BEFORE THE ENVIRONMENTAL QUALITY COUNCIL
STATE OF WYOMING

| | | |
|---|---|---|
| IN THE MATTER OF: | ) | |
| BASIN ELECTRICAL POWER COOPERATIVE | ) | |
| DRY FORK STATION, | ) | Docket No. 07-2801 |
| AIR PERMIT CT-4631 | ) | |

**RESPONDENT DEPARTMENT OF ENVIRONMENTAL QUALITY'S MEMORANDUM IN SUPPORT OF MOTION FOR PARTIAL SUMMARY JUDGMENT**

# Schlichtemeir Affidavit

## EXHIBIT J

**BASIN ELECTRIC**
**POWER COOPERATIVE**
1717 EAST INTERSTATE AVENUE
BISMARCK, NORTH DAKOTA 58501-0564
PHONE: 701/223-0441
FAX: 701/224-5336

June 14, 2006

JUN 2006
RECEIVED
AIR QUALITY
DIVISION

Mr. Bernard J. Dailey
NSR Program Manager
Department of
Environmental Quality
Division of Air Quality
122 W. 25th Street
Cheyenne, WY 82002

Re: Permit Application AP-3546

Dear Mr. Dailey:

Enclosed are five copies of the response to the completeness review comments dated March 28, 2006. These comments are in response to the permit application (AP-3546) submitted for the construction of the Dry Fork Station located near Gillette, Wyoming. The enclosure includes a diskette with the modeling data inputs and results which are addressed in the response.

If you have any questions, please contact me.

Sincerely,

Jerry Menge
Air Quality Project Coordinator

/gmj
enclosures
cc: Clyde Bush w/o enclosure
J.K. Miller w/o enclosure

Document Summary

# BASIN ELECTRIC POWER COOPERATIVE



## DRY FORK STATION
### Gillette, Wyoming

**Permit Application Number AP-3546**

**Response To**
**Wyoming Department of Environmental Quality**
**Completeness Review**
**March 28, 2006**

**Submitted:**
**June 14, 2006**

**Basin Electric Power Cooperative**
**Dry Fork Unit 1 PSD Permit Application**
**Response to Wyoming Department of Environmental Quality, Air Quality Division**
**Permit Application No. AP-3546 Completeness Review Dated March 28, 2006**

Provided below is a detailed response to questions included in the Wyoming Department of Environmental Quality's (WDEQ) Completeness Review dated March 28, 2006. WDEQ comments are provided below in italics.

**WDEQ Comment 1:** *Modeling of Colstrip Units #3 and #4:*

*The Class I area significance analysis for the proposed project indicated that the modeled impacts from the proposed coal-fired boiler were above the EPA proposed Class I Significant Impact levels (SILs) for sulfur dioxide ($SO_2$) at the Northern Cheyenne Indian Reservation (NCIR) for the 3-hour and 24-hour averaging periods. As a result, a cumulative impact analysis for $SO_2$ at the NCIR was submitted as part of the permit application based on the increment consuming sources identified by the State of Montana Department of Environmental Quality, which included the Colstrip facility (Unit #3 and Unit #4), in Montana.*

*In reviewing the permit application, the Division noted that the Colstrip Unit #3 and Unit #4 boilers were modeled using a calculated 90th percentile of the 3-hour and 24-hour block averages, based on a two-year average (2003 and 2004) of actual $SO_2$ emissions from these two (2) units.*

*Based on information received from the State of Montana Department of Environmental Quality (MDEQ) regarding the modeling analyses conducted for Colstrip Unit #3 and Unit #4, these $SO_2$ sources were constructed after the Minor Source Baseline Date for the NCIR of March, 1979. Since the Class I SIL analysis demonstrated that a cumulative increment analysis was required to address short-term $SO_2$ increment consumption at NCIR, it is the Division's position that the allowable short-term emission rates are representative of short-term actual emission rates, as a practical means to quantify short-term emission rates in a dispersion modeling analysis. Therefore, the Division will require that Unit #3 and Unit #4 at the Colstrip facility are both modeled using the short-term permitted $SO_2$ emission rates for these sources.*

**Response:** Basin Electric Power Cooperative (BEPC) has conducted revised Class I cumulative $SO_2$ increment consumption modeling for Northern Cheyenne Indian Reservation (NCIR) in response to comments from the WDEQ. The revised modeling responds to comments received from WDEQ in their letters of December 21, 2005 and March 28, 2006.

In the letter dated December 21, 2005, WDEQ stated that the Wyodak unit should be included in cumulative $SO_2$ increment consumption modeling because the unit was not a pre-baseline unit as was first assumed by BEPC. WDEQ also stated that the Neil Simpson Unit 1 source was a pre-baseline source and could be removed from the modeling. In a more recent letter dated March 28, 2006, WDEQ requested that: 1) Potential to Emit (PTE) emission rates be used for the Colstrip sources in Montana, and 2) a new 2044-receptor grid that was supplied to WDEQ by Montana DEQ be used for any future modeling for NCIR.

BEPC feels that it is important to point out that the Class I cumulative $SO_2$ increment consumption modeling submitted in the original application is based on USEPA's policy as published in the October 1990 New Source Review Workshop Manual. Guidance in Section II.E, page C.10 of the manual states:

"Emissions increases that consume a portion of the applicable increment, in general, all those not accounted for in the baseline concentration and specifically include:

- *actual* emissions increases occurring after the major source baseline date, which are associated with physical changes or changes in the method of operation (i.e., construction) at a major stationary source; and
- *actual* emissions increases at any stationary source, area source, or mobile source occurring after the minor source baseline date."

However, as requested by WDEQ, BEPC had CH2M HILL revise the NCIR $SO_2$ modeling with all of the requested changes. The results of the modeling are presented in Table 1. Modeled exceedances of the 3-hour and 24-hour Class I $SO_2$ increment were predicted for all three years of meteorology. However, in each case, the contributions from the Dry Fork Station Project were less than the Class I modeling significance levels.

**Table 1: Cumulative Modeled Class I $SO_2$ Increment Consumption in Northern Cheyenne Indian Reservation ($\mu g/m^3$)**

| Year of Meteorology | Highest 2nd-High 3-hour $SO_2$ | Highest 2nd-High 24-Hour $SO_2$ |
|---|---|---|
| 2001 | 37.8 | 5.2 |
| 2002 | 37.2 | 7.2 |
| 2003 | 38.9 | 5.1 |
| Class I PSD Increment | 25 | 5 |
| Class Modeling Significance Level* | 1.0 | 0.2 |

Notes:
PSD = Prevention of Significant Deterioration
$\mu g/m^3$ = micrograms per cubic meter
*Class I Modeling Significance Levels were proposed by EPA on July 23, 1996 [61 FR 38250], but were never adopted as a final rule.

**WDEQ Comment 2:** *Receptor Grid for NCIR:*

*The Division originally provided a receptor grid for the NCIR Class I area, based on using a 4 kilometer (km) receptor resolution which was developed as part of a previous modeling analysis for the NCIR. In discussing with MDEQ, the current modeling analyses that have been conducted for the NCIR, the Division learned that a finer resolution receptor grid has been generated, which includes the boundary and interior area of the NCIR; this receptor grid resolution is approximately 1 km. This particular receptor grid for the NCIR was employed in the latest NCR modeling analysis using AERMOD, which was reviewed by both the MDEQ and EPA Region VIII with respect to Class I $SO_2$ increment consumption at the NCIR. Therefore, the Division will require that Basin Electric utilize this same receptor grid for any further modeling* *analyses at the NCIR Class I area. An electronic copy of the receptor grid file, entitled, CHEYRECS.ROU which was generated by AERMAP, is attached to this letter.*

**Response:** The finer resolution receptor grid was used for both the revised $SO_2$ cumulative analysis (per WDEQ Comment 1) and the revised CALPUFF visibility modeling (see response to WDEQ Comment 3, *Revised CALPUFF Visibility Modeling*).

**WDEQ Comment 3:** *Quantification of Condensible Particulate Emissions from Boiler:*

*During the Division's review of several modeling protocols for sources that have proposed coal-fired boilers, questions with regard to the quantification of condensible particulate emissions have arisen. The Division recognizes that there is a great deal of uncertainty in the quantification of condensible particulate emissions from coal-fired boilers, and in order to conduct a thorough technical review of this application, the Division will require Basin Electric to submit additional documentation which justifies the basis used to quantify condensible particulate emission rates from the boiler. Based on this additional documentation, if the calculated condensible particulate emission rates are revised from the emission rates originally submitted in the Dry Fork permit application, the Class I area modeling analyses will need to be revised and submitted to the Division.*

**Response:** BEPC submitted an air construction permit application for the Dry Fork Generating Station on November 10, 2005 (the "Permit Application"). The Permit Application included all the information required in a Prevention of Significant Deterioration (PSD) permit application, including a Best Available Control Technology (BACT) analysis and impact modeling. A BACT analysis was prepared for each PSD pollutant, including particulate matter with an aerodynamic diameter of less than 10 microns ($PM_{10}$). Based on the BACT analysis, BEPC proposed the following $PM_{10}$ permit limits. These permit limits were used as input to the Class I modeling analyses.

- $PM_{10}$ (filterable) 0.012 lb/mmBtu
- $PM_{10}$ (total – including filterable and condensible): 0.017 lb/mmBtu.

The filterable $PM_{10}$ ($FPM_{10}$) emission limit proposed in the Permit Application was based on a comprehensive review of available control technologies, anticipated vendor guarantees, and permit limits included in other recently issued PSD permits for coal-fired boilers. The condensible $PM_{10}$ ($CPM_{10}$) emission rate was calculated based on site-specific fuel characteristics and control technology removal efficiencies.

BEPC agrees with the WDEQ's statement regarding the uncertainty in the quantification of condensible particulate emissions from coal-fired boilers. $PM_{10}$ emissions from coal-fired boilers have historically been measured and reported as $FPM_{10}$, and there is limited information available characterizing $CPM_{10}$ emissions from coal-fired boilers. This response includes a detailed description of the methodology used to quantify $CPM_{10}$ emissions from the proposed Dry Fork boiler, and provides additional documentation to justify the condensible particulate constituent emission rates used in the Class I impact modeling.

***$PM_{10}$ Composition, Control and Measurement***

$PM_{10}$ composition and emission levels are a complex function of boiler firing configuration, boiler operation, pollution control equipment and coal properties. Uncontrolled particulate matter emissions from coal-fired boilers include ash from coal-combustion, noncombustible metals present in trace quantities and unburned carbon resulting from incomplete combustion. In pulverized coal systems, combustion is almost complete, thus, particulate matter exiting the boiler is primarily composed of inorganic ash residues. Other sources of particulate matter may include condensable organics and minerals present in the combustion air.

$PM_{10}$ can be classified as either "filterable" or "condensible." Basically, $FPM_{10}$ is composed of solids that can be captured on a filter media, while $CPM_{10}$ is a gas at the sampling location, which condenses into a liquid or solid within a few seconds of leaving the stack. The terms "filterable" and "condensible" describe how the particulate matter is captured in the sampling train. $FPM_{10}$ is captured in the filtering media located in the front-half of the sampling train. $CPM_{10}$ passes through the filter media and is captured in the sampling train impinger solution.

There is limited data available regarding CPM emissions from fossil fuel combustion sources. Historically, compliance with particulate matter emission limits has been demonstrated using reference methods that involve filtration at 250 °F (EPA Method 5) or at actual stack temperatures (EPA Method 17). For example, compliance with the federal PM new source performance standard (NSPS) for electric utility steam generating units must be demonstrated using Method 5 at facilities without wet FGD systems and Method 5B after wet FGD systems (see, 40 CFR 40.48a(b)). Both methods measure FPM.

With the change of the federal ambient air quality standard for particulate matter from total particulate to $PM_{10}$, USEPA promulgated a series of reference methods to measure $PM_{10}$ emissions from stationary sources.[1] These included Methods 201 and 201A for $FPM_{10}$, and Method 202 for $CPM_{10}$. These methods do not apply to any federal emissions limits and have not been incorporated into the federal NSPS. However, some recently issued PSD permits for new coal-fired units have included $PM_{10}$ emission limits including both filterable and condensible particulates.

Sulfate ($SO_4$) compounds (e.g., sulfuric acid ($H_2SO_4$) mist) are the most widely recognized form of CPM emitted by combustion sources.[2] Sulfuric acid formed in the boiler and subsequent emission control systems (e.g., SCR and FGD) has a vapor pressure sufficiently low to condense at ambient conditions.

Beyond the $H_2SO_4$ component, there are limited analytical data characterizing CPM from coal-fired boilers. Other inorganic species will contribute to CPM emissions, including ammonium sulfate, other acid gases, and trace volatile metals. For example, ammonium sulfate ($(NH_4)_2SO_4$) will be formed when $SO_3$ in the flue gas reacts with free ammonia ($NH_3$) from the SCR control system. Trace levels of chlorine and fluorine in the coal will convert to HCl and HF gas during the combustion process, and may be captured as condensible particulates. Organic species in the flue gas may also exist as vapors at stack temperatures but condense to liquid or solid aerosols at ambient temperatures. Because pulverized coal-fired boilers are typically operated with essentially complete combustion, condensible organic emissions

[1] See, Pjetraj, M., "Condensible Particulate Matter – Regulatory History and Proposed Policy", North Carolina Department of Air Quality, January 27, 1998.
[2] See, Corio, L.A., Sherwell, J., "In-Stack Condensible Particulate Matter Measurements and Issues", Journal of the Air & Waste Management Associate, vol. 50, February 2000, page 207.

should be very low. USEPA-sponsored evaluations of test Method 202 show that the inorganic constituents typically account for approximately 90 to 95% of the total condensible PM, with sulfate compounds, primarily $H_2SO_4$, accounting for most of the inorganic condensible emissions.[3]

USEPA's Compilation of Air Pollution Emission Factors (AP-42)[4] includes an emission factor for CPM from pulverized coal-fired boilers equipped with FGD control (AP-42 Table 1.1-5). However, the emission factor (0.02 lb/mmBtu total CPM) does not distinguish between the inorganic and organic fractions, and has an emission factor rating of "E". An emission factor rating of "E" indicates that the factor was developed from a small number of facilities, and that there may be reason to suspect that the facilities tested do not represent a random sample of the industry.

Because there is limited information from existing sources characterizing CPM emissions, and because the AP-42 emission factor for CPM from pulverized coal-fired boilers has an "E" rating, emission calculations are typically used to estimate CPM emissions from a specific source. $CPM_{10}$ emission limits proposed in the Permit Application were estimated using site-specific coal characteristics, boiler operating conditions, and assumed emission control efficiencies. A summary of the $CPM_{10}$ constituents, and a description of the methodology used to calculate each emission rate, is provided in Table 2.

**Table 2: CPM Constituents Proposed in the Original (11/10/05) Permit Application**

| Constituent | Emission Rate (lb/hr) | Emission Rate (lb/mmBtu) | Methodology |
|---|---|---|---|
| $H_2SO_4$ | 9.50 | 0.0025 | Sulfur content of fuel, 2% $SO_2$ to $SO_3$ conversion in boiler and SCR, 100% conversion of $SO_3$ to $H_2SO_4$, and 90% control in the SDA/FF. |
| $(NH_4)_2SO_4$ | 1.53 | 0.000402 | Ammonia slip of 2.0 ppmvd @ 3% $O_2$, 25% conversion of the ammonia slip to $(NH_4)_2SO_4$, and 90% control in the SDA/FF |
| HF | 2.62 | 0.00069 | 80 ppmwd fluorine in the coal, 100% conversion F to HF, 90% removal in the SDA/FF. |
| HCl | 3.23 | 0.00085 | 100 ppmwd chlorine in the coal, 100% conversion Cl to HCl, and 90% removal in the SDA/FF |
| Organic Condensibles | 1.88 | 0.00049 | Organic CPM was calculated by summing the organic compounds listed in AP-42 Tables 1.1-13 (Polynuclear Aromatic Hydrocarbons from Controlled Coal Combustion) and 1.1-14 (Various Organic Compounds from Controlled Coal Combustion) with boiling temperatures of 300 °F or less. |
| Total | 18.76 | 0.005 | |

In addition to the limitations associated with calculating CPM emissions, stack testing methodologies used to measure $H_2SO_4$ and $CPM_{10}$ (Methods 8 and 202, respectively) have proven to be problematic at coal-fired boilers. For example, interfering agents with Method 8 include fluorides and free ammonia ($NH_3$). Method 8 states that if "any of these interfering agents is present… alternative methods, subject

[3] Method Development and Evaluation of Draft Protocol for Measurement of Condensible Particulate Emissions; U.S. Environmental Protection Agency, Research Triangle Park, NC, 1990.
[4] *Compilation of Air Pollution Emission Factors (AP-42),* U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards.

to the approval of the Administrator, are required." Because of the difficulties associated with demonstrating compliance with low $H_2SO_4$ emission rates, equipment vendors have not been willing to guarantee $H_2SO_4$ emissions below approximately 2 ppmvd @ 3% $O_2$. Based on information from equipment vendors, an emission rate of 2 ppmvd @ 3% $O_2$ (approximately 0.005 lb/mmBtu), represents the practical analytical detection limit of Method 8 on a coal-fired boiler.

Likewise, Method 202 has been shown to have a false positive bias when used on sources with $SO_2$ and $NH_3$ in the flue gas, such as coal-fired boilers.[5] In Method 202, flue gas is bubbled through water-filled impingers located downstream of the filters used to capture filterable particulates. The contents of the impingers are evaporated and the residue is weighed to determine condensible particulate emissions. The basic problem involved in using Method 202 is that the method by which condensible species are collected in the impingers differs from the method by which condensible species coalesce into particles in the stack plume. For example, gaseous species in the flue gas that would not condense in the atmosphere (e.g., $SO_2$ and $NH_3$) may be collected in the impingers and converted to particulate species in the sampling train.

As an example of this phenomenon, during sampling, a portion of the $SO_2$ in the sample gas (which is not a condensible species) will be dissolved in the impinger water. In the impinger sample, test data have shown that a portion of this $SO_2$ will oxidize to sulfate ion ($SO_4^{=}$) which will form sulfuric acid and be indistinguishable from true condensible particulates. Similarly, when both $SO_2$ and $NH_3$ are in the gas stream, they will both dissolve in the impingers, and have been shown to react to form either ammonium sulfate or ammonium bisulfate, which tend to oxidize to ammonium sulfate ($(NH_4)_2SO_4$) and ammonium bisulfate ($(NH_4)HSO_4$) during sample storage and handling. Gaseous $SO_2$ and $NH_3$ are not condensible species, however, ammonium sulfate and ammonium bisulfate will be measured as condensible particulates.

Because of the limited data from existing plants and limitations associated with Method 202, equipment vendors have not provided guarantees for stringent CPM emission limits. On one recent project (subbituminous-fired PC equipped with dry FGD) the most aggressive guaranteed emission rate available for total $PM_{10}$ (FPM and CPM) was 0.025 lb/mmBtu, conditioned upon including modifications to the CPM compliance test method. Based on recent conversations with equipment vendors, it is anticipated that the most aggressive total $PM_{10}$ (FPM and CPM) emission limit available for the proposed Dry Fork unit will be in the range of 0.020 to 0.025 lb/mmBtu.

