that will be held in front of the Board of Minerals and Environment. The comments from the public and others and DENR response to those comments may be reviewed in Appendix E.

11.0 Periodic Review

11.1 Evaluation and Reassess Every 10 Years

In accordance with 40 CFR § 51.308(f), DENR will review, revise, and submit revisions to South Dakota's State Implementation Plan by July 31, 2018, and every ten years thereafter. The review shall consist of DENR evaluating and reassessing all of the elements required in 40 CFR § 51.308(d), taking into account improvements in monitoring data collection and analysis techniques, control technologies, and other relevant factors. The evaluation and reassessing shall address at least the following:

1. In accordance with 40 CFR § 51.308(d)(2)(iv)(B), current visibility conditions for the 20% most impaired and 20% least impaired days, and actual progress made towards natural conditions during the previous implementation period. The period for calculating current visibility conditions is the most recent five year period preceding the required date of the implementation plan submittal for which data are available. Current visibility conditions must be calculated based on the annual average level of visibility impairment for the most and least impaired days for each of these five years. Current visibility conditions are the average of these annual values;
2. The effectiveness of the long-term strategy for achieving reasonable progress goals over the prior implementation period(s); and
3. Affirmation of, or revision to, the reasonable progress goal in accordance with the procedures set forth in 40 CFR § 51.308(d)(1). If DENR established a reasonable

progress goal for the prior period which provided a slower rate of progress than that needed to attain natural conditions by the year 2064, DENR must evaluate and determine the reasonableness, based on the factors in 40 CFR § 51.308(d)(1)(i)(A), of additional measures that could be adopted to achieve the degree of visibility improvement projected by the analysis contained in the first implementation plan described in 40 CFR § 51.308(d)(1)(i)(B).

DENR will also coordinate with EPA to conduct these reviews jointly to satisfy the requirements of 40 CFR § 51.306(c).

11.2 Report Every 5 Years

In accordance with 40 CFR § 51.308(g), DENR will evaluate and report its progress towards the reasonable progress goal for each mandatory Class I federal area located within South Dakota and in each mandatory Class I federal area located outside the state which may be affected by emissions from within the state. The first progress report is due 5 years from submittal of DENR's initial implementation plan for South Dakota's Regional Haze Program and every 5 years thereafter. The progress reports will be in the form of an implementation plan revision that complies with the procedural requirements of 40 CFR §§ 51.102 and 51.103. The periodic progress reports shall contain at a minimum the following elements:

1. A description of the status of implementation of all measures included in the implementation plan for achieving reasonable progress goals for mandatory Class I federal areas both within and outside South Dakota;
2. A summary of the emissions reductions achieved throughout South Dakota through implementation of the measures described in 40 CFR § 51.308(g)(1);
3. For each mandatory Class I federal area within South Dakota, DENR will assess the following visibility conditions and changes with values for most impaired and least impaired days expressed in terms of 5-year averages of these annual values:
   a. The current visibility conditions for the most impaired and least impaired days;
   b. The difference between current visibility conditions for the most impaired and least impaired days and baseline visibility conditions;
   c. The change in visibility impairment for the most impaired and least impaired days over the past 5 years;
4. An analysis tracking the change over the past 5 years in emissions of pollutants contributing to visibility impairment from all sources and activities within South Dakota. Emissions changes should be identified by type of source or activity. The analysis must be based on the most recent updated emissions inventory, with estimates projected forward as necessary and appropriate, to account for emissions changes during the applicable 5-year period;
5. An assessment of any significant changes in anthropogenic emissions within or outside South Dakota that have occurred over the past 5 years that have limited or impeded progress in reducing pollutant emissions and improving visibility;
6. An assessment of whether the current implementation plan elements and strategies are sufficient to enable South Dakota, or other states with mandatory Class I federal areas

affected by emissions from South Dakota, to meet all established reasonable progress goals.
7. A review of DENR's visibility monitoring strategy and any modifications to the strategy as necessary.

DENR will coordinate with EPA as it develops its long term strategy for reasonably attributable visibility impairment under 40 CFR § 51.306(c).

11.3 Determination of Adequacy

In accordance with 40 CFR § 51.308(h), at the same time that DENR is required to submit any 5-year progress report to EPA in accordance with 40 CFR § 51.308(g), DENR will also take one of the following actions based upon the information presented in the progress report:

1. If DENR determines the existing implementation plan requires no further substantive revision at this time in order to achieve established goals for visibility improvement and emissions reductions, DENR must provide EPA with a negative declaration that further revision of the existing implementation plan is not needed at this time;
2. If DENR determines that the implementation plan is or may be inadequate to ensure reasonable progress due to emissions from sources in another state(s) which participated in a regional planning process, DENR must provide notification to EPA and to the other state(s) which participated in the regional planning process with DENR. DENR must also collaborate with the other state(s) through the regional planning process for the purpose of developing additional strategies to address the plan's deficiencies;
3. Where DENR determines that the implementation plan is or may be inadequate to ensure reasonable progress due to emissions from sources in another country, DENR shall provide notification, along with available information, to EPA; and
4. Where DENR determines that the implementation plan is or may be inadequate to ensure reasonable progress due to emissions from sources within South Dakota, DENR shall revise its implementation plan to address the plan's deficiencies within one year from the date the progress report is due.

Appendix A

Otter Tail Power Company's BART Modeling Protocol and Approval Letter

Appendix B

Otter Tail Power Company's Visibility Impact Analysis

Appendix C

Otter Tail Power Company's Case-by-Case BART Analysis

Appendix D

Federal Land Managers' Comments
and
DENR's Response

Appendix E

Public Notice Comments
and
DENR's Response

APPENDIX F

WRAP's FOUR FACTOR ANALYSIS
FOR
GCC DACOTAH
AND
BLACK HILLS CORPORATION (BEN FRENCH)

APPENDIX G

VISIBILITY MODELING RESULTS FOR

GCC DACOTAH

APPENDIX H

VISIBILITY MODELING RESULTS FOR

BLACK HILLS CORPORATION

BEN FRENCH

APPENDIX I

VISIBILITY MODELING RESULTS FOR

PETE LIEN AND SONS, INC