***$PM_{10}$* Emission Rate Conclusions/Recommendations**

The approach used to calculate the inorganic portion of the condensible particulates, including $H_2SO_4$, HCl, HF, and $(NH_4)_2SO_4$, is consistent with the approach used in other permit applications. However, because $H_2SO_4$ is the major inorganic CPM constituent, and because of the limitations associated with the test method used to demonstrate $H_2SO_4$ compliance, BEPC has concluded that the proposed total $PM_{10}$ emission rate of 0.0025 lb/mmBtu was too aggressive (see, the $H_2SO_4$ BACT analysis prepared as part of this response, Attachment 1). Several recently proposed subbituminous-fired PC units have been permitted with the combination of dry FGD plus fabric filter as BACT for $H_2SO_4$ control. Units proposing this combination of controls have been permitted with controlled $H_2SO_4$ emission rates ranging from 0.0042 to 0.0048 lb/mmBtu (approximately 2 ppmvd @ 3% $O_2$). An emission rate of 2 ppmvd @

[5] See, Corio, L.A., Sherwell, J., "In-Stack Condensible Particulate Matter Measurements and Issues", Journal of Air & Waste Management Association, 50:207-218, February 2000.

3% $O_2$ is very close to the Method 8 detection limit on a coal-fired boiler. Therefore, to ensure a guarantee can be obtained for the proposed emission rate, and to ensure that Class I impacts are modeled at an emission rate that can be demonstrated with compliance testing, BEPC is proposing to increase the controlled $H_2SO_4$ emission rate to 17.1 lb/hr (0.0045 lb/mmBtu or approximately 2 ppmvd @ 3% $O_2$).

Similarly, because of the difficulties associated with quantifying organic condensibles, BEPC is also proposing to increase the organic fraction of the CPM emissions. As noted in Table 2, organic CPM was calculated based on organic constituents listed in AP-42 Tables 1.1-13 and 1.1-14 with boiling points less then 300 °F. However, all of the organic compounds listed in Tables 1.1-13 and 1.1-14 add up to and emission rate of approximately 0.0092 lb/ton. This emission rate is about 1/6$^{th}$ the AP-42 emission factor for total uncontrolled nonmethane organic compounds (AP-42 Table 1.1-19) of 0.06 lb/ton. Therefore, calculating condensible organic emissions using only the constituents listed in Tables 1.1-13 and 1.1-14 may underestimate organic CPM. Without more specific data, BEPC is proposing to adjust the organic CPM emission rate up such that the total $PM_{10}$ emission rate (filterable + condensible) equals 0.020 lb/mmBtu. An emission rate of 0.020 lb/mmBtu is equivalent to the most stringent guarantee expected to be available from emission control vendors.

A summary of the revised CPM emission rates is provided in Table 3. Class I impact modeling has been revised to be consistent with the new CPM emission rates.

**Table 3: Revised CPM Constituent Emission Rates**

| Constituent | Emission Rate (lb/hr) | Emission Rate (lb/mmBtu) | Methodology |
|---|---|---|---|
| $H_2SO_4$ | 17.1 | 0.0045 | Sulfur content of fuel, 2% $SO_2$ to $SO_3$ conversion in boiler and SCR, 100% conversion of $SO_3$ to $H_2SO_4$, and approximately 82% control in the SDA/FF. Emission rate based on limitations associated with the test method used to demonstrate compliance (Method 8). |
| $(NH_4)_2SO_4$ | 1.53 | 0.000402 | Ammonia slip of 2.0 ppmvd @ 3% $O_2$, 25% conversion of the ammonia slip to $(NH_4)_2SO_4$, and 90% control in the SDA/FF. |
| HF | 2.62 | 0.00069 | 80 ppmwd fluorine in the coal, 100% conversion F to HF, 90% removal in the SDA/FF. |
| HCl | 3.23 | 0.00085 | 100 ppmwd chlorine in the coal, 100% conversion Cl to HCl, and 90% removal in the SDA/FF |
| Organic Condensibles | 5.60 | 0.00147 | Organic CPM emission rate was revised to reflect an overall $PM_{10}$ emission rate (filterable + condensible) of 0.020 lb/mmBtu, which is equivalent to the most aggressive guarantee available from equipment vendors. |
| Total $CPM_{10}$ | 30.1 | 0.008 | |
| Total $PM_{10}$ | 75.7 | 0.020 | $FPM_{10}$ = 0.012 lb/mmBtu |

Although calculations can be used to predict $CPM_{10}$ emissions, there is very limited information from existing coal-fired plants characterizing actual CPM emissions that can be used to check the veracity of the emission calculations. Without sufficient data from existing plants, it is not practical to establish an enforceable CPM BACT emission limit. Therefore, BEPC is including the CPM emission rates for emission inventory purposes only, and not as an enforceable BACT emission limit. BEPC is proposing emission control technologies, and compliance with the BACT emission limit for $H_2SO_4$ as BACT for CPM. $H_2SO_4$ is the most widely recognized form of CPM emitted by combustion sources, and control technologies designed to minimize sulfuric acid mist emissions will also minimize inorganic CPM, including other acid gases and ammonium sulfate. USEPA's Environmental Appeals Board (EAB) recently upheld the Nevada Division of Environmental Protection's (NDEP) decision to issue a PSD permit without including a specific CPM BACT emission limit. See, *In re Newmont Nevada Energy Investment, L.L.C., TS Power Plant,* PSD Appeal No. 05-04, slip opinion, December 21, 2005. The PSD permit issued by NDEP for a new coal-fired boiler included a BACT emission limit for FPM, but did not include a BACT emission limit for CPM. During the permit review process, NDEP concluded that "BACT is typically set for the filterable fraction of $PM/PM_{10}$ only, as no technology has been identified... to control condensible $PM/PM_{10}$ emissions from coal-fired boilers and thus it would be technically impossible to establish BACT limits for condensibles in circumstances such as these." The EAB upheld NDEP's decision to exclude a CPM BACT emission limit citing several PSD cases holding "[a]lthough BACT is defined as an 'emission limitation,' it is also, as its name implies, keyed to a specific control technology." *citing In re Hibbing Taconite Co.*, 2 E.A.D. 838, 844 (Adm'r 1989).

***Revised $H_2SO_4$ BACT Analysis***

A revised BACT analysis has been prepared to support a proposed $H_2SO_4$ emission limit of 17.1 lb/hr (0.0045 lb/mmBtu). This has been included as Attachment 1 to this response.

***Revised Permit Emission Limits***

BEPC has revised Section 6.3 of the original (11/10/05) permit application to show the requested permit limits based on the analysis in this response. This has been included as Attachment 2 to this response.

***Revised Emissions Calculations Workbook***

BEPC has revised the Emissions Calculations Workbook (Appendix B of the original 11/10/05 permit application) to include both the proposed changes in this response as well as the revisions made to the auxiliary equipment emissions inventory as part of the response to the WDEQ completeness letter of December 21, 2005. This workbook has been included as part of the electronic file package on the data CD attached to this response.

***Revised CALPUFF Visibility Modeling***

BEPC had CH2M HILL conduct revised Class I visibility modeling for Wind Cave NP, Badlands NP, and Northern Cheyenne Indian Reservation (NCIR) to account for the proposed increase in the total condensible $PM_{10}$ (CPM) estimate. The modeling for NCIR included the new 2044-receptor grid that was supplied to BEPC by WDEQ to be used for any future modeling for NCIR. Table 4 presents a summary of the (raw) revised visibility results.

**Table 4: Raw CALPUFF Visibility Results (Revised)**

| Area | Maximum Modeled Light Extinction | Number of Days with Percentage Change > 5% | Number of Days with Percentage Change > 10% |
|---|---|---|---|
| 2001 | | | |
| Wind Cave NP | 8.6% | 2 | 0 |
| Badlands NP | <5% | 0 | 0 |
| Northern Cheyenne Indian Reservation | 12.5% | 3 | 1 |
| 2002 | | | |
| Wind Cave NP | 9.1% | 2 | 0 |
| Badlands NP | 5.8% | 1 | 0 |
| Northern Cheyenne Indian Reservation | 5.9% | 3 | 0 |
| 2003 | | | |
| Wind Cave NP | 8.3% | 3 | 0 |
| Badlands NP | 5.2% | 1 | 0 |
| Northern Cheyenne Indian Reservation | 54.4% | 1 | 1 |
| Notes: NP = National Park | | | |

The following discussion examines each instance for which the raw 24-hour visibility result exceeded 5 percent. Most of the 24-hour periods that yielded raw visibility impacts greater than 5 percent occurred on the same days as with the initial submittal for the project. Three additional days yielded raw impacts greater than 5 percent, and descriptions for those days are presented at the end of the discussion. Detailed data sheets that summarize observed weather and visibility for these days are presented as Attachment 3 to this response.

March 22, 2001: Wind Cave NP

The raw, modeled 24-hour average visibility result for this day was 8.59 percent. Transmissometer readings at nearby Badlands NP and surface meteorological observations at Rapid City indicate that pronounced natural obscuration was in place for most of the day. Observed weather at Rapid City included 19 hours of rain, mist, or fog. Visibility at Rapid City was reduced to 0.2 mile for nine hours during the 24-hour period. Hourly transmissometer readings at Badlands were greater than 50 $Mm^{-1}$ for 20 hours of the day, and for 13 of these hours the reading was 942 $Mm^{-1}$, which indicates total obscuration along the 4.15 km optical path of the instrument. Using the transmissometer data as a substitute for natural background when the hourly reading exceeded 50 $Mm^{-1}$, the predicted 24-hour visibility impact is reduced to 0.25 percent.

March 23, 2001: Wind Cave NP

For this day, the raw, modeled visibility impact was 5.51 percent. Transmissometer readings at nearby Badlands NP and surface meteorological observations at Rapid City indicate that the weather event of March 22 continued into the first half of March 23. Observed weather at Rapid City included 11 hours of fog, rain, mist, snow, or drizzle. Visibility at Rapid City was reduced to 0.2 mile for four hours during the first half of the day. Hourly transmissometer readings at Badlands were greater than 50 $Mm^{-1}$ for the entire day, with five of these readings at 942 $Mm^{-1}$ (total obscuration). Using the transmissometer reading as a substitute for natural background when the hour exceeded 50 $Mm^{-1}$, the predicted 24-hour visibility impact is reduced to 0.32 percent.

February 23, 2001: Northern Cheyenne Indian Reservation

The raw, modeled visibility result for this day was 12.47 percent. Surface meteorological observations at Billings, Montana and Sheridan, Wyoming indicate that a weather event is affecting the area that includes strong natural obscuration. Observed weather at Billings included 11 hours of mist, and observed weather at Sheridan included 16 hours of mist or fog. Visibility was reduced at Billings for most of the day, while visibility at Sheridan was reduced for the entire period, with a minimum of 0.2 miles for three hours. To arrive at a predicted visibility impact that accounts for natural obscuration, CH2M HILL took the measured visual range from the nearest NWS surface station (Sheridan) for hours that included obscuring weather, and converted the visual range to units of $Mm^{-1}$. Using the calculated extinction for the obscured hours as a substitute for natural background, the predicted 24-hour visibility impact is reduced to 0.11 percent.

April 6, 2001: Northern Cheyenne Indian Reservation

The raw, modeled visibility result for this day was 9.92 percent. Surface meteorological observations include three to four hours of thunderstorms and rain at Billings, Montana and Sheridan, Wyoming. Visibility (visual range) readings do not fall below the instrument maximum reading of 10 km at either location, but one cannot conclude from this that visibility was not reduced to some degree because the visual range on a clear day would be much higher than 10 km. A visual range of just 10 km is equivalent to an atmospheric light extinction of 391 $Mm^{-1}$ which is well into the light scattering range due to condensed water. Therefore, even if the actual visual range is somewhat above 10 km, this still indicates natural obscuration from condensed water is occurring. If the visual range for the hour at Sheridan that included rain showers is converted to units of $Mm^{-1}$ and substituted for natural background, the predicted 24-hour visibility impact is reduced to 6.29 percent.

October 26, 2002: Wind Cave NP

The raw, modeled visibility result for this day was 9.09 percent. Transmissometer readings at nearby Badlands NP and surface meteorological observations at Rapid City and Ellsworth AFB near Rapid City indicate that pronounced natural obscuration was in place for more than half of the day. Surface weather observations at Rapid City were missing for the first 10 hours of the day, but the weather station at nearby Ellsworth AFB observed fog for four hours during the morning. Rapid City recorded two hours of mist after the station came back on line at 1100. Visibility at Ellsworth was reduced to 0.2 mile (0.32 km) or less for three hours from 0800-1000. This 0.32 km visual range is equivalent to a light extinction of 12,225 $Mm^{-1}$. Hourly transmissometer readings at Badlands were greater than 50 $Mm^{-1}$ for the entire day, with three of these readings at 942 $Mm^{-1}$, which indicates total obscuration of the 4.15-km transmissometer. Using the transmissometer reading as a substitute for natural background when the hourly reading exceeded 50 $Mm^{-1}$, the predicted 24-hour visibility impact is reduced to 0.54 percent.

October 26, 2002: Badlands NP

The raw, modeled visibility result for this day was 5.81 percent. This predicted impact occurred on the same day as the October 26, 2002 impact predicted at Wind Cave NP (described above). Using Badlands transmissometer data as a substitute for natural background when the hourly reading exceeded 50 $Mm^{-1}$, the predicted 24-hour visibility impact is reduced to 0.34 percent.

October 27, 2002: Northern Cheyenne Indian Reservation

The raw, modeled visibility result for this day was 5.92 percent. There were no observations of "present weather" or reduced visibility at Billings, Montana or Sheridan, Wyoming on this day. Therefore, there is no evidence of natural obscuration due to condensed water or means to further refine the result for this day.

March 23, 2002: Northern Cheyenne Indian Reservation

The raw, modeled visibility result for this day was 5.59 percent. Surface meteorological observations at Billings, Montana and Sheridan, Wyoming indicate that a weather event is affecting the area that includes strong natural obscuration. Observed weather at Billings included four hours of snow or mist, and observed weather at Sheridan included seven hours of snow or mist. Visibility was reduced at Billings for the later part of the day, and for most of the morning and the later part of the day at Sheridan. To arrive at a predicted visibility impact that accounts for natural obscuration, CH2M HILL took the measured visual range from the nearest surface station (Sheridan) for hours that included observed weather, and converted the visual range to units of $Mm^{-1}$. Using the calculated extinction for the obscured hours as a substitute for natural background, the predicted 24-hour visibility impact is reduced to 0.55 percent.

March 9, 2003: Wind Cave NP

The raw, modeled visibility result for this day was 8.31 percent. Transmissometer readings from nearby Badlands NP were missing for all but the final five hours of the day, but surface meteorological observations at Rapid City indicate that strong natural obscuration was in place for most of the day. Observed weather at Rapid City included 11 hours of snow, mist, or haze. Visibility at Rapid City was reduced for each of these 11 hours. To arrive at a predicted visibility impact that accounts for natural obscuration, CH2M HILL took the measured visual range from Rapid City for hours that included observed weather, and converted the visual range to units of $Mm^{-1}$. Using the calculated extinction for the obscured hours as a substitute for natural background, the predicted 24-hour visibility impact is reduced to 0.69 percent.

December 11, 2003: Wind Cave NP

The raw, modeled visibility result for this day was 8.25 percent. Transmissometer readings at nearby Badlands NP and surface meteorological observations at Rapid City indicate that natural obscuration was in place intermittently during the day. Observed weather at Rapid City included seven hours of light snow. Hourly transmissometer readings at Badlands were greater than 50 $Mm^{-1}$ for the entire day, with four readings of 942 $Mm^{-1}$ (total obscuration). Using the transmissometer reading as a substitute for natural background when the hourly reading exceeded 50 $Mm^{-1}$, the predicted 24-hour visibility impact is reduced to 0.51 percent.

November 5, 2003: Wind Cave NP

The raw, modeled visibility result for this day was 8.03 percent. Transmissometer readings at nearby Badlands NP and surface meteorological observations in and around Rapid City indicate that natural obscuration was in place. Surface observations at Rapid City include traces of precipitation throughout the day. Measured visibility at Ellsworth AFB is reduced from an instrument maximum reading of 30 miles (48 km) to only 7 miles (11 km) for four hours during the day. The equivalent light extinction value for a visual range of 7 miles is 355 $Mm^{-1}$. Hourly transmissometer readings at Badlands were greater than 50 $Mm^{-1}$ for the entire day, with a maximum reading of 81 $Mm^{-1}$. Using the transmissometer reading as a substitute for natural background when the hourly reading exceeded 50 $Mm^{-1}$, the predicted 24-hour visibility impact is reduced to 2.27 percent.

December 12, 2003: Badlands NP

The raw, modeled visibility result for this day was 5.2 percent. Transmissometer readings from Badlands NP and surface meteorological observations at Rapid City indicate that natural obscuration was in place for most of the day. Observed weather at Rapid City included two hours of mist. Visibility at Rapid City was reduced for several hours, with a minimum reading of 1.2 miles. Hourly transmissometer readings at Badlands were greater than 50 $Mm^{-1}$ for the entire day, with two readings of 942 $Mm^{-1}$ (total obscuration). Using the transmissometer reading as a substitute for natural background when the hourly reading exceeded 50 $Mm^{-1}$, the predicted 24-hour visibility impact is reduced to 0.38 percent.

November 3, 2003: Northern Cheyenne Indian Reservation

The raw, modeled visibility result for this day was 54.95 percent. Surface meteorological observations at Billings, Montana and Sheridan, Wyoming indicate that a weather event is affecting the area with strong natural obscuration. Observed weather at Billings included 10 hours of snow or mist, and observed weather at Sheridan included 11 hours of mist or freezing rain/rain. Visibility was reduced at Sheridan for the hours that weather was observed, with a minimum reading of 1.5 miles. To arrive at a predicted visibility impact that accounts for natural obscuration, CH2M HILL took the measured visual range from the nearest surface station (Sheridan) for hours that included observed weather, and converted the visual range to units of $Mm^{-1}$. Using the calculated extinction for the obscured hours as a substitute for natural background, the predicted 24-hour visibility impact is reduced to 2.2 percent.

Additional Days Yielding Raw Impacts > 5%

February 21, 2001: Northern Cheyenne Indian Reservation

The raw, modeled visibility result for this day was 5.05 percent. Surface meteorological observations at Billings, Montana and Sheridan, Wyoming indicate that a weather event is affecting the area that includes natural obscuration. Observed weather at Billings included four hours of fog, ice fog, or mist. Observed weather at Sheridan included four hours with observations of snow or mist. Visibility was reduced at Billings to five miles in the early part of the morning, while visibility at Sheridan was reduced to two miles for a short period in the morning. To arrive at a predicted visibility impact that accounts for natural obscuration, CH2M HILL took the measured visual range from the nearest NWS surface station (Sheridan) for hours that included obscuring weather, and converted the visual range to units of $Mm^{-1}$. Using the calculated extinction for the obscured hours as a substitute for natural background, the predicted 24-hour visibility impact is reduced to 0.56 percent.

December 5, 2002: Wind Cave NP

The raw, modeled visibility result for this day was 5.17 percent. Transmissometer readings at nearby Badlands NP indicate that pronounced natural obscuration was in place for more than half of the day. Hourly transmissometer readings at Badlands were greater than 50 $Mm^{-1}$ for 14 hours, with a maximum reading of 942 $Mm^{-1}$ during the first hour of the day which indicated total obscuration of the 4.15-km transmissometer. Surface maps indicate that a stationary front was located near the southwest corner of South Dakota during the morning hours. Using the transmissometer reading as a substitute for natural background when the hourly reading exceeded 50 $Mm^{-1}$, the predicted 24-hour visibility impact is reduced to 0.80 percent.

March 7, 2002: Northern Cheyenne Indian Reservation

The raw, modeled visibility result for this day was 5 percent. Surface meteorological observations at Billings, Montana and Sheridan, Wyoming indicate that a pronounced weather event is affecting the area that includes strong natural obscuration. Observed weather at Billings included 22 hours of snow, and observed weather at Sheridan included 11 hours of snow. Visibility was reduced at Billings to less than one mile for several hours during the day, and for one hour at Sheridan. To arrive at a predicted visibility impact that accounts for natural obscuration, CH2M HILL took the measured visual range from the nearest surface station (Sheridan) for hours that included observed weather, and converted the visual range to units of $Mm^{-1}$. Using the calculated extinction for the obscured hours as a substitute for natural background, the predicted 24-hour visibility impact is reduced to 0.17 percent.

A summary of adjusted CALPUFF visibility results for the years 2001, 2002 and 2003 are shown in Table 5.

**Table 5: CALPUFF Visibility Results After Adjustment**

| Area | Maximum Modeled Light Extinction | Number of Days with Percentage Change > 5% | Number of Days with Percentage Change > 10% |
|---|---|---|---|
| 2001 | | | |
| Wind Cave NP | <5% | 0 | 0 |
| Badlands NP | <5% | 0 | 0 |
| Northern Cheyenne Indian Reservation | 6.29% | 1 | 0 |
| 2002 | | | |
| Wind Cave NP | <5% | 0 | 0 |
| Badlands NP | <5% | 0 | 0 |
| Northern Cheyenne Indian Reservation | 5.92% | 1 | 0 |
| 2003 | | | |
| Wind Cave NP | <5% | 0 | 0 |
| Badlands NP | <5% | 0 | 0 |
| Northern Cheyenne Indian Reservation | <5% | 0 | 0 |
| Notes:<br>NP = National Park | | | |

Table 6 presents a list of CALPUFF/CALPOST files that are associated with the revised Class I modeling for cumulative $SO_2$ impacts at NCIR and revised visibility modeling for increased condensible particulate emissions. These files and the revised emissions calculations workbook are on the enclosed data CD.

**Table 6: Files on Data CD**

| Filename | Description |
|---|---|
| | |
| B-1_BEPC_Dry_Fork_Emission_ Calculations_for_WDEQ_ 05-31-06.xls | Appendix B Emissions Calculation Workbook |
| | |
| CALPUFF/CALSUM/POSTUTIL/CALPOST Files | |
| 1. Visibility Modeling* | |
| Files for Wind Cave and Badlands | |
| DRYFORK.INP (.LST) | CALPUFF input (.INP) and summary file (.LST) |
| DF_VisPst.INP (.LST) | POSTUTIL input (.INP) and summary file (.LST) |
| DF_BL-V.INP (.LST) | CALPOST input (.INP) and output (.LST) file for Badlands |
| DF_WC-V.INP (.LST) | CALPOST input (.INP) and output (.LST) file for Wind Cave |
| Files for NCIR (2044-receptor grid) | |
| DRYFORK.INP (.LST) | CALPUFF input (.INP) and summary file (.LST) |
| DF_VisPst.INP (.LST) | POSTUTIL input (.INP) and summary file (.LST) |
| DF_NR-V.INP (.LST) | CALPOST input (.INP) and output (.LST) file for NCIR |
| | |
| 2. Cumulative $SO_2$ Increment Modeling at NCIR* | |
| CALPUFF Files | |
| NRC_CS3.INP (.LST) | CALPUFF input (.INP) and summary file (.LST) for Colstrip 3-hour PTE |
| NRC_CS24.INP (.LST) | CALPUFF input (.INP) and summary file (.LST) for Colstrip 24-hour PTE |
| NRC_WYG.INP (.LST) | CALPUFF input (.INP) and summary file (.LST) for Wygen3 Project |
| NRC_DF.INP (.LST) | CALPUFF input (.INP) and summary file (.LST) for Dry Fork Project |
| NRC_MT.INP (.LST) | CALPUFF input (.INP) and summary file (.LST) for (other) Montana sources |
| NRC_ND.INP (.LST) | CALPUFF input (.INP) and summary file (.LST) for N. Dakota source |
| NRC_WY.INP (.LST) | CALPUFF input (.INP) and summary file (.LST) for (other) Wyoming sources |
| CALSUM Files | |
| CALSUM_3hr.INP (.LST) | CALSUM input and summary file for 3-hour concentrations |
| CALSUM_24hr.INP (.LST) | CALSUM input and summary file for 24-hour concentrations |
| CALPOST Files | |
| PST_NRC3_SO2.INP (.LST) | CALPOST input and output file for 3-hour concentrations in NCIR (all sources) |

| Filename | Description |
| --- | --- |
| PST_NRC24_SO2.INP (.LST) | CALPOST input and output file for 24-hour concentrations in NCIR (all sources) |
| PST_NRC_SO2DF.INP (.LST) | CALPOST input and output file for concentrations in NCIR (Dry Fork) |
| * The same list of files applies for each of the years modeled (2001, 2002, and 2003). | |

List of Attachments:

Attachment 1 Revised $H_2SO_4$ BACT Analysis PC Boiler
Attachment 2 Revised Section 6.3 Requested Permit Limits PC Boiler
Attachment 3 Revised CALPUFF Visibility Analysis Data Sheets

Attachment 1

# Attachment 1
# Dry Fork Station Unit 1 Permit Application
# Revised $H_2SO_4$ BACT Analysis PC Boiler

Based on information provided in the Basin Electric Power Cooperative (BEPC) response to Wyoming Department of Environmental Quality's (WDEQ) Completeness Review dated March 28, 2006 Comment 3, BEPC would like to submit a revised BACT Analysis for $H_2SO_4$. The requested $H_2SO_4$ BACT permit limit has been increased from 0.0025 to 0.0045 lb/MMBtu. The revised CALPUFF Class I visibility modeling was performed with the higher $H_2SO_4$ (and total $PM_{10}$) values. The modeling results are discussed in the BEPC response memo (under Comment 3) and the files have been enclosed on CD. In the original permit application submitted to WDEQ on November 10, 2005, the $H_2SO_4$ BACT analysis was coupled with the $SO_2$ BACT analysis since the same control options apply. The original BACT analysis has been revised, relative to the $H_2SO_4$ portion, based on recent analysis and discussions with Air Pollution Control equipment vendors.

## 5.2 BACT Determination

This section presents the required BACT analyses.

### 5.2.1 Applicability

The requirement to conduct a BACT analysis and determination is set forth in section 165(a)(4) of the Clean Air Act and in federal regulations 40 CFR 52.21(j).

### 5.2.2 Top-Down BACT Process

EPA has developed a process for conducting BACT analyses. This method is referred to as the "top-down" method. The steps to conducting a "top-down" analysis are listed in EPA's "New Source Review Workshop Manual," Draft, October 1990. The steps are the following:

- Step 1 – Identify All Control Technologies
- Step 2 – Eliminate Technically Infeasible Options
- Step 3 – Rank Remaining Control Technologies by Control Effectiveness
- Step 4 – Evaluate Most Effective Controls and Document Results
- Step 5 – Select BACT

Each of these steps has been conducted for $SO_2$ and $H_2SO_4$, and are described below.

### 5.2.3 $SO_2$ and $H_2SO_4$ Analysis

The BACT analysis for sulfur dioxide is presented below. The analysis is also applicable to sulfuric acid mist ($H_2SO_4$).

### Step 1 – Identify All Control Technologies

Sulfur dioxide ($SO_2$) will be emitted from the proposed Dry Fork Station as a result of the combustion of coal that contains sulfur. The first step is to evaluate $SO_2$ controls determined to be BACT by permitting agencies across the United States. This information is available from the EPA RACT/BACT/LAER Clearinghouse (RBLC) database accessible on the Internet. The printout from the database for $SO_2$ is shown in Appendix E, Table E-7 in the original permit application. The printout from the database for $H_2SO_4$ is shown in Appendix E, Table E-9 in the original permit application. A broad range of other information sources were also reviewed in an effort to identify all potentially applicable emission control technologies.

The potential $SO_2$ emission reduction options found in the RBLC and other sources that could be applied to the Dry Fork Station are:

- Wet lime/limestone scrubbing
- Dry lime scrubbing

The control efficiencies for these technologies range from 73 percent to 95 percent. However, with the exception of two projects in Wyoming using a circulating dry lime scrubber and one project in Wyoming using a lime spray dryer, the reported removal rates are 90 percent to 95 percent. FGD control efficiencies will be in the lower end of this range when used with low sulfur coal.

### Step 2 – Eliminate Technically Infeasible Options

Both of these options are technically feasible for use in reducing $SO_2$ emissions from the Dry Fork Station. Control efficiencies for circulating dry scrubbers (CDS) have not been demonstrated above 80 percent in the RBLC database. However, this technology has demonstrated $SO_2$ removal efficiencies above 90 percent in European installations. For this reason this technology was included for further consideration.

### Step 3 – Rank Remaining Control Technologies by Control Effectiveness

Emission rates for each of the $SO_2$ removal technologies are ranked in order of their control effectiveness. These effectiveness values are provided in Table 5-1. The PSD NSR regulations require that BACT, at a minimum, meet the applicable NSPS limit, 40 CFR 60 Subpart Da. Because there is an NSPS that applies to the boiler, the NSPS emission limit is also included in the ranking.

**TABLE 5-1**
$SO_2$ Control Technology Emission Rate Ranking

| Control Technology | $SO_2$ Emission Rate [a] |
|---|---|
| Wet Limestone Scrubbing | 0.09 – 0.40 |
| Lime Spray Dryer | 0.10 – 0.32 |
| Circulating Dry Scrubber[c] | 0.10 – 0.32 |
| Wet Lime Scrubbing | 0.13 – 0.25 |
| NSPS Limit | 0.34[b] |

[a] Pounds per million BTU as found in the RBLC database and recently approved PSD permits.
[b] Based on an uncontrolled $SO_2$ emission rate of 1.12 Lb/MmBtu and a removal efficiency of 70 percent, which is the applicable standard under NSPS subpart Da when $SO_2$ emissions are less than 0.60 pounds per MmBtu.
[c] An assumption is made that the current Circulating Dry Scrubber designs are capable of achieving the emission rates shown.

Nomenclature:

NSPS = New Source Performance Standards

## Step 4 – Evaluate Most Effective Controls and Document Results

This step involves the consideration of energy, environmental, and economic impacts associated with each control technology. The top-down process requires that the evaluation begin with the most effective technology.

### Wet Limestone/Lime FGD

Wet $SO_2$ scrubbers operate by flowing the flue gas upward through a large reactor vessel that has an alkaline reagent (i.e. limestone or lime slurry) flowing down from the top. The scrubber mixes the flue gas and alkaline reagent using a series of spray nozzles to distribute the reagent across the scrubber vessel. The calcium in the reagent reacts with the $SO_2$ in the flue gas to form calcium sulfite and/or calcium sulfate that is removed from the scrubber with the sludge and is disposed. Most wet FGD systems utilize forced oxidation to assure that only calcium sulfate sludge is produced. The wet limestone forced oxidation (LSFO) process is used in most new wet FGD installations. Several variations on the wet FGD technology are offered by various process developers. These variations include using a jet bubbling reactor as a combination $SO_2$ absorber and calcium sulfite oxidation vessel, and using magnesium enhanced lime as the alkaline reagent.

The creation of a wet sludge from the scrubber does create a solid waste handling and disposal problem. This sludge needs to be handled in a manner to not result in ground water contamination. Also, the sludge disposal area needs to be permanently set aside from future surface uses since the disposed sludge can not bear any weight from such uses as buildings or cultivated agriculture. Wet FGD systems can produce salable gypsum if a gypsum market is available, reducing the quantity of solid waste that needs to be disposed of from the power plant.

Other disadvantages associated with wet limestone or lime FGD includes the creation of a wet stack plume, generation of primary particulate matter by the scrubbing process, increased acid gas emissions, incompatibility with mercury removal options and water/wastewater issues. Wet FGD generates more primary particulate emissions leaving the stack than dry FGD systems because the particulate removal device (ESP or Fabric Filter) is upstream of the scrubber instead of downstream as in this case. Sulfuric acid removal for a wet FGD system is in the range of 40 to 60 percent compared to 80 to 90 percent for a dry lime absorber/fabric filter combination. The potential future use of activated carbon or sorbent injection for mercury removal is also limited with a wet FGD application since the fabric filter is upstream of the scrubber and the flue gas temperature is higher than the optimum mercury capture range.

Wet FGD also requires more makeup water than Dry FGD, and typically requires a wastewater blowdown stream that must be treated to limit the buildup of chlorides in the absorber scrubbing loop. Given that the amount of water available for the Dry Fork Station is quite limited to the point of requiring dry cooling for much of its heat dissipation, the increased water consumption required for the wet scrubber is a serious concern.

### Dry Lime FGD Absorber Followed by Fabric Filter

In CDS and lime spray dryer systems, $SO_2$ reacts with lime in an absorber vessel. The CDS absorber operates as a circulating fluidized bed of hydrated lime, reaction products and ash. The flue gas is humidified at the venturi inlet in the bottom of the fluidized bed. Dry hydrated lime and recycle solids are injected above the venturi. The hydrated lime reacts with the $SO_2$ in the flue gas reacts to form particulate calcium sulfate. This dry material is captured in the fabric filter along with the fly ash.

The lime spray dryer typically injects lime slurry in the top of the vessel with a rapidly rotating atomizer wheel. The rapid speed of the atomizer wheel causes the lime slurry to separate into very fine droplets that intermix with the flue gas where the $SO_2$ in the flue gas reacts with the calcium in the lime slurry to form particulate calcium sulfate. This dry material is captured in the fabric filter along with the fly ash.

The CDS and lime spray dryer FGD systems produce a dry waste product suitable for landfill disposal.

CDS and lime spray dryer systems are in operation at many facilities in Europe, China and the U.S. ranging in size from less than 10 MW to 350 MW. CDS and lime spray dryer FGD are commercially available from multiple process developers/vendors.

The dry FGD systems have a number of advantages when compared to wet FGD technology. The absorber vessel can be constructed of unlined carbon steel, as opposed to lined carbon steel or solid alloy construction for wet FGD, and the capital cost is typically lower than for wet FGD.

The pressure drop across the absorber is typically lower than wet FGD systems. Pumping requirements and overall power consumption are lower than for wet FGD systems. The dry FGD systems use less equipment than does the wet FGD system, resulting in fixed, lower operations and maintenance (O&M) labor requirements.

Sulfur trioxide ($SO_3$) in the vapor above approximately 300°F, which condenses to liquid sulfuric acid at a lower temperature (below acid dew point), is removed efficiently with a CDS or lime spray dryer system. Wet scrubbers capture less than 40 to 60 percent of $SO_3$ and may require the addition of a wet ESP, or hydrated lime injection, to remove the balance of $SO_3$. Otherwise, the emission of sulfuric acid mist, if above a threshold value, may result in a visible plume after the vapor plume dissipates.

Flue gas following a dry FGD system is not saturated with water (30°F to 50°F above dew point), which reduces or eliminates a visible moisture plume. Wet FGD scrubbers produce flue gas that is saturated with water, which would require a gas-gas heat exchanger to reheat the flue gas if it were to operate as a dry stack. Due to the high capital and operating costs associated with heating the flue gas, all recent wet FGD systems in the United States have used wet stack operation.

Waste produced is in a dry form and can be handled with conventional pneumatic fly ash handling equipment. The waste is stable for landfill purposes and can be disposed of concurrently with fly ash.

There is no liquid waste from a dry FGD system, while wet FGD systems may produce a liquid waste stream, especially if the gypsum is to be sold for wallboard. In some cases, a wastewater treatment plant must be installed to treat the liquid waste prior to disposal. The wastewater treatment plant produces a small volume of solid waste, which may be contaminated with toxic metals (including mercury) that must be disposed of in a landfill. The humidification stream of a CDS system provides a way to achieve a dry by-product from process wastewater from other parts of the plant when processing residue for disposal.

Dry FGD technology has only a few disadvantages when compared to wet FGD technology. The dry FGD process uses a more expensive reagent (hydrated lime) than limestone-based FGD systems, and the reagent has to be stored in a steel or concrete silo. Reagent utilization is lower than for wet limestone systems to achieve comparable $SO_2$ removal. The lime stoichiometric ratio is higher than the limestone stoichiometric ratio (on the same basis) to achieve comparable $SO_2$ removal.

The CDS process is applicable mostly for base-load applications such as at the Dry Fork Station, as high velocities are required to maintain the bed in suspension. The standard design includes provisions for ID fan recycle to keep the gas velocity high in the CDS vessel to mitigate this shortcoming.

Since dry FGD is being proposed for this project, the environmental, energy and economic impacts must be examined. Sargent & Lundy, the Engineer for the Dry Fork project, developed cost estimates for a dry lime FGD and for a wet limestone FGD installation and operation. The average cost effectiveness of a dry lime FGD system designed to achieve a controlled $SO_2$ emission rate of 0.10 lb/mmBtu (87.8 percent $SO_2$ removal efficiency based on 0.33 wt. percent average coal sulfur content) was estimated at $1,248 per ton of $SO_2$ controlled. The average cost effectiveness of the wet scrubbing system designed to achieve ~~a controlled SO2 emission rate of 0.09 lb/mmBtu (89.0 percent SO2 removal efficiency based~~ on 0.33 wt. percent average coal sulfur content) was estimated to be $1,450 per ton of SO2 controlled.

Based on average cost effectiveness calculations, both wet and dry FGD systems appear to be cost effective. An incremental cost analysis was also prepared to evaluate the incremental cost effectiveness of the wet scrubbing system. The incremental cost effectiveness of the wet limestone FGD (compared to the dry lime FGD) was calculated at $13,157 per additional ton of $SO_2$. The incremental cost effectiveness reflects the additional capital, O&M, and fabric filter costs associated with the wet FGD system.

With a wet FGD design, the fabric filter would be prior to the FGD system, and the resultant capital and operating costs are higher than a similar fabric filter that follows a dry lime FGD system. A comparison of the costs and $SO_2$ removed is summarized in Table 5-2. The annualized cost estimate for a wet lime system would be similar to the one prepared for wet limestone with the primary difference being the higher cost of lime reagent. Because wet limestone FGD has a similar removal efficiency to wet lime FGD and the operating costs are lower, it was decided that wet limestone FGD was the appropriate cost comparison alternative to the dry lime FGD system.

Dry FGD has the advantages of producing a dry waste material and requiring less makeup water in the absorber over a wet scrubber. Given that the amount of water available for Dry Fork is quite limited to the point of requiring dry cooling for much of its heat dissipation, the reduced water consumption required for dry FGD is major advantage for this technology.

A Dry FGD system has the additional advantage of requiring less electric power for its operation compared to a Wet FGD system. A dry FGD system at Dry Fork would require approximately 2.8 MW of power compared to approximately 5.3 MW for Wet FGD. This would equate to an annual power savings of approximately 18.6 million kW-Hr for dry FGD versus wet FGD for Dry Fork based on an 85 percent annual plant capacity factor. Instead of this amount of power being used in the power plant, this power can instead be sold to Basin Electric's customers reducing the need to produce this power elsewhere.

**TABLE 5-2**
Dry Form $SO_2$ Control Cost Comparison

| Factor | Dry Lime FGD | Wet Limestone FGD |
|---|---|---|
| Total Installed Capital Costs | $ 63.6 Million | $ 77.4 Million |
| Total Fixed & Variable O&M Costs | $ 4.4 Million | $ 4.8 Million |
| Total Annualized Cost | $ 15.0 Million | $ 17.6 Million |
| FGD Design Control Efficiency | 87.8 percent | 89.0 percent |
| Tons $SO_2$ Removed per Year | 11,980 | 12,144 |
| Cost Effectiveness per Ton of $SO_2$ Removed | $ 1,248 | $ 1,450 |
| Incremental Annualized Cost Difference between Wet LSFO FGD and dry lime FGD | - | $ 2.6 Million |
| Incremental Tons $SO_2$ Removed between Wet LSFO FGD and dry lime FGD | - | 202 |
| Incremental Cost Effectiveness per Ton of Additional $SO_2$ Removed by Wet LSFO FGD | - | $ 13,157 |

Basin Electric believes that the high additional cost of wet limestone/lime scrubbing is not warranted for this project based on the use of low sulfur coal and the limited additional tons of $SO_2$ removed. Wet FGD also has the disadvantages of waste disposal of a wet FGD sludge, increased water consumption requirements, possible future complications with mercury removal, higher particulate emissions and the fact that dry FGD can meet a $SO_2$ emission limit that is comparable to BACT as determined in other recent permits listed in the RBLC database.

## Step 5 – Select BACT

### $SO_2$

The final step in the top-down BACT analysis process is to select BACT. EPA's RACT/BACT/LAER Clearinghouse (RBLC), a database of past technology decisions, and recently approved PSD permits were again consulted to assist in selecting BACT for this project.

Both dry FGD and wet limestone scrubbing have been demonstrated at removal efficiencies greater than 90 percent. The installation of a dry FGD system on Dry Fork will result in a $SO_2$ removal efficiency of 91.7 percent for the design maximum coal sulfur content of 0.47 weight percent. The highest collection efficiency shown in the RBLC is 95 percent on Santee Cooper Cross Unit No. 1, however, this unit burns high sulfur coal and is equipped with a wet limestone FGD system.

The recent additions of the 750-net MW MidAmerican Council Bluffs Energy Center (CBEC) Unit 4 and the 750-net MW Xcel Energy Comanche Unit 3, which are under construction, were both permitted at 0.10 lb/mmBtu (30-day rolling average) based on the use of low sulfur PRB coal and a lime spray dryer FGD. The design $SO_2$ emission rate for Dry Fork is 0.10 lb/mmBtu which is identical to the CBEC Unit 4 and Comanche Unit 3 design $SO_2$ emission rate, and consistent with the low end of the range of emissions for units in the RBLC.

The 950-gross MW Intermountain Power Project (IPP) Unit 3 was recently permitted at 0.09 lb/mmBtu (30-day rolling average) based on the use of western bituminous coal and a wet limestone FGD. This is equivalent to 92.5 percent $SO_2$ removal in the wet FGD system when firing the worst case design fuel. Using low sulfur coal and dry FGD, Dry Fork will achieve a controlled emission rate almost equivalent to IPP. As shown above, wet FGD is not incrementally cost effective on this project. Therefore, dry FGD is selected as the technology to achieve the BACT $SO_2$ emission limit for this project of 0.10 lb/mmBtu based on a 3-hour block average.

On March 9, 2006, BEPC provided additional $SO_2$ BACT analysis information to WDEQ as part of the response to the December 21, 2005 completeness letter. In Attachment 1 to that response, BEPC analyzed the technical feasibility and costs associated with dry lime and wet limestone scrubbers to achieve controlled emission rates of 0.07, 0.08 and 0.09 lb/mmBtu. The conclusions supported the original analysis of dry lime scrubbing with a controlled emission rate of 0.10 lb/mmBtu (or 380.1 lb/hr at the maximum design heat input of 3,801 mmBtu/hr).

### $H_2SO_4$

The EPA NSR RBLC database shows the comparable sources related to sulfuric acid mist ($H_2SO_4$). They are shown in Table E-9 in Appendix E of the original application. Many of the sources determined that the use of a dry lime scrubber followed by a fabric filter was technology chosen to achieve BACT. Most of the other sources selected wet FGD system to achieve BACT emissions levels for sulfuric acid. Sargent & Lundy estimates a 80 to 90 percent sulfuric acid control level with the proposed Dry Fork Unit 1 design.

As discussed in the BEPC response memo to the WDEQ March 28, 2006 completeness letter (Comment 3), air pollution control equipment vendors have not been willing to guarantee $H_2SO_4$ emission rates below approximately 2 ppmvd @ 3% $O_2$ (approximately 0.005 lb/mmBtu depending on boiler design and performance) due to the detection limit and interference issues associated with EPA Test Method 8 used to demonstrate compliance. Therefore, to ensure that a guarantee can be obtained for the proposed emission rate, BEPC is proposing a controlled $H_2SO_4$ emission rate of 17.1 lb/hr (0.0045 lb/mmBtu or approximately 2 ppmvd @ 3% $O_2$).

Other recent permit limits for $H_2SO_4$ include Roundup Units 1 and 2 at 0.0064 lb/mmBtu, CBEC Unit 4 at 0.0042 lb/mmBtu, IPP Unit 3 at 0.0044 lb/mmBtu, Weston Unit 4 at 0.0050 lb/mmBtu and Comanche Unit 3 at 0.0042 lb/mmBtu.

Based on the technology and clearinghouse database discussion above, a dry lime FGD system followed by a fabric filter are selected as BACT for the project with a sulfuric acid emission rate of 0.0045 lb/mmBtu (or 17.1 lb/hr at the maximum design heat input of 3,801 mmBtu/hr).

Attachment 2

# Attachment 2
# Dry Fork Station Unit 1 Permit Application
# Revised Section 6.3 Requested Permit Limits PC Boiler

Based on information provided in the Basin Electric Power Cooperative (BEPC) response to Wyoming Department of Environmental Quality's (WDEQ) Completeness Review dated March 28, 2006 Comment 3, BEPC would like to request revised Unit 1 PC boiler permit limits as shown below. The total $PM_{10}$ emission estimate (filterable and condensible) has been increased from 0.017 to 0.020 lb/mmBtu. However, because of the uncertainties associated with establishing a condensible $PM_{10}$ emission rate, and the issues associated with the test method used to demonstrate compliance with a condensible $PM_{10}$ emission limit, we request that the limit be placed in the permit for emission inventory purposes only and not as an enforceable emission limit. The requested $H_2SO_4$ BACT permit limit has been increased from 9.5 to 17.1 lb/hr (0.0025 to 0.0045 lb/mmBtu) to account for anticipated emission guarantees and test method limitations. The revised CALPUFF Class I visibility modeling was performed with the higher total $PM_{10}$ and $H_2SO_4$ values. The modeling results are discussed in the BEPC response memo (under Comment 3) and the files have been enclosed on CD. BEPC is also requesting that the short-term 3-hr $SO_2$ limit, and the BACT limits for $H_2SO_4$ and HF be on a lb/hr basis versus a lb/mmBtu basis.

**$SO_2$:** 380.1 lb/hr based on a 3-hr block average, except during periods of startup, shutdown, maintenance/planned outage, or malfunction. Compliance with the emission limit will be demonstrated using a $SO_2$ CEMS compliant with the requirements of 40 CFR Part 75.

**$SO_2$:** 0.10 lb/mmBtu heat input based on a 30 day rolling average as determined by the arithmetic average of all hourly emission rates for the 30 successive boiler operating days, except during periods of startup, shutdown, maintenance/planned outage, or malfunction. Compliance with the emission limit will be demonstrated using a $SO_2$ CEMS compliant with the requirements of 40 CFR Part 75.

**$SO_2$:** 1,625 tpy annual 12-month rolling including periods of startup, shutdown and malfunction. Compliance with the emission limit will be demonstrated using a $SO_2$ CEMS compliant with the requirements of 40 CFR Part 75.

**$NO_x$:** 0.07 lb/mmBtu heat input based on a 30 day rolling average as determined by the arithmetic average of all hourly emission rates for the 30 successive boiler operating days, except during periods of startup, shutdown, maintenance/planned outage, or malfunction. Compliance with the emission limit will be demonstrated using a $NO_x$ CEMS compliant with the requirements of 40 CFR Part 75.

**$NO_x$:** 1,137 tpy annual 12-month rolling including periods of startup, shutdown and malfunction. Compliance with the emission limit will be demonstrated using a $NO_x$ CEMS compliant with the requirements of 40 CFR Part 75.

**$PM_{10}$ (filterable):** 0.012 lb/mmBtu heat input except during periods of startup, shutdown, maintenance/planned outage, or malfunction based on the average of three (3) one-hour stack tests conducted annually using USEPA Test Methods 5, 17, 201, or 201A as described in Section 9.0 of the permit application.

**Opacity:** 20% based on six minute averages except for one 6-minute period per hour that may not exceed 27%.

**CO:** 0.15 lb/mmBtu heat input based on a 30 day rolling average as determined by the arithmetic average of all hourly emission rates for the 30 successive boiler operating days, except during periods of startup, shutdown, maintenance/planned outage, or malfunction. Compliance with the emission limit will be demonstrated using a CO CEMS compliant with the requirements of 40 CFR Part 60.

**CO:** 2,437 tpy annual 12-month rolling including periods of startup, shutdown and malfunction. Compliance with the emission limit will be demonstrated using a CO CEMS compliant with the requirements of 40 CFR Part 60.

**VOC:** 61 tpy on an annualized average based on an emission rate of 0.00385 lb/mmBtu heat input, except during periods of startup, shutdown, maintenance/planned outage, or malfunction. Compliance with the VOC emission rate will be demonstrated based on the average of three (3) one-hour stack tests using USEPA Test Method 25 or 25A as described in Section 9.0 of the permit application.

**$H_2SO_4$:** 17.1 lb/hr. Compliance with the $H_2SO_4$ emission rate will be demonstrated based on the average of three (3) on-hour stack tests using USEPA Test Method 8 or WDEQ approved alternate method as described in Section 9.0 of the permit application.

**HF:** 2.62 lb/hr. Compliance with the HF emission rate will be demonstrated based on the average of three (3) on-hour stack tests using USEPA Test Method 26A or WDEQ approved alternate method as described in Section 9.0 of the permit application.

**Mercury:** 78 x $10^{-6}$ lb/MW-hr on an output basis 12 month rolling average. Compliance will be demonstrated with a mercury CEMS per 40 CFR Part 75 requirements.

Attachment 3

Attachment 4

**JD 81 (82,0): Mar 22**

| YEAR | DAY | TIME | REC# | TOT EXT | MODEL EXT | FLAG BGRND | % CHANGE | RH-FAC | BGRND (FLAG/BAD) | %CHNG (FLAG/BAD)* | Rapid City Weather | Rapid City Visibility (miles) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2001 | 81 | 100 | 285 | 15.783 | 0.107 | 15.676 | 0.68 | 1.96 | 15.676 | | rain, thunderstorm | 10 |
| 2001 | 81 | 200 | 285 | 16.421 | 0.145 | 16.276 | 0.89 | 2.959 | 16.276 | | | 10 |
| 2001 | 81 | 300 | 285 | 17.354 | 0.238 | 17.116 | 1.39 | 4.359 | 17.116 | | | 10 |
| 2001 | 81 | 400 | 285 | 16.738 | 0.22 | 16.518 | 1.33 | 3.364 | 16.518 | | | 10 |
| 2001 | 81 | 500 | 285 | 16.81 | 0.292 | 16.518 | 1.77 | 3.364 | 53 | | | 10 |
| 2001 | 81 | 600 | 285 | 16.936 | 0.418 | 16.518 | 2.53 | 3.364 | 157 | | | 9.9 |
| 2001 | 81 | 700 | 285 | 17.814 | 0.698 | 17.116 | 4.08 | 4.359 | 942 | | mist, fog | 0.2 |
| 2001 | 81 | 800 | 285 | 22.386 | 2.018 | 20.368 | 9.91 | 9.779 | 942 | | fog | 0.2 |
| 2001 | 81 | 900 | 285 | 22.729 | 2.361 | 20.368 | 11.59 | 9.779 | 942 | | fog | 0.2 |
| 2001 | 81 | 1000 | 285 | 22.942 | 2.574 | 20.368 | 12.64 | 9.779 | 942 | | fog | 0.2 |
| 2001 | 81 | 1100 | 285 | 23.259 | 2.891 | 20.368 | 14.19 | 9.779 | 942 | | mist, fog | 0.2 |
| 2001 | 81 | 1200 | 285 | 23.629 | 3.261 | 20.368 | 16.01 | 9.779 | 437 | | mist, fog | 0.5 |
| 2001 | 81 | 1300 | 285 | 23.764 | 3.396 | 20.368 | 16.67 | 9.779 | 561 | | mist | 1.7 |
| 2001 | 81 | 1400 | 285 | 23.61 | 3.242 | 20.368 | 15.92 | 9.779 | 414 | | mist | 1.7 |
| 2001 | 81 | 1500 | 285 | 19.859 | 1.794 | 18.065 | 9.93 | 5.941 | 789 | | mist | 6 |
| 2001 | 81 | 1600 | 285 | 22.916 | 2.548 | 20.368 | 12.51 | 9.779 | 818 | | mist | 6 |
| 2001 | 81 | 1700 | 285 | 22.61 | 2.242 | 20.368 | 11.01 | 9.779 | 942 | | mist | 3 |
| 2001 | 81 | 1800 | 285 | 22.353 | 1.985 | 20.368 | 9.75 | 9.779 | 942 | | mist | 3 |
| 2001 | 81 | 1900 | 285 | 22.128 | 1.76 | 20.368 | 8.64 | 9.779 | 942 | | mist | 0.8 |
| 2001 | 81 | 2000 | 285 | 21.602 | 1.234 | 20.368 | 6.06 | 9.779 | 942 | | mist | 0.8 |
| 2001 | 81 | 2100 | 285 | 22.076 | 1.708 | 20.368 | 8.39 | 9.779 | 942 | | fog | 0.2 |
| 2001 | 81 | 2200 | 285 | 22.031 | 1.663 | 20.368 | 8.16 | 9.779 | 942 | | fog | 0.2 |
| 2001 | 81 | 2300 | 285 | 21.611 | 1.243 | 20.368 | 6.10 | 9.779 | 942 | | fog | 0.2 |
| 2001 | 82 | 0 | 285 | 21.822 | 1.454 | 20.368 | 7.14 | 9.779 | 942 | | fog | 0.2 |
| | | | | 20.80 | 1.65 | 19.15 | 8.59 | 7.756 | 647.52 | 0.25 | | |

DEQ/AQD 000660

* % change based on background from IMPROVE transmissometer at Badlands NP (if >50 1/Mm)

Model Extinctio by Species

| YEAR | DAY | HR | RECEP | COORDIN (km) | | TYPE | BEXT(Mod | BEXT(BKG | BEXT(Total) | %CHANGE | F(RH) | bxSO4 | bxNO3 | bxOC | bxEC | bxPMC | bxPMF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2001 | 82 | 0 | 285 | 117.585 | -37.827 | D | 1.65 | 19.15 | 20.80 | 8.59 | 7.756 | 1.079 | 0.562 | 0.004 | 0 | 0 | 0.001 |

**JD 82 (83,0): Mar 23**

| YEAR | DAY | TIME | REC# | TOT EXT | MODEL EXT | FLAG BGRND | % CHANGE | RH-FAC | BGRND (FLAG/BAD) | %CHNG (FLAG/BAD)* | Rapid City Weather | Rapid City Visibility (miles) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2001 | 82 | 100 | 104 | 21.81 | 1.442 | 20.368 | 7.08 | 9.779 | 942 | | fog | 0.2 |
| 2001 | 82 | 200 | 104 | 21.991 | 1.623 | 20.368 | 7.97 | 9.779 | 921 | | mist | 0.8 |
| 2001 | 82 | 300 | 104 | 22.184 | 1.816 | 20.368 | 8.92 | 9.779 | 942 | | fog | 0.2 |
| 2001 | 82 | 400 | 104 | 22.356 | 1.988 | 20.368 | 9.76 | 9.779 | 942 | | fog | 0.2 |
| 2001 | 82 | 500 | 104 | 22.495 | 2.127 | 20.368 | 10.44 | 9.779 | 942 | | fog, mist | 0.2 |
| 2001 | 82 | 600 | 104 | 22.577 | 2.209 | 20.368 | 10.85 | 9.779 | 942 | | snow | 5 |
| 2001 | 82 | 700 | 104 | 22.588 | 2.22 | 20.368 | 10.90 | 9.779 | 368 | | drizzle, mist | 5 |
| 2001 | 82 | 800 | 104 | 22.618 | 2.25 | 20.368 | 11.05 | 9.779 | 214 | | mist | 7 |
| 2001 | 82 | 900 | 104 | 22.479 | 2.111 | 20.368 | 10.36 | 9.779 | 216 | | mist, snow | 2.5 |
| 2001 | 82 | 1000 | 104 | 22.27 | 1.902 | 20.368 | 9.34 | 9.779 | 124 | | mist | 6 |
| 2001 | 82 | 1100 | 104 | 19.068 | 1.003 | 18.065 | 5.55 | 5.941 | 121 | | mist | 6 |
| 2001 | 82 | 1200 | 104 | 18.901 | 0.836 | 18.065 | 4.63 | 5.941 | 99 | | mist | 3.7 |
| 2001 | 82 | 1300 | 104 | 21.465 | 1.097 | 20.368 | 5.39 | 9.779 | 72 | | | 10+ |
| 2001 | 82 | 1400 | 104 | 21.208 | 0.84 | 20.368 | 4.12 | 9.779 | 72 | | | 10+ |
| 2001 | 82 | 1500 | 104 | 16.737 | 0.219 | 16.518 | 1.33 | 3.364 | 68 | | | 10+ |
| 2001 | 82 | 1600 | 104 | 16.686 | 0.168 | 16.518 | 1.02 | 3.364 | 108 | | | 10+ |
| 2001 | 82 | 1700 | 104 | 16.647 | 0.129 | 16.518 | 0.78 | 3.364 | 118 | | | 10+ |
| 2001 | 82 | 1800 | 104 | 16.615 | 0.097 | 16.518 | 0.59 | 3.364 | 68 | | | 9.9 |
| 2001 | 82 | 1900 | 104 | 16.591 | 0.073 | 16.518 | 0.44 | 3.364 | 68 | | | 10+ |
| 2001 | 82 | 2000 | 104 | 16.584 | 0.066 | 16.518 | 0.40 | 3.364 | 74 | | | 10+ |
| 2001 | 82 | 2100 | 104 | 16.604 | 0.086 | 16.518 | 0.52 | 3.364 | 70 | | | 10+ |
| 2001 | 82 | 2200 | 104 | 16.607 | 0.089 | 16.518 | 0.54 | 3.364 | 80 | | | 10+ |
| 2001 | 82 | 2300 | 104 | 18.225 | 0.16 | 18.065 | 0.89 | 5.941 | 82 | | | 10+ |
| 2001 | 83 | 0 | 104 | 18.224 | 0.159 | 18.065 | 0.88 | 5.941 | 77 | | | 9.9 |
| | | | | 19.73 | 1.03 | 18.701 | 5.51 | 7.001 | 322.08 | 0.32 | | |

* % change based on background from IMPROVE transmissometer at Badlands NP (if >50 1/Mm)

Model Extinctio by Species

| YEAR | DAY | HR | RECEP | COORDIN (km) | | TYPE | BEXT(Mod | BEXT(BKG | BEXT(Total) | %CHANGE | F(RH) | bxSO4 | bxNO3 | bxOC | bxEC | bxPMC | bxPMF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2001 | 83 | 0 | 104 | 115.858 | -49.5 | D | 1.03 | 18.701 | 19.73 | 5.51 | 7.001 | 0.728 | 0.299 | 0.002 | 0 | 0 | 0 |

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**JD 54 (55,0): Feb 23**

| YEAR | DAY | TIME | REC# | TOT EXT | MODEL EXT | FLAG BGRND | % CHANGE | RH-FAC | Billings Weather | Billings VR | Sheridan Weather | Sheridan VR | Sheridan (km) | FLAG or Method7 BGRND* | % CHANGE (Method 7) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2001 | 54 | 100 | 1960 | 18.23 | 0.165 | 18.065 | 0.91 | 5.941 | | 10+ | | 7 | | 18.065 | |
| 2001 | 54 | 200 | 1960 | 18.085 | 0.02 | 18.065 | 0.11 | 5.941 | | 10+ | mist | 1.2 | 1.9 | 2026 | |
| 2001 | 54 | 300 | 1960 | 20.375 | 0.007 | 20.368 | 0.03 | 9.779 | | 10+ | fog, depositing rime, sky not | 0.2 | 0.3 | 12154 | |
| 2001 | 54 | 400 | 1960 | 16.52 | 0.002 | 16.518 | 0.01 | 3.364 | | 10+ | fog, depositing rime, sky not | 0.5 | 0.8 | 4862 | |
| 2001 | 54 | 500 | 1960 | 20.379 | 0.011 | 20.368 | 0.05 | 9.779 | | 9 | fog, depositing rime, sky not | 0.2 | 0.3 | 12154 | |
| 2001 | 54 | 600 | 1960 | 18.139 | 0.074 | 18.065 | 0.41 | 5.941 | Mist | 5 | fog, depositing rime, sky not | 0.2 | 0.3 | 12154 | |
| 2001 | 54 | 700 | 1960 | 19.074 | 1.009 | 18.065 | 5.59 | 5.941 | Mist | 5 | mist | 4 | 6.4 | 608 | |
| 2001 | 54 | 800 | 1960 | 19.417 | 1.352 | 18.065 | 7.48 | 5.941 | Mist | 6 | mist | 5 | 8.0 | 486 | |
| 2001 | 54 | 900 | 1960 | 16.751 | 0.233 | 16.518 | 1.41 | 3.364 | Mist | 5 | mist | 5 | 8.0 | 486 | |
| 2001 | 54 | 1000 | 1960 | 26.316 | 5.948 | 20.368 | 29.20 | 9.779 | Mist | 4 | mist | 4 | 6.4 | 608 | |
| 2001 | 54 | 1100 | 1960 | 22.225 | 4.16 | 18.065 | 23.03 | 5.941 | Mist | 5 | mist | 4 | 6.4 | 608 | |
| 2001 | 54 | 1200 | 1960 | 20.078 | 3.15 | 16.928 | 18.61 | 4.047 | | 8.7 | mist | 3.7 | 6.0 | 657 | |
| 2001 | 54 | 1300 | 1960 | 23.639 | 5.574 | 18.065 | 30.86 | 5.941 | | 10+ | mist | 5 | 8.0 | 486 | |
| 2001 | 54 | 1400 | 1960 | 22.106 | 4.99 | 17.116 | 29.15 | 4.359 | | 9 | mist | 6 | 9.7 | 405 | |
| 2001 | 54 | 1500 | 1960 | 30.255 | 9.887 | 20.368 | 48.54 | 9.779 | Mist | 5 | mist | 3 | 4.8 | 810 | |
| 2001 | 54 | 1600 | 1960 | 21.387 | 4.271 | 17.116 | 24.95 | 4.359 | Mist | 5 | mist | 5 | 8.0 | 486 | |
| 2001 | 54 | 1700 | 1960 | 21.725 | 4.609 | 17.116 | 26.93 | 4.359 | Mist | 5 | | 8 | | 17.116 | |
| 2001 | 54 | 1800 | 1960 | 19.78 | 3.262 | 16.518 | 19.75 | 3.364 | Mist | 5 | | 8.7 | | 16.518 | |
| 2001 | 54 | 1900 | 1960 | 19.736 | 2.62 | 17.116 | 15.31 | 4.359 | Mist | 6 | | 9 | | 17.116 | |
| 2001 | 54 | 2000 | 1960 | 18.418 | 1.302 | 17.116 | 7.61 | 4.359 | | 8 | | 9 | | 17.116 | |
| 2001 | 54 | 2100 | 1960 | 18.904 | 0.839 | 18.065 | 4.64 | 5.941 | | 10+ | | 7 | | 18.065 | |
| 2001 | 54 | 2200 | 1960 | 18.38 | 0.315 | 18.065 | 1.74 | 5.941 | | 10+ | | 9 | | 18.065 | |
| 2001 | 54 | 2300 | 1960 | 18.151 | 0.086 | 18.065 | 0.48 | 5.941 | | 8 | | 9 | | 18.065 | |
| 2001 | 55 | 0 | 1960 | 18.078 | 0.013 | 18.065 | 0.07 | 5.941 | | 6.8 | mist | 5.6 | 9.0 | 434 | |
| | | | | | 2.246 | 18.01 | 12.47 | 5.85 | | | | | | 2065.209 | 0.11 |

* When fog/precip, etc. is observed, BGRND (1/Mm) = 3912/VR(km). CALPOST Method 7.

| YEAR | DAY | HR | RECEF | COORDIN/ (km) | | TYPE | BEXT(Mod | BEXT(BKG | BEXT(Total) | %CHANGE | F(RH) | bxSO4 | bxNO3 | bxOC | bxEC | bxPMC | bxPMF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Model Extinction by Species | | | | | | |
| 2001 | 55 | 0 | 1960 | -102.137 | 159.738 | D | 2.246 | 18.01 | 20.256 | 12.47 | 5.85 | 1.36 | 0.863 | 0.017 | 0 | 0 | 0.006 |

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**JD 96 (97,0): Apr 6**

| YEAR | DAY | TIME | REC# | TOT EXT | MODEL EXT | FLAG BGRND | % CHANGE | RH-FAC | Billings Weather | Billings VR | Sheridan Weather | Sheridan VR | Sheridan (km) | FLAG or Method7 BGRND* | % CHANGE (Method 7) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2001 | 96 | 100 | 913 | 17.866 | 0.75 | 17.116 | 4.38 | 4.359 | | 10+ | | 10+ | | 17.116 | 4.4% |
| 2001 | 96 | 200 | 913 | 19.865 | 2.749 | 17.116 | 16.06 | 4.359 | | 10+ | | 10+ | | 17.116 | 16.1% |
| 2001 | 96 | 300 | 913 | 35.463 | 15.095 | 20.368 | 74.11 | 9.779 | | 10+ | | 10+ | | 20.368 | 74.1% |
| 2001 | 96 | 400 | 913 | 33.246 | 12.878 | 20.368 | 63.23 | 9.779 | | 10+ | | 10+ | | 20.368 | 63.2% |
| 2001 | 96 | 500 | 913 | 22.361 | 4.296 | 18.065 | 23.78 | 5.941 | | 10+ | | 10+ | | 18.065 | 23.8% |
| 2001 | 96 | 600 | 913 | 20.071 | 2.006 | 18.065 | 11.10 | 5.941 | | 9.9 | | 9.9 | | 18.065 | 11.1% |
| 2001 | 96 | 700 | 913 | 16.808 | 0.29 | 16.518 | 1.76 | 3.364 | | 10+ | | 10+ | | 16.518 | 1.8% |
| 2001 | 96 | 800 | 913 | 18.678 | 0 | 18.678 | - | 6.963 | | 10+ | | 10+ | | 18.678 | 0.0% |
| 2001 | 96 | 900 | 913 | 16.14 | 0 | 16.14 | - | 2.733 | | 10+ | | 10+ | | 16.140 | 0.0% |
| 2001 | 96 | 1000 | 913 | 15.534 | 0.015 | 15.519 | 0.10 | 1.699 | | 10+ | | 10+ | | 15.519 | 0.1% |
| 2001 | 96 | 1100 | 913 | 15.443 | 0.065 | 15.378 | 0.42 | 1.463 | | 10+ | | 10+ | | 15.378 | 0.4% |
| 2001 | 96 | 1200 | 913 | 15.467 | 0.129 | 15.338 | 0.84 | 1.397 | | 9.9 | | 9.9 | | 15.338 | 0.8% |
| 2001 | 96 | 1300 | 913 | 15.359 | 0.149 | 15.21 | 0.98 | 1.183 | | 10+ | | 10+ | | 15.210 | 1.0% |
| 2001 | 96 | 1400 | 913 | 15.398 | 0.188 | 15.21 | 1.24 | 1.183 | | 10+ | | 10+ | | 15.210 | 1.2% |
| 2001 | 96 | 1500 | 913 | 15.49 | 0.209 | 15.281 | 1.37 | 1.302 | | 10+ | slight, continuous rain | 10 | 16.1 | 243 | 0.1% |
| 2001 | 96 | 1600 | 913 | 15.718 | 0.199 | 15.519 | 1.28 | 1.699 | | 10+ | | 10+ | | 15.519 | 1.3% |
| 2001 | 96 | 1700 | 913 | 15.474 | 0.096 | 15.378 | 0.62 | 1.463 | | 10+ | Thunderstorm, no precipitation | 10+ | | 15.378 | 0.6% |
| 2001 | 96 | 1800 | 913 | 15.653 | 0.04 | 15.613 | 0.26 | 1.855 | | 9.9 | Thunderstorm, no precipitation | 9.9 | | 15.613 | 0.3% |
| 2001 | 96 | 1900 | 913 | 15.345 | 0.007 | 15.338 | 0.05 | 1.397 | | 10+ | | 10+ | | 15.338 | 0.0% |
| 2001 | 96 | 2000 | 913 | 15.77 | 0.001 | 15.769 | 0.01 | 2.115 | Thunderstorms with no precipitation | 10+ | | 10+ | | 15.769 | 0.0% |
| 2001 | 96 | 2100 | 913 | 15.769 | 0 | 15.769 | - | 2.115 | Thunderstorms, slight rain showers | 10+ | | 10+ | | 15.769 | 0.0% |
| 2001 | 96 | 2200 | 913 | 15.769 | 0 | 15.769 | - | 2.115 | Thunderstorms, Slight, Continuous rain | 10+ | | 10+ | | 15.769 | 0.0% |
| 2001 | 96 | 2300 | 913 | 15.858 | 0 | 15.858 | - | 2.263 | Slight, Continuous rain | 10+ | | 10+ | | 15.858 | 0.0% |
| 2001 | 97 | 0 | 913 | 15.579 | 0 | 15.579 | - | 1.798 | | 9.9 | | 9.9 | | 15.579 | 0.0% |
| | | | | 18.09 | 1.632 | 16.457 | 9.92 | 3.261 | | | | | | 25.949 | 6.29 |

* When fog/precip, etc. is observed, BGRND (1/Mm) = 3912/VR(km). CALPOST Method 7.

| | Model Extinctic | by | Species | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| YEAR | DAY | HR | RECEF | COORDIN/ (km) | | TYPE | BEXT(Mod | BEXT(BKG | BEXT(Total) | %CHANGE | F(RH) | bxSO4 | bxNO3 | bxOC | bxEC | bxPMC | bxPMF |
| 2001 | 97 | 0 | 913 | -124.947 | 166.811 | D | 1.632 | 16.457 | 18.09 | 9.92 | 3.261 | 0.838 | 0.782 | 0.008 | 0 | 0 | 0.004 |

JD 52 (53,0): Feb 21

| YEAR | DAY | TIME | REC# | TOT EXT | MODEL EXT | FLAG BGRND | % CHANGE | RH-FAC | Billings Weather | Billings VR | Sheridan Weather | Sheridan VR | Sheridan (km) | FLAG or Method7 BGRND* | % CHANGE (Method 7) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2001 | 52 | 100 | 924 | 17.751 | 0.823 | 16.928 | 4.86 | 4.047 | | 10+ | slight, continuous fall of snowflakes, mist | 2.5 | 4.0 | 972 | |
| 2001 | 52 | 200 | 924 | 25.911 | 5.543 | 20.368 | 27.21 | 9.779 | | 10+ | slight, continuous fall of snowflakes, mist | 2 | 3.2 | 1215 | |
| 2001 | 52 | 300 | 924 | 24.502 | 4.134 | 20.368 | 20.30 | 9.779 | | 9 | slight, continuous fall of snowflakes, mist | 4 | 6.4 | 608 | |
| 2001 | 52 | 400 | 924 | 24.161 | 3.793 | 20.368 | 18.62 | 9.779 | | 9 | | 10+ | | 20.368 | |
| 2001 | 52 | 500 | 924 | 20.503 | 2.438 | 18.065 | 13.50 | 5.941 | mist | 6 | | 10+ | | 18.065 | |
| 2001 | 52 | 600 | 924 | 18.059 | 1.131 | 16.928 | 6.68 | 4.047 | mist | 5 | | 8.7 | | 16.928 | |
| 2001 | 52 | 700 | 924 | 19.027 | 0.962 | 18.065 | 5.33 | 5.941 | mist | 5 | | 9 | | 18.065 | |
| 2001 | 52 | 800 | 924 | 18.793 | 0.728 | 18.065 | 4.03 | 5.941 | fog or ice fog | 9 | | 8 | | 18.065 | |
| 2001 | 52 | 900 | 924 | 16.75 | 0.315 | 16.435 | 1.92 | 3.224 | | 10+ | mist | 5 | 8.0 | 486 | |
| 2001 | 52 | 1000 | 924 | 16.657 | 0.222 | 16.435 | 1.35 | 3.224 | | 10+ | | 9 | | 16.435 | |
| 2001 | 52 | 1100 | 924 | 16.321 | 0.113 | 16.208 | 0.70 | 2.846 | | 10+ | | 7 | | 16.208 | |
| 2001 | 52 | 1200 | 924 | 16.244 | 0.036 | 16.208 | 0.22 | 2.846 | | 9.9 | | 7.5 | | 16.208 | |
| 2001 | 52 | 1300 | 924 | 15.987 | 0.005 | 15.982 | 0.03 | 2.469 | | 10+ | | 9 | | 15.982 | |
| 2001 | 52 | 1400 | 924 | 15.613 | 0 | 15.613 | - | 1.855 | | 10+ | | 10+ | | 15.613 | |
| 2001 | 52 | 1500 | 924 | 15.647 | 0 | 15.647 | - | 1.911 | | 10+ | | 10+ | | 15.647 | |
| 2001 | 52 | 1600 | 924 | 15.401 | 0 | 15.401 | - | 1.501 | | 10+ | | 10+ | | 15.401 | |
| 2001 | 52 | 1700 | 924 | 15.401 | 0 | 15.401 | - | 1.501 | | 10+ | | 10+ | | 15.401 | |
| 2001 | 52 | 1800 | 924 | 15.401 | 0 | 15.401 | - | 1.501 | | 9.9 | | 9.9 | | 15.401 | |
| 2001 | 52 | 1900 | 924 | 15.46 | 0 | 15.46 | - | 1.599 | | 10+ | | 10+ | | 15.46 | |
| 2001 | 52 | 2000 | 924 | 15.46 | 0 | 15.46 | - | 1.599 | | 10+ | | 10+ | | 15.46 | |
| 2001 | 52 | 2100 | 924 | 15.46 | 0 | 15.46 | - | 1.599 | | 10+ | | 10+ | | 15.46 | |
| 2001 | 52 | 2200 | 924 | 15.46 | 0 | 15.46 | - | 1.599 | | 10+ | | 10+ | | 15.46 | |
| 2001 | 52 | 2300 | 924 | 15.338 | 0 | 15.338 | - | 1.397 | | 10+ | | 10+ | | 15.338 | |
| 2001 | 53 | 0 | 924 | 16.208 | 0 | 16.208 | - | 2.846 | | 9.9 | | 9.9 | | 16.208 | |
| | | | | | 0.84 | 16.720 | 5.04 | 3.70 | | | | | | 150.37 | 0.56 |

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Model Extinction by Species

| YEAR | DAY | HR | RECEI | COORDIN/ (km) | | TYPE | BEXT(Mod | BEXT(BKG | BEXT(Total) | %CHANGE | F(RH) | bxSO4 | bxNO3 | bxOC | bxEC | bxPMC | bxPMF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2001 | 53 | 0 | 924 | -114.354 | 166.812 | D | 0.84 | 16.72 | 17.563 | 5.05 | 3.699 | 0.385 | 0.45 | 0.005 | 0 | 0 | 0.004 |

**JD 299 (300,0): Oct 26 [Wind Cave]**

| YEAR | DAY | TIME | REC# | TOT EXT | MODEL EXT | FLAG BGRND | % CHANGE | RH-FAC | BGRND (FLAG/BAD) | %CHNG (FLAG/BAD)* | Rapid City Weather | Rapid City Visibility (miles) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2002 | 299 | 100 | 103 | 15.467 | 0.234 | 15.233 | 1.54 | 1.222 | 190 | | missing | missing |
| 2002 | 299 | 200 | 103 | 22.493 | 2.125 | 20.368 | 10.43 | 9.779 | 228 | | missing | missing |
| 2002 | 299 | 300 | 103 | 22.762 | 2.394 | 20.368 | 11.75 | 9.779 | 181 | | missing | missing |
| 2002 | 299 | 400 | 103 | 22.94 | 2.572 | 20.368 | 12.63 | 9.779 | 189 | | missing | missing |
| 2002 | 299 | 500 | 103 | 23.057 | 2.689 | 20.368 | 13.20 | 9.779 | 495 | | missing | missing |
| 2002 | 299 | 600 | 103 | 23.12 | 2.752 | 20.368 | 13.51 | 9.779 | 498 | | missing | missing |
| 2002 | 299 | 700 | 103 | 23.116 | 2.748 | 20.368 | 13.49 | 9.779 | 942 | | missing | missing |
| 2002 | 299 | 800 | 103 | 23.385 | 3.017 | 20.368 | 14.81 | 9.779 | 495 | | missing | missing |
| 2002 | 299 | 900 | 103 | 23.459 | 3.091 | 20.368 | 15.18 | 9.779 | 376 | | missing | missing |
| 2002 | 299 | 1000 | 103 | 23.345 | 2.977 | 20.368 | 14.62 | 9.779 | 942 | | missing | missing |
| 2002 | 299 | 1100 | 103 | 19.703 | 1.638 | 18.065 | 9.07 | 5.941 | 942 | | mist | 4 |
| 2002 | 299 | 1200 | 103 | 23.425 | 3.057 | 20.368 | 15.01 | 9.779 | 428 | | mist | 5 |
| 2002 | 299 | 1300 | 103 | 20.045 | 1.98 | 18.065 | 10.96 | 5.941 | 125 | | | 8 |
| 2002 | 299 | 1400 | 103 | 17.694 | 1.176 | 16.518 | 7.12 | 3.364 | 563 | | | 10 |
| 2002 | 299 | 1500 | 103 | 17.295 | 1.019 | 16.276 | 6.26 | 2.959 | 62 | | | 10 |
| 2002 | 299 | 1600 | 103 | 16.598 | 0.74 | 15.858 | 4.67 | 2.263 | 257 | | | 10 |
| 2002 | 299 | 1700 | 103 | 16.496 | 0.638 | 15.858 | 4.02 | 2.263 | 85 | | | 10 |
| 2002 | 299 | 1800 | 103 | 17.359 | 0.841 | 16.518 | 5.09 | 3.364 | 95 | | | 9.9 |
| 2002 | 299 | 1900 | 103 | 19.334 | 1.269 | 18.065 | 7.02 | 5.941 | 92 | | | 10 |
| 2002 | 299 | 2000 | 103 | 19.111 | 1.046 | 18.065 | 5.79 | 5.941 | 86 | | | 10 |
| 2002 | 299 | 2100 | 103 | 18.918 | 0.853 | 18.065 | 4.72 | 5.941 | 82 | | | 9 |
| 2002 | 299 | 2200 | 103 | 18.721 | 0.656 | 18.065 | 3.63 | 5.941 | 67 | | | 7 |
| 2002 | 299 | 2300 | 103 | 18.558 | 0.493 | 18.065 | 2.73 | 5.941 | 59 | | | 7 |
| 2002 | 300 | 0 | 103 | 18.445 | 0.38 | 18.065 | 2.10 | 5.941 | 52 | | | 6.8 |
| | | | | 20.20 | 1.683 | 18.519 | 9.09 | 6.698 | 313.79 | 0.54 | | |

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* % change based on background from IMPROVE transmissometer at Badlands NP (if >50 1/Mm)

Modele Extinctic by Species

| YEAR | DAY | HR | RECEI | COORDIN | (km) | TYPE | BEXT(Mod | BEXT(BKG | BEXT(Total) | %CHANGE | F(RH) | bxSO4 | bxNO3 | bxOC | bxEC | bxPMC | bxPMF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2002 | 300 | 0 | 103 | 118.471 | -50.346 | D | 1.683 | 18.519 | 20.202 | 9.09 | 6.698 | 0.989 | 0.688 | 0.006 | 0 | 0 | 0 |

**JD 339 (340,0): Dec 5**

| YEAR | DAY | TIME | REC# | TOT EXT | MODEL EXT | FLAG BGRND | % CHANGE | RH-FAC | BGRND (FLAG/BAD) | %CHNG (FLAG/BAD)* | Rapid City Weather** | Rapid City Visibility (miles) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2002 | 339 | 100 | 120 | 18.396 | 0.712 | 17.684 | 4.03 | 5.307 | 942 | | | 7 |
| 2002 | 339 | 200 | 120 | 17.338 | 0.567 | 16.771 | 3.38 | 3.785 | 214 | | | 10 |
| 2002 | 339 | 300 | 120 | 17.059 | 0.708 | 16.351 | 4.33 | 3.085 | 168 | | | 10 |
| 2002 | 339 | 400 | 120 | 20.014 | 2.33 | 17.684 | 13.18 | 5.307 | 146 | | | 10 |
| 2002 | 339 | 500 | 120 | 17.971 | 1.62 | 16.351 | 9.91 | 3.085 | 117 | | | 10 |
| 2002 | 339 | 600 | 120 | 17.626 | 0.855 | 16.771 | 5.10 | 3.785 | 114 | | | 9.9 |
| 2002 | 339 | 700 | 120 | 17.262 | 0.911 | 16.351 | 5.57 | 3.085 | 108 | | | 10 |
| 2002 | 339 | 800 | 120 | 20.08 | 2.396 | 17.684 | 13.55 | 5.307 | 113 | | | 10 |
| 2002 | 339 | 900 | 120 | 22.255 | 1.887 | 20.368 | 9.26 | 12.429 | 93 | | | 10 |
| 2002 | 339 | 1000 | 120 | 22.954 | 2.586 | 20.368 | 12.70 | 12.429 | 67 | | | 10 |
| 2002 | 339 | 1100 | 120 | 16.214 | 0.412 | 15.802 | 2.61 | 2.17 | 65 | | | 10 |
| 2002 | 339 | 1200 | 120 | 15.923 | 0.31 | 15.613 | 1.99 | 1.855 | 56 | | | 9.9 |
| 2002 | 339 | 1300 | 120 | 15.963 | 0.35 | 15.613 | 2.24 | 1.855 | 15.613 | | | 10 |
| 2002 | 339 | 1400 | 120 | 15.655 | 0.195 | 15.46 | 1.26 | 1.599 | 15.46 | | | 10 |
| 2002 | 339 | 1500 | 120 | 15.453 | 0.115 | 15.338 | 0.75 | 1.397 | 15.338 | | | 10 |
| 2002 | 339 | 1600 | 120 | 15.673 | 0.213 | 15.46 | 1.38 | 1.599 | 105 | | | 10 |
| 2002 | 339 | 1700 | 120 | 15.787 | 0.327 | 15.46 | 2.12 | 1.599 | 139 | | | 10 |
| 2002 | 339 | 1800 | 120 | 15.681 | 0.303 | 15.378 | 1.97 | 1.463 | 15.378 | | | 9.9 |
| 2002 | 339 | 1900 | 120 | 16.102 | 0.397 | 15.705 | 2.53 | 2.008 | 15.705 | | | 10 |
| 2002 | 339 | 2000 | 120 | 17.92 | 0.992 | 16.928 | 5.86 | 4.047 | 16.928 | | | 10 |
| 2002 | 339 | 2100 | 120 | 22.838 | 2.47 | 20.368 | 12.13 | 12.429 | 20.368 | | | 10 |
| 2002 | 339 | 2200 | 120 | 17.093 | 0.165 | 16.928 | 0.97 | 4.047 | 16.928 | | | 10 |
| 2002 | 339 | 2300 | 120 | 16.94 | 0.012 | 16.928 | 0.07 | 4.047 | 16.928 | | | 10 |
| 2002 | 340 | 0 | 120 | 15.802 | 0 | 15.802 | - | 2.17 | 15.802 | | | 9.9 |
| | | | | 17.667 | 0.868 | 16.799 | 5.17 | 4.162 | 108.81 | 0.80 | | |

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* % change based on background from IMPROVE transmissometer at Badlands NP (if >50 1/Mm)

Modele Extinctic by Species

| YEAR | DAY | HR | RECEI | COORDIN. (km) | | TYPE | BEXT(Mod | BEXT(BKG | BEXT(Total) | %CHANGE | F(RH) | bxSO4 | bxNO3 | bxOC | bxEC | bxPMC | bxPMF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2002 | 340 | 0 | 120 | 115.824 | -47.71 | D | 0.868 | 16.798 | 17.666 | 5.17 | 3.831 | 0.389 | 0.461 | 0.012 | 0 | 0 | 0.006 |

**JD 299 (300,0): Oct 26 [Badlands]**

| YEAR | DAY | TIME | REC# | TOT EXT | MODEL EXT | FLAG BGRND | % CHANGE | RH-FAC | BGRND (FLAG/BAD) | %CHNG (FLAG/BAD)* | Rapid City Weather | Rapid City Visibility (miles) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2002 | 299 | 100 | 1 | 15.33 | 0.097 | 15.233 | 0.231 | 1.222 | 190 | | missing | missing |
| 2002 | 299 | 200 | 1 | 21.197 | 0.829 | 20.368 | 2.102 | 9.779 | 228 | | missing | missing |
| 2002 | 299 | 300 | 1 | 21.276 | 0.908 | 20.368 | 2.362 | 9.779 | 181 | | missing | missing |
| 2002 | 299 | 400 | 1 | 21.42 | 1.052 | 20.368 | 2.533 | 9.779 | 189 | | missing | missing |
| 2002 | 299 | 500 | 1 | 21.62 | 1.252 | 20.368 | 2.647 | 9.779 | 495 | | missing | missing |
| 2002 | 299 | 600 | 1 | 21.81 | 1.442 | 20.368 | 2.704 | 9.779 | 498 | | missing | missing |
| 2002 | 299 | 700 | 1 | 21.994 | 1.626 | 20.368 | 2.698 | 9.779 | 942 | | missing | missing |
| 2002 | 299 | 800 | 1 | 22.379 | 2.011 | 20.368 | 2.964 | 9.779 | 495 | | missing | missing |
| 2002 | 299 | 900 | 1 | 22.619 | 2.251 | 20.368 | 3.043 | 9.779 | 376 | | missing | missing |
| 2002 | 299 | 1000 | 1 | 22.869 | 2.501 | 20.368 | 2.938 | 9.779 | 942 | | missing | missing |
| 2002 | 299 | 1100 | 1 | 19.739 | 1.674 | 18.065 | 1.586 | 5.941 | 942 | | mist | 4 |
| 2002 | 299 | 1200 | 1 | 23.295 | 2.927 | 20.368 | 2.996 | 9.779 | 428 | | mist | 5 |
| 2002 | 299 | 1300 | 1 | 19.795 | 1.73 | 18.065 | 1.95 | 5.941 | 125 | | | 8 |
| 2002 | 299 | 1400 | 1 | 17.451 | 0.933 | 16.518 | 1.164 | 3.364 | 563 | | | 10 |
| 2002 | 299 | 1500 | 1 | 17.007 | 0.731 | 16.276 | 1.013 | 2.959 | 62 | | | 10 |
| 2002 | 299 | 1600 | 1 | 16.339 | 0.481 | 15.858 | 0.74 | 2.263 | 257 | | | 10 |
| 2002 | 299 | 1700 | 1 | 16.245 | 0.387 | 15.858 | 0.641 | 2.263 | 85 | | | 10 |
| 2002 | 299 | 1800 | 1 | 17.001 | 0.483 | 16.518 | 0.85 | 3.364 | 95 | | | 9.9 |
| 2002 | 299 | 1900 | 1 | 18.762 | 0.697 | 18.065 | 1.288 | 5.941 | 92 | | | 10 |
| 2002 | 299 | 2000 | 1 | 18.623 | 0.558 | 18.065 | 1.066 | 5.941 | 86 | | | 10 |
| 2002 | 299 | 2100 | 1 | 18.511 | 0.446 | 18.065 | 0.872 | 5.941 | 82 | | | 9 |
| 2002 | 299 | 2200 | 1 | 18.403 | 0.338 | 18.065 | 0.673 | 5.941 | 67 | | | 7 |
| 2002 | 299 | 2300 | 1 | 18.319 | 0.254 | 18.065 | 0.507 | 5.941 | 59 | | | 7 |
| 2002 | 300 | 0 | 1 | 18.261 | 0.196 | 18.065 | 1.08 | 5.941 | 52 | | | 6.8 |
| | | | | 19.59 | 1.075 | 18.519 | 5.81 | 6.698 | 313.79 | 0.34 | | |

* % change based on background from IMPROVE transmissometer at Badlands NP (if >50 1/Mm)

DEQ/AQD 000667

Modele Extinctic by Species

| YEAR | DAY | HR | RECEI | COORDIN. | (km) | TYPE | BEXT(Mod | BEXT(BKG | BEXT(Total) | %CHANGE | F(RH) | bxSO4 | bxNO3 | bxOC | bxEC | bxPMC | bxPMF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2002 | 300 | 0 | 1 | 200.083 | -23.183 | D | 1.075 | 18.519 | 19.594 | 5.81 | 6.698 | 0.631 | 0.441 | 0.003 | 0 | 0 | 0 |

JD 300 (301,0): Oct 27

| YEAR | DAY | TIME | REC# | TOT EXT | MODEL EXT | FLAG BGRND | % CHANGE | RH-FAC | Billings Weather | Billings VR | Sheridan Weather | Sheridan VR | Sheridan (km) | FLAG or Method7 BGRND* | % CHANGE (Method 7) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2002 | 300 | 100 | 1843 | 17.668 | 1.15 | 16.518 | 6.96 | 3.364 | | 10+ | | 10+ | | 16.518 | |
| 2002 | 300 | 200 | 1843 | 18.373 | 1.445 | 16.928 | 8.54 | 4.047 | | 10+ | | 10+ | | 16.928 | |
| 2002 | 300 | 300 | 1843 | 18.481 | 1.553 | 16.928 | 9.17 | 4.047 | | 10+ | | 10+ | | 16.928 | |
| 2002 | 300 | 400 | 1843 | 20.535 | 2.47 | 18.065 | 13.67 | 5.941 | | 10+ | | 10+ | | 18.065 | |
| 2002 | 300 | 500 | 1843 | 18.006 | 1.488 | 16.518 | 9.01 | 3.364 | | 10+ | | 10+ | | 16.518 | |
| 2002 | 300 | 600 | 1843 | 20.73 | 2.665 | 18.065 | 14.75 | 5.941 | | 9.9 | | 9.9 | | 18.065 | |
| 2002 | 300 | 700 | 1843 | 24.662 | 4.294 | 20.368 | 21.08 | 9.779 | | 10+ | | 10+ | | 20.368 | |
| 2002 | 300 | 800 | 1843 | 24.514 | 4.146 | 20.368 | 20.36 | 9.779 | | 10+ | | 10+ | | 20.368 | |
| 2002 | 300 | 900 | 1843 | 17.615 | 1.339 | 16.276 | 8.23 | 2.959 | | 10+ | | 10+ | | 16.276 | |
| 2002 | 300 | 1000 | 1843 | 16.436 | 0.789 | 15.647 | 5.04 | 1.911 | | 10+ | | 10+ | | 15.647 | |
| 2002 | 300 | 1100 | 1843 | 16.184 | 0.636 | 15.548 | 4.09 | 1.747 | | 10+ | | 10+ | | 15.548 | |
| 2002 | 300 | 1200 | 1843 | 15.666 | 0.385 | 15.281 | 2.52 | 1.302 | | 9.9 | | 9.9 | | 15.281 | |
| 2002 | 300 | 1300 | 1843 | 15.524 | 0.282 | 15.242 | 1.85 | 1.237 | | 10+ | | 10+ | | 15.242 | |
| 2002 | 300 | 1400 | 1843 | 15.444 | 0.227 | 15.217 | 1.49 | 1.196 | | 10+ | | 10+ | | 15.217 | |
| 2002 | 300 | 1500 | 1843 | 15.379 | 0.188 | 15.191 | 1.24 | 1.153 | | 10+ | | 10+ | | 15.191 | |
| 2002 | 300 | 1600 | 1843 | 15.278 | 0.142 | 15.136 | 0.94 | 1.06 | | 10+ | | 10+ | | 15.136 | |
| 2002 | 300 | 1700 | 1843 | 15.274 | 0.099 | 15.175 | 0.65 | 1.125 | | 10+ | | 10+ | | 15.175 | |
| 2002 | 300 | 1800 | 1843 | 15.424 | 0.069 | 15.355 | 0.45 | 1.424 | | 9.9 | | 9.9 | | 15.355 | |
| 2002 | 300 | 1900 | 1843 | 16.346 | 0.07 | 16.276 | 0.43 | 2.959 | | 10+ | | 10+ | | 16.276 | |
| 2002 | 300 | 2000 | 1843 | 15.811 | 0.009 | 15.802 | 0.06 | 2.17 | | 10+ | | 10+ | | 15.802 | |
| 2002 | 300 | 2100 | 1843 | 17.124 | 0.008 | 17.116 | 0.05 | 4.359 | | 10+ | | 10+ | | 17.116 | |
| 2002 | 300 | 2200 | 1843 | 16.281 | 0.005 | 16.276 | 0.03 | 2.959 | | 10+ | | 10+ | | 16.276 | |
| 2002 | 300 | 2300 | 1843 | 16.523 | 0.005 | 16.518 | 0.03 | 3.364 | | 10+ | | 10+ | | 16.518 | |
| 2002 | 301 | 0 | 1843 | 16.522 | 0.004 | 16.518 | 0.02 | 3.364 | | 9.9 | | 9.9 | | 16.518 | |
| | | | | 17.492 | 0.978 | 16.514 | 5.92 | 3.356 | | | | | | 16.514 | 5.92 |

* When fog/precip, etc. is observed, BGRND (1/Mm) = 3912/VR(km). CALPOST Method 7.

| YEAR | Mode DAY | Extincti HR | by RECE | Species COORDIN (km) | | TYPE | BEXT(Mod | BEXT(BKG | BEXT(Total) | %CHANGE | F(RH) | bxSO4 | bxNO3 | bxOC | bxEC | bxPMC | bxPMF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2002 | 301 | 0 | 1843 | -96.809 | 167.715 | D | 0.978 | 16.514 | 17.491 | 5.92 | 3.356 | 0.549 | 0.422 | 0.006 | 0 | 0 | 0.001 |

**JD 82 (83,0): Mar 23**

| YEAR | DAY | TIME | REC# | TOT EXT | MODEL EXT | FLAG BGRND | % CHANGE | RH-FAC | Billings Weather | Billings VR | Sheridan Weather | Sheridan VR | Sheridan (km) | FLAG or Method7 BGRND* | % CHANGE (Method 7) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2002 | 82 | 100 | 930 | 18.065 | 0 | 18.065 | - | 5.941 | | 10+ | | 10+ | | 18.065 | |
| 2002 | 82 | 200 | 930 | 17.116 | 0 | 17.116 | - | 4.359 | | 10+ | | 8 | | 17.116 | |
| 2002 | 82 | 300 | 930 | 17.116 | 0 | 17.116 | - | 4.359 | | 10+ | | 8 | | 17.116 | |
| 2002 | 82 | 400 | 930 | 17.159 | 0.043 | 17.116 | 0.25 | 4.359 | | 10+ | | 7 | | 17.116 | |
| 2002 | 82 | 500 | 930 | 17.124 | 0.196 | 16.928 | 1.16 | 4.047 | | 10+ | | 9 | | 16.928 | |
| 2002 | 82 | 600 | 930 | 16.96 | 0.899 | 16.061 | 5.60 | 2.601 | | 9.9 | mist | 6 | 9.7 | 405 | |
| 2002 | 82 | 700 | 930 | 19.435 | 3.577 | 15.858 | 22.56 | 2.263 | | 10+ | mist | 5 | 8.0 | 486 | |
| 2002 | 82 | 800 | 930 | 21.675 | 5.614 | 16.061 | 34.95 | 2.601 | | 10+ | mist | 6 | 9.7 | 405 | |
| 2002 | 82 | 900 | 930 | 23.934 | 3.566 | 20.368 | 17.51 | 9.779 | | 10+ | mist | 5 | 8.0 | 486 | |
| 2002 | 82 | 1000 | 930 | 22.79 | 2.422 | 20.368 | 11.89 | 9.779 | | 10+ | | 10+ | | 20.368 | |
| 2002 | 82 | 1100 | 930 | 17.684 | 1.826 | 15.858 | 11.51 | 2.263 | | 10+ | | 7 | | 15.858 | |
| 2002 | 82 | 1200 | 930 | 16.863 | 0.802 | 16.061 | 4.99 | 2.601 | | 9.9 | | 9.9 | | 16.061 | |
| 2002 | 82 | 1300 | 930 | 16.629 | 0.568 | 16.061 | 3.54 | 2.601 | | 10+ | | 10+ | | 16.061 | |
| 2002 | 82 | 1400 | 930 | 17.615 | 0.499 | 17.116 | 2.92 | 4.359 | | 10+ | | 10+ | | 17.116 | |
| 2002 | 82 | 1500 | 930 | 16.376 | 0.315 | 16.061 | 1.96 | 2.601 | | 10+ | | 10+ | | 16.061 | |
| 2002 | 82 | 1600 | 930 | 16.806 | 0.288 | 16.518 | 1.74 | 3.364 | | 10+ | | 9 | | 16.518 | |
| 2002 | 82 | 1700 | 930 | 16.769 | 0.251 | 16.518 | 1.52 | 3.364 | | 10+ | | 10+ | | 16.518 | |
| 2002 | 82 | 1800 | 930 | 16.024 | 0.222 | 15.802 | 1.40 | 2.17 | | 9.9 | | 9.9 | | 15.802 | |
| 2002 | 82 | 1900 | 930 | 18.226 | 0.161 | 18.065 | 0.89 | 5.941 | | 10+ | | | | 18.065 | |
| 2002 | 82 | 2000 | 930 | 16.736 | 0.218 | 16.518 | 1.32 | 3.364 | slight, continuous fall of snowflakes | 6 | | 10+ | | 16.518 | |
| 2002 | 82 | 2100 | 930 | 16.762 | 0.244 | 16.518 | 1.48 | 3.364 | slight, continuous fall of snowflakes, mist | 5 | | 7 | | 16.518 | |
| 2002 | 82 | 2200 | 930 | 16.447 | 0.465 | 15.982 | 2.91 | 2.469 | slight, continuous fall of snowflakes, mist | 3 | slight continuous fall of snowflakes, mist | 3 | 4.8 | 810 | |
| 2002 | 82 | 2300 | 930 | 18.489 | 0.424 | 18.065 | 2.35 | 5.941 | mist, slight, continuous fall of snowflakes | 2 | mist | 5 | 8.0 | 486 | |
| 2002 | 83 | 0 | 930 | 18.292 | 0.227 | 18.065 | 1.26 | 5.941 | | 9.9 | slight continuous fall of snowflakes, mist | 3 | 4.8 | 810 | |
| | | | | 17.962 | 0.951 | 17.011 | 5.59 | 4.185 | | | | | 0.46 | 174.050 | 0.55 |

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| YEAR | Mode DAY | Extincti HR | by RECE | Species COORDIN (km) | | TYPE | BEXT(Mod | BEXT(BKG | BEXT(Total) | %CHANGI | F(RH) | bxSO4 | bxNO3 | bxOC | bxEC | bxPMC | bxPMF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2002 | 83 | 0 | 930 | -108.576 | 166.812 | D | 0.951 | 17.011 | 17.962 | 5.59 | 4.185 | 0.458 | 0.481 | 0.007 | 0 | 0 | 0.004 |

DEQ/AQD 000670

**JD 66 (67.0): Mar 7**

| YEAR | DAY | TIME | REC# | TOT EXT | MODEL EXT | FLAG BGRND | % CHANGE | RH-FAC | Billings Weather | Billings VR | Sheridan Weather | Sheridan VR | Sheridan (km) | FLAG or Method7 BGRND* | % CHANGE (Method 7) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2002 | 66 | 100 | 2009 | 22.509 | 5.581 | 16.928 | 32.97 | 4.047 | slight, continuous fall of snowflakes | 10+ | | 7 | | 16.928 | |
| 2002 | 66 | 200 | 2009 | 19.501 | 3.293 | 16.208 | 20.32 | 2.846 | slight, continuous fall of snowflakes | 10+ | | | | 16.208 | |
| 2002 | 66 | 300 | 2009 | 20.666 | 3.738 | 16.928 | 22.08 | 4.047 | slight, continuous fall of snowflakes | 7 | | 8 | | 16.928 | |
| 2002 | 66 | 400 | 2009 | 20.062 | 3.134 | 16.928 | 18.51 | 4.047 | slight, continuous fall of snowflakes, mist | 5 | slight continuous fall of snowflakes, mist | 4 | 6.4 | 608 | |
| 2002 | 66 | 500 | 2009 | 18.127 | 1.692 | 16.435 | 10.30 | 3.224 | slight, continuous fall of snowflakes | 10+ | slight continuous fall of snowflakes, mist | 6 | 9.7 | 405 | |
| 2002 | 66 | 600 | 2009 | 17.071 | 0.72 | 16.351 | 4.40 | 3.085 | slight, continuous fall of snowflakes | 9.9 | slight continuous fall of snowflakes, mist | 6 | 9.7 | 405 | |
| 2002 | 66 | 700 | 2009 | 16.824 | 0.473 | 16.351 | 2.89 | 3.085 | slight, continuous fall of snowflakes | 10+ | slight continuous fall of snowflakes, mist | 3 | 4.8 | 810 | |
| 2002 | 66 | 800 | 2009 | 16.697 | 0.346 | 16.351 | 2.12 | 3.085 | slight, continuous fall of snowflakes | 7 | slight continuous fall of snowflakes, mist | 2 | 3.2 | 1215 | |
| 2002 | 66 | 900 | 2009 | 16.006 | 0.148 | 15.858 | 0.93 | 2.263 | slight, continuous fall of snowflakes | 3 | slight continuous fall of snowflakes | 0.8 | 1.3 | 3039 | |
| 2002 | 66 | 1000 | 2009 | 16.237 | 0.097 | 16.14 | 0.60 | 2.733 | moderate, continuous fall of snowflakes, fog, depositing rime, sky visible | 0.5 | slight continuous fall of snowflakes | 1.5 | 2.4 | 1621 | |
| 2002 | 66 | 1100 | 2009 | 15.902 | 0.044 | 15.858 | 0.28 | 2.263 | slight, continuous fall of snowflakes, mist | 1.5 | Haze | 5 | 8.0 | 486 | |
| 2002 | 66 | 1200 | 2009 | 15.758 | 0.022 | 15.736 | 0.14 | 2.06 | slight, continuous fall of snowflakes, mist | 1 | | 9.9 | | 15.736 | |
| 2002 | 66 | 1300 | 2009 | 15.559 | 0.011 | 15.548 | 0.07 | 1.747 | | 7 | | 10+ | | 15.548 | |
| 2002 | 66 | 1400 | 2009 | 15.554 | 0.006 | 15.548 | 0.04 | 1.747 | | 10+ | | 10+ | | 15.548 | |
| 2002 | 66 | 1500 | 2009 | 15.74 | 0.004 | 15.736 | 0.03 | 2.06 | slight, continuous fall of snowflakes | 0.8 | | 10+ | | 15.736 | |
| 2002 | 66 | 1600 | 2009 | 15.738 | 0.002 | 15.736 | 0.01 | 2.06 | slight, continuous fall of snowflakes, mist | 1 | | 10+ | | 15.736 | |
| 2002 | 66 | 1700 | 2009 | 15.737 | 0.001 | 15.736 | 0.01 | 2.06 | slight, continuous fall of snowflakes | 5 | | 10+ | | 15.736 | |
| 2002 | 66 | 1800 | 2009 | 15.651 | 0.004 | 15.647 | 0.03 | 1.911 | slight, continuous fall of snowflakes | 9.9 | | 9.9 | | 15.647 | |
| 2002 | 66 | 1900 | 2009 | 15.746 | 0.01 | 15.736 | 0.06 | 2.06 | slight, continuous fall of snowflakes | 1 | | 10+ | | 15.736 | |
| 2002 | 66 | 2000 | 2009 | 15.746 | 0.01 | 15.736 | 0.06 | 2.06 | slight, continuous fall of snowflakes, mist | 6 | | 10+ | | 15.736 | |
| 2002 | 66 | 2100 | 2009 | 16.95 | 0.022 | 16.928 | 0.13 | 4.047 | slight, continuous fall of snowflakes, mist | 5 | slight continuous fall snowflakes | 4 | 6.4 | 608 | |
| 2002 | 66 | 2200 | 2009 | 16.954 | 0.026 | 16.928 | 0.15 | 4.047 | slight, continuous fall of snowflakes | 9 | slight continuous fall snowflakes | 3 | 4.8 | 810 | |
| 2002 | 66 | 2300 | 2009 | 16.959 | 0.031 | 16.928 | 0.18 | 4.047 | slight, continuous fall of snowflakes | 10+ | slight continuous fall snowflakes, mist | 4 | 6.4 | 608 | |
| 2002 | 67 | 0 | 2009 | 16.164 | 0.024 | 16.14 | 0.15 | 2.733 | slight, continuous fall of snowflakes | 6.8 | slight continuous fall snowflakes | 6 | 9.7 | 405 | |
| | | | | | 0.810 | 16.184 | 5.0 | 2.807 | | | | | | 467.132 | 0.17 |

Mode Extincll by Species

| YEAR | DAY | HR | RECE | COORDIN (km) | | TYPE | BEXT(Mod | BEXT(BKG | BEXT(Total) | %CHANGI | F(RH) | bxSO4 | bxNO3 | bxOC | bxEC | bxPMC | bxPMF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2002 | 67 | 0 | 2009 | -151.518 | 147.276 | D | 0.81 | 16.184 | 16.994 | 5 | 2.807 | 0.415 | 0.385 | 0.009 | 0 | 0 | 0.001 |

**JD 68 (69,0): March 9 [Wind Cave]**

| YEAR | DAY | TIME | REC# | TOT EXT | MODEL EXT | FLAG BGRND | % CHANGE | RH-FAC | BGRND (FLAG/BAD)** | %CHNG (FLAG/BAD)** | Rapid City Weather | Rapid City Visibility (miles) | Rapid City Visibility (km) | FLAG or Method7 BGRND** | % CHANGE (Method 7) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2003 | 68 | 100 | 101 | 19.624 | 2.853 | 16.771 | 17.01 | 3.785 | * | | light snow | 9 | 14.5 | 270 | |
| 2003 | 68 | 200 | 101 | 19.619 | 2.848 | 16.771 | 16.98 | 3.785 | * | | | | | 16.771 | |
| 2003 | 68 | 300 | 101 | 19.307 | 2.536 | 16.771 | 15.12 | 3.785 | * | | | | | 16.771 | |
| 2003 | 68 | 400 | 101 | 18.817 | 2.046 | 16.771 | 12.20 | 3.785 | * | | | | | 16.771 | |
| 2003 | 68 | 500 | 101 | 18.321 | 1.55 | 16.771 | 9.24 | 3.785 | * | | | | | 16.771 | |
| 2003 | 68 | 600 | 101 | 16.747 | 0.686 | 16.061 | 4.27 | 2.601 | * | | | | | 16.061 | |
| 2003 | 68 | 700 | 101 | 16.67 | 0.609 | 16.061 | 3.79 | 2.601 | * | | | | | 16.061 | |
| 2003 | 68 | 800 | 101 | 22.855 | 2.487 | 20.368 | 12.21 | 9.779 | * | | | | | 20.368 | |
| 2003 | 68 | 900 | 101 | 17.965 | 1.194 | 16.771 | 7.12 | 3.785 | * | | mist | 4 | 6.4 | 608 | |
| 2003 | 68 | 1000 | 101 | 17.998 | 1.227 | 16.771 | 7.32 | 3.785 | * | | light snow | 7 | 11.3 | 347 | |
| 2003 | 68 | 1100 | 101 | 16.474 | 0.738 | 15.736 | 4.69 | 2.06 | * | | light snow | 4 | 6.4 | 608 | |
| 2003 | 68 | 1200 | 101 | 16.593 | 0.857 | 15.736 | 5.45 | 2.06 | * | | light snow | 9 | 14.5 | 270 | |
| 2003 | 68 | 1300 | 101 | 16.667 | 0.931 | 15.736 | 5.92 | 2.06 | * | | | | | 15.736 | |
| 2003 | 68 | 1400 | 101 | 16.737 | 1.001 | 15.736 | 6.36 | 2.06 | * | | haze | 5 | 8.0 | 486 | |
| 2003 | 68 | 1500 | 101 | 16.404 | 0.856 | 15.548 | 5.51 | 1.747 | * | | haze | 6 | 9.7 | 405 | |
| 2003 | 68 | 1600 | 101 | 17.395 | 1.255 | 16.14 | 7.78 | 2.733 | * | | light snow | 3 | 4.8 | 810 | |
| 2003 | 68 | 1700 | 101 | 16.233 | 0.685 | 15.548 | 4.41 | 1.747 | * | | | | | 16.140 | |
| 2003 | 68 | 1800 | 101 | 16.695 | 0.781 | 15.914 | 4.91 | 2.356 | * | | | | | 15.548 | |
| 2003 | 68 | 1900 | 101 | 18.228 | 1.3 | 16.928 | 7.68 | 4.047 | * | | light snow, mist | 6 | 9.7 | 405 | |
| 2003 | 68 | 2000 | 101 | 18.226 | 1.298 | 16.928 | 7.67 | 4.047 | 50 | | | | | 16.928 | |
| 2003 | 68 | 2100 | 101 | 18.208 | 1.28 | 16.928 | 7.56 | 4.047 | 51 | | light snow, mist | 4 | 6.4 | 51 | |
| 2003 | 68 | 2200 | 101 | 18.172 | 1.244 | 16.928 | 7.35 | 4.047 | 16.928 | | light snow | 8 | 12.9 | 304 | |
| 2003 | 68 | 2300 | 101 | 18.158 | 1.23 | 16.928 | 7.27 | 4.047 | 16.928 | | | | | 16.928 | |
| 2003 | 69 | 0 | 101 | 19.31 | 1.626 | 17.684 | 9.19 | 5.307 | 17.684 | | | | | 17.684 | |
| | | | | 17.98 | 1.38 | 16.596 | 8.31 | 3.493 | | | | | | 199.294 | 0.69 |

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* transmissometer data missing
** when fog/precip, etc. is observed, BGRND (1/Mm) = 3912/VR(km). CALPOST Method 7 or
% change based on background from IMPROVE transmissometer at Badlands NP (if >50 1/Mm)

Model Extincti by Species

| YEAR | DAY | HR | RECEP | COORDIN | (km) | TYPE | BEXT(Mod | BEXT(BKG | BEXT(Total) | %CHANGE | F(RH) | bxSO4 | bxNO3 | bxOC | bxEC | bxPMC | bxPMF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2003 | 69 | 0 | 101 | 117.172 | -50.371 | D | 1.38 | 16.596 | 17.98 | 8.31 | 3.493 | 0.738 | 0.629 | 0.011 | 0 | 0 | 0.002 |

**JD 345 (346,0): Dec 11 [Wind Cave]**

| YEAR | DAY | TIME | REC# | TOT EXT | MODEL EXT | FLAG BGRND | % CHANGE | RH-FAC | (FLAG/BAD) | %CHNG (FLAG/BAD)* | Rapid City Weather | Rapid City Visibility (miles) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2003 | 345 | 100 | 267 | 18.18 | 0.115 | 18.065 | 0.64 | 5.941 | 942 | | light snow | 3 |
| 2003 | 345 | 200 | 267 | 18.156 | 0.091 | 18.065 | 0.50 | 5.941 | 942 | | light snow, mist | 2.5 |
| 2003 | 345 | 300 | 267 | 18.148 | 0.083 | 18.065 | 0.46 | 5.941 | 942 | | | |
| 2003 | 345 | 400 | 267 | 16.48 | 0.045 | 16.435 | 0.27 | 3.224 | 942 | | | |
| 2003 | 345 | 500 | 267 | 18.151 | 0.086 | 18.065 | 0.48 | 5.941 | 469 | | | |
| 2003 | 345 | 600 | 267 | 16.987 | 0.059 | 16.928 | 0.35 | 4.047 | 128 | | | |
| 2003 | 345 | 700 | 267 | 18.153 | 0.088 | 18.065 | 0.49 | 5.941 | 216 | | light snow | 9 |
| 2003 | 345 | 800 | 267 | 18.154 | 0.089 | 18.065 | 0.49 | 5.941 | 178 | | | |
| 2003 | 345 | 900 | 267 | 18.159 | 0.094 | 18.065 | 0.52 | 5.941 | 229 | | | |
| 2003 | 345 | 1000 | 267 | 18.199 | 0.134 | 18.065 | 0.74 | 5.941 | 180 | | light snow, mist | 4 |
| 2003 | 345 | 1100 | 267 | 18.296 | 0.231 | 18.065 | 1.28 | 5.941 | 469 | | | |
| 2003 | 345 | 1200 | 267 | 18.471 | 0.406 | 18.065 | 2.25 | 5.941 | 133 | | | |
| 2003 | 345 | 1300 | 267 | 16.781 | 0.346 | 16.435 | 2.11 | 3.224 | 117 | | | |
| 2003 | 345 | 1400 | 267 | 16.933 | 0.498 | 16.435 | 3.03 | 3.224 | 100 | | | |
| 2003 | 345 | 1500 | 267 | 16.416 | 0.502 | 15.914 | 3.15 | 2.356 | 90 | | | |
| 2003 | 345 | 1600 | 267 | 16.544 | 0.63 | 15.914 | 3.96 | 2.356 | 88 | | | |
| 2003 | 345 | 1700 | 267 | 17.564 | 1.129 | 16.435 | 6.87 | 3.224 | 98 | | | |
| 2003 | 345 | 1800 | 267 | 20.808 | 2.743 | 18.065 | 15.18 | 5.941 | 98 | | | |
| 2003 | 345 | 1900 | 267 | 19.265 | 2.337 | 16.928 | 13.81 | 4.047 | 93 | | mist | 1.7 |
| 2003 | 345 | 2000 | 267 | 27.234 | 6.866 | 20.368 | 33.71 | 9.779 | 84 | | mist | 1.2 |
| 2003 | 345 | 2100 | 267 | 20.271 | 3.343 | 16.928 | 19.75 | 4.047 | 82 | | | |
| 2003 | 345 | 2200 | 267 | 22.597 | 4.913 | 17.684 | 27.78 | 5.307 | 90 | | mist | 1 |
| 2003 | 345 | 2300 | 267 | 22.824 | 5.14 | 17.684 | 29.07 | 5.307 | 77 | | | |
| 2003 | 346 | 0 | 267 | 22.411 | 4.727 | 17.684 | 26.73 | 5.307 | 75 | | | |
| | | | | 18.97 | 1.446 | 17.52 | 8.25 | 5.033 | 285.92 | 0.51 | | |

* % change based on background from IMPROVE transmissometer at Badlands NP (if >50 1/Mm)

Modeled Extinction by Species

| YEAR | DAY | HR | RECEP | COORDIN. (km) | | TYPE | BEXT(Mod | BEXT(BKG | BEXT(Total) | %CHANGE | F(RH) | bxSO4 | bxNO3 | bxOC | bxEC | bxPMC | bxPMF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2003 | 346 | 0 | 267 | 116.954 | -38.735 | D | 1.446 | 17.52 | 18.966 | 8.25 | 5.033 | 0.812 | 0.625 | 0.007 | 0 | 0 | 0.001 |

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**JD 309 (310,0): Nov 5th [Wind Cave]**

| YEAR | DAY | TIME | REC# | TOT EXT | MODEL EXT | FLAG BGRND | % CHANGE | RH-FAC | (FLAG/BAD) | %CHNG (FLAG/BAD)* | Rapid City Weather | Rapid City Visibility (miles) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2003 | 309 | 100 | 101 | 16.442 | 0.302 | 16.14 | 1.87 | 2.733 | 52 | | | 10 |
| 2003 | 309 | 200 | 101 | 16.469 | 0.329 | 16.14 | 2.04 | 2.733 | 52 | | | 10 |
| 2003 | 309 | 300 | 101 | 16.499 | 0.359 | 16.14 | 2.22 | 2.733 | 16.14 | | | 10 |
| 2003 | 309 | 400 | 101 | 16.54 | 0.4 | 16.14 | 2.48 | 2.733 | 52 | | | 10 |
| 2003 | 309 | 500 | 101 | 16.599 | 0.459 | 16.14 | 2.84 | 2.733 | 52 | | | 10 |
| 2003 | 309 | 600 | 101 | 16.675 | 0.535 | 16.14 | 3.31 | 2.733 | 55 | | | 9.9 |
| 2003 | 309 | 700 | 101 | 18.903 | 1.219 | 17.684 | 6.89 | 5.307 | 55 | | | 10 |
| 2003 | 309 | 800 | 101 | 17.284 | 0.933 | 16.351 | 5.71 | 3.085 | 57 | | | 10 |
| 2003 | 309 | 900 | 101 | 17.521 | 1.17 | 16.351 | 7.16 | 3.085 | 58 | | | 10 |
| 2003 | 309 | 1000 | 101 | 18.805 | 1.877 | 16.928 | 11.09 | 4.047 | 53 | | | 10 |
| 2003 | 309 | 1100 | 101 | 16.922 | 1.153 | 15.769 | 7.31 | 2.115 | 52 | | | 10 |
| 2003 | 309 | 1200 | 101 | 17.353 | 1.439 | 15.914 | 9.04 | 2.356 | 52 | | | 9.9 |
| 2003 | 309 | 1300 | 101 | 16.808 | 1.229 | 15.579 | 7.89 | 1.798 | 53 | | | 10 |
| 2003 | 309 | 1400 | 101 | 16.948 | 1.369 | 15.579 | 8.79 | 1.798 | 53 | | | 10 |
| 2003 | 309 | 1500 | 101 | 16.992 | 1.413 | 15.579 | 9.07 | 1.798 | 55 | | | 10 |
| 2003 | 309 | 1600 | 101 | 16.799 | 1.308 | 15.491 | 8.44 | 1.652 | 57 | | | 10 |
| 2003 | 309 | 1700 | 101 | 16.855 | 1.276 | 15.579 | 8.19 | 1.798 | 60 | | | 10 |
| 2003 | 309 | 1800 | 101 | 18.61 | 2.175 | 16.435 | 13.23 | 3.224 | 59 | | | 9.9 |
| 2003 | 309 | 1900 | 101 | 17.314 | 1.456 | 15.858 | 9.18 | 2.263 | 61 | | | 10 |
| 2003 | 309 | 2000 | 101 | 18.26 | 1.909 | 16.351 | 11.68 | 3.085 | 67 | | | 10 |
| 2003 | 309 | 2100 | 101 | 20.961 | 3.277 | 17.684 | 18.53 | 5.307 | 71 | | | 10 |
| 2003 | 309 | 2200 | 101 | 18.277 | 1.926 | 16.351 | 11.78 | 3.085 | 76 | | | 10 |
| 2003 | 309 | 2300 | 101 | 19.127 | 2.356 | 16.771 | 14.05 | 3.785 | 81 | | | 10 |
| 2003 | 310 | 0 | 101 | 17.228 | 1.37 | 15.858 | 8.64 | 2.263 | 75 | | | 9.9 |
| | | | | 17.508 | 1.302 | 16.206 | 8.03 | 2.844 | 57.26 | 2.27 | | |

* % change based on background from IMPROVE transmissometer at Badlands NP (if >50 1/Mm)

Model Extincti by Species

| YEAR | DAY | HR | RECEP | COORDIN. (km) | | TYPE | BEXT(Mod | BEXT(BKG | BEXT(Total) | %CHANGE | F(RH) | bxSO4 | bxNO3 | bxOC | bxEC | bxPMC | bxPMF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2003 | 310 | 0 | 101 | 117.172 | -50.371 | D | 1.302 | 16.206 | 17.508 | 8.03 | 2.844 | 0.819 | 0.473 | 0.009 | 0 | 0 | 0.001 |

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**JD 346 (347,0): Dec 12 [Badlands]**

| YEAR | DAY | TIME | REC# | TOT EXT | MODEL EXT | FLAG BGRND | % CHANGE | RH-FAC | (FLAG/BAD) | %CHNG (FLAG/BAD)* | Rapid City Weather | Rapid City Visibility (miles) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2003 | 346 | 100 | 28 | 16.624 | 0.563 | 16.061 | 3.51 | 2.601 | 98 | | | |
| 2003 | 346 | 200 | 28 | 17.823 | 1.052 | 16.771 | 6.27 | 3.785 | 111 | | mist | 2.5 |
| 2003 | 346 | 300 | 28 | 17.451 | 1.1 | 16.351 | 6.73 | 3.085 | 113 | | | 10 |
| 2003 | 346 | 400 | 28 | 18.501 | 1.73 | 16.771 | 10.32 | 3.785 | 140 | | | 10 |
| 2003 | 346 | 500 | 28 | 18.932 | 2.161 | 16.771 | 12.89 | 3.785 | 192 | | | 10 |
| 2003 | 346 | 600 | 28 | 18.408 | 2.057 | 16.351 | 12.58 | 3.085 | 751 | | | 9.9 |
| 2003 | 346 | 700 | 28 | 18.514 | 2.163 | 16.351 | 13.23 | 3.085 | 403 | | | 10 |
| 2003 | 346 | 800 | 28 | 19.249 | 2.478 | 16.771 | 14.78 | 3.785 | 180 | | | 10 |
| 2003 | 346 | 900 | 28 | 18.876 | 2.105 | 16.771 | 12.55 | 3.785 | 104 | | | 10 |
| 2003 | 346 | 1000 | 28 | 24.175 | 3.807 | 20.368 | 18.69 | 9.779 | 82 | | | 10 |
| 2003 | 346 | 1100 | 28 | 18.137 | 1.209 | 16.928 | 7.14 | 4.047 | 68 | | | 10 |
| 2003 | 346 | 1200 | 28 | 15.851 | 0.36 | 15.491 | 2.32 | 1.652 | 67 | | | 9.9 |
| 2003 | 346 | 1300 | 28 | 15.88 | 0.267 | 15.613 | 1.71 | 1.855 | 61 | | | 10 |
| 2003 | 346 | 1400 | 28 | 15.766 | 0.153 | 15.613 | 0.98 | 1.855 | 54 | | | 10 |
| 2003 | 346 | 1500 | 28 | 15.706 | 0.093 | 15.613 | 0.60 | 1.855 | 942 | | | 10 |
| 2003 | 346 | 1600 | 28 | 15.66 | 0.047 | 15.613 | 0.30 | 1.855 | 942 | | | 10 |
| 2003 | 346 | 1700 | 28 | 16.971 | 0.043 | 16.928 | 0.25 | 4.047 | 79 | | | 10 |
| 2003 | 346 | 1800 | 28 | 16.947 | 0.019 | 16.928 | 0.11 | 4.047 | 85 | | | 9.9 |
| 2003 | 346 | 1900 | 28 | 18.076 | 0.011 | 18.065 | 0.06 | 5.941 | 99 | | | 10 |
| 2003 | 346 | 2000 | 28 | 20.373 | 0.005 | 20.368 | 0.02 | 9.779 | 110 | | | 10 |
| 2003 | 346 | 2100 | 28 | 20.368 | 0 | 20.368 | - | 9.779 | 135 | | | |
| 2003 | 346 | 2200 | 28 | 20.368 | 0 | 20.368 | - | 9.779 | 417 | | | 8 |
| 2003 | 346 | 2300 | 28 | 17.684 | 0 | 17.684 | - | 5.307 | 333 | | mist | 1.2 |
| 2003 | 347 | 0 | 28 | 16.928 | 0 | 16.928 | - | 4.047 | 141 | | | 9.9 |
| | | | | 18.05 | 0.89 | 17.16 | 5.2 | 4.434 | 237.79 | 0.38 | | |

* % change based on background from IMPROVE transmissometer at Badlands NP (if >50 1/Mm)

| YEAR | Model( DAY | Extincti HR | by RECEP | Species COORDIN. (km) | | TYPE | BEXT(Mod | BEXT(BKG | BEXT(Total) | %CHANGE | F(RH) | bxSO4 | bxNO3 | bxOC | bxEC | bxPMC | bxPMF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2003 | 347 | 0 | 28 | 227.093 | -18.671 | D | 0.89 | 17.16 | 18.053 | 5.2 | 4.434 | 0.496 | 0.39 | 0.006 | 0 | 0 | 0.001 |

**JD 307 (308,0): November 3**

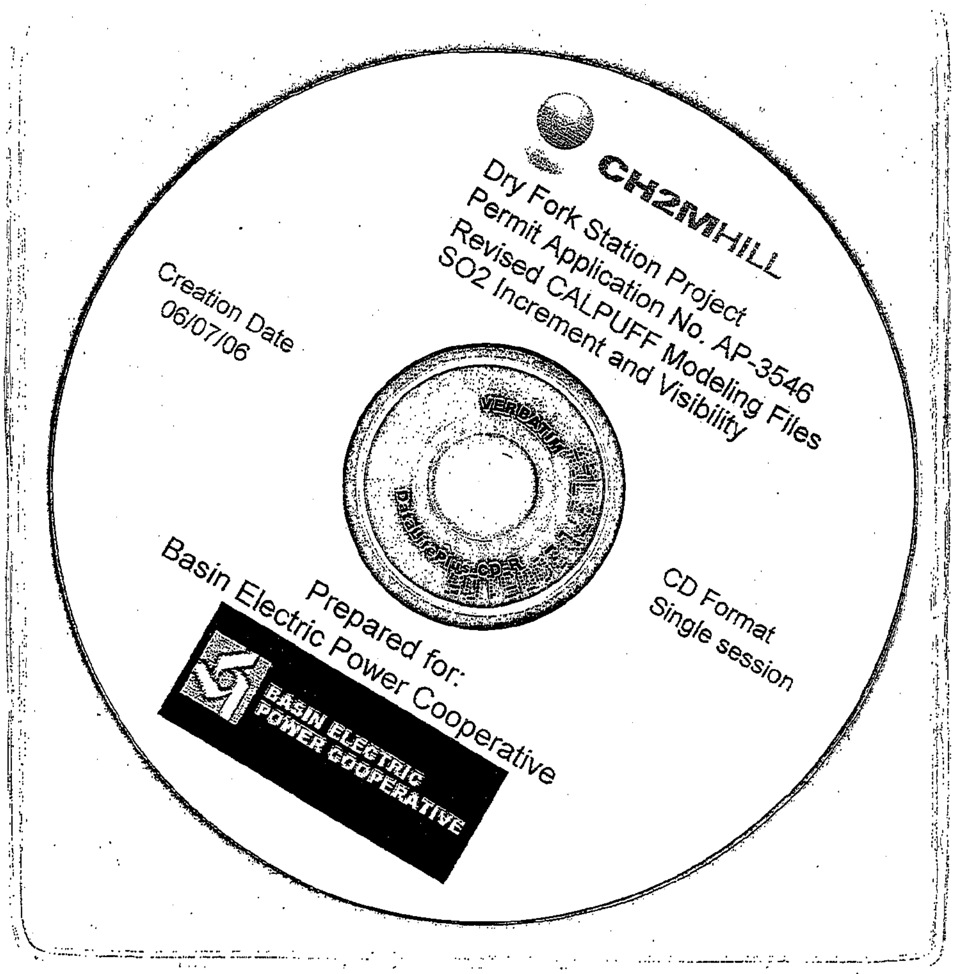
| YEAR | DAY | TIME | REC# | TOT EXT | MODEL EXT | FLAG BGRND | % CHANGE | RH-FAC | Billings Weather | Billings VR | Sheridan Weather | Sheridan VR | Sheridan VR (km) | FLAG or Method7 BGRND* | % CHANGE (Method 7) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2003 | 307 | 100 | 1879 | 18.159 | 1.883 | 16.276 | 11.57 | 2.959 | | | | | | 16.276 | |
| 2003 | 307 | 200 | 1879 | 20.63 | 3.514 | 17.116 | 20.53 | 4.359 | light snow | 9 | | | | 17.116 | |
| 2003 | 307 | 300 | 1879 | 21.092 | 3.976 | 17.116 | 23.23 | 4.359 | light snow | 10 | | | | 17.116 | |
| 2003 | 307 | 400 | 1879 | 28.39 | 8.022 | 20.368 | 39.39 | 9.779 | light snow | 9 | mist | 3 | 4.8 | 810 | |
| 2003 | 307 | 500 | 1879 | 28.389 | 8.021 | 20.368 | 39.38 | 9.779 | light snow | 9 | mist | 1.7 | 2.7 | 1430 | |
| 2003 | 307 | 600 | 1879 | 29.604 | 9.236 | 20.368 | 45.35 | 9.779 | light snow | 8.7 | mist | 2.5 | 4.0 | 972 | |
| 2003 | 307 | 700 | 1879 | 23.653 | 5.588 | 18.065 | 30.93 | 5.941 | light snow | 9 | mist | 2.5 | 4.0 | 972 | |
| 2003 | 307 | 800 | 1879 | 25.198 | 7.133 | 18.065 | 39.49 | 5.941 | | | mist | 2.5 | 4.0 | 972 | |
| 2003 | 307 | 900 | 1879 | 27.383 | 9.318 | 18.065 | 51.58 | 5.941 | | | mist | 1.5 | 2.4 | 1621 | |
| 2003 | 307 | 1000 | 1879 | 29.216 | 11.151 | 18.065 | 61.73 | 5.941 | | | mist | 2 | 3.2 | 1215 | |
| 2003 | 307 | 1100 | 1879 | 31.127 | 13.062 | 18.065 | 72.31 | 5.941 | | | mist | 2.5 | 4.0 | 972 | |
| 2003 | 307 | 1200 | 1879 | 43.077 | 22.709 | 20.368 | 111.49 | 9.779 | | | | | | 20.368 | |
| 2003 | 307 | 1300 | 1879 | 41.657 | 21.289 | 20.368 | 104.52 | 9.779 | | | mist | 2 | 3.2 | 1215 | |
| 2003 | 307 | 1400 | 1879 | 41.016 | 20.648 | 20.368 | 101.37 | 9.779 | | | | | | 20.368 | |
| 2003 | 307 | 1500 | 1879 | 40.189 | 19.821 | 20.368 | 97.31 | 9.779 | | | | | | 20.368 | |
| 2003 | 307 | 1600 | 1879 | 39.037 | 18.669 | 20.368 | 91.66 | 9.779 | | | | | | 20.368 | |
| 2003 | 307 | 1700 | 1879 | 24.688 | 7.572 | 17.116 | 44.24 | 4.359 | | | | | | 17.116 | |
| 2003 | 307 | 1800 | 1879 | 21.824 | 5.306 | 16.518 | 32.12 | 3.364 | | | | | | 16.518 | |
| 2003 | 307 | 1900 | 1879 | 20.401 | 4.125 | 16.276 | 25.34 | 2.959 | | | | | | 16.276 | |
| 2003 | 307 | 2000 | 1879 | 31.572 | 11.204 | 20.368 | 55.01 | 9.779 | light snow, mist | 5 | | | | 20.368 | |
| 2003 | 307 | 2100 | 1879 | 32.63 | 12.262 | 20.368 | 60.20 | 9.779 | light snow, mist | 1 | | | | 20.368 | |
| 2003 | 307 | 2200 | 1879 | 31.092 | 10.724 | 20.368 | 52.65 | 9.779 | light snow, mist | 1 | | | | 20.368 | |
| 2003 | 307 | 2300 | 1879 | 29.819 | 9.451 | 20.368 | 46.40 | 9.779 | light snow, mist | 2.5 | freezing rain, mist | 5 | 8.0 | 486 | |
| 2003 | 308 | 0 | 1879 | 22.432 | 4.367 | 18.065 | 24.17 | 5.941 | light snow, mist | 3 | freezing rain | 8 | 12.9 | 304 | |
| | | | | 29.261 | 10.38 | 18.884 | 54.95 | 7.31 | | | | | | 467.254 | 2.2 |

* When fog/precip, etc. is observed, BGRND (1/Mm) = 3912/VR(km). CALPOST Method 7.

DEQ/AQD 000675

Modele Extinctic by Species

| YEAR | DAY | HR | RECEF | COORDIN (km) | | TYPE | BEXT(Mod | BEXT(BKG | BEXT(Total) | %CHANG | F(RH) | bxSO4 | bxNO3 | bxOC | bxEC | bxPMC | bxPMF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2003 | 308 | 0 | 1879 | -126.282 | 151.458 | D | 10.38 | 18.884 | 29.261 | 54.95 | 7.31 | 6.019 | 4.293 | 0.047 | 0.001 | 0 | 0.017 |


CH2MHILL
Dry Fork Station Project
Permit Application No. AP-3546
Revised CALPUFF Modeling Files
SO2 Increment and Visibility
Creation Date
06/07/06
CD Format
Single session
Prepared for:
Basin Electric Power Cooperative
BASIN ELECTRIC
POWER COOPERATIVE