Sunflower Electric Power Corporation

Holcomb Expansion Project
Visibility Impact on Class I Areas
and
$PM_{2.5}$ Impact in Northeast Kansas

For submittal to:
Kansas Department of Health and Environment
Division of Environment
Bureau of Air and Radiation
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Table of Contents

List of Sections

Section I	Introduction and Conclusions		1
Section II	Emission Basis		3
Section III	Meteorological Data Processing		5
Section IV	Model Results		5
	IV.1	Visibility Impact Modeling	5
	IV.2	Predicted $PM_{2.5}$ (PMF) Impacts	7

List of Attachments

Attachment 1	Best Available Retrofit Technology (BART) Dispersion Modeling Protocol for Selected Nebraska Utilities
Attachment 2	Wind Rose Plot, Dodge City Regional AP

I. INTRODUCTION and CONCLUSIONS

On behalf Sunflower Electric (Sunflower), HDR conducted an air quality modeling study to estimate the impact the proposed three new units at Holcomb will have on regional haze at certain locations designated as mandatory Class I areas (national parks, national wilderness areas, and national wildlife refuges). This report describes the results of this modeling.

The modeling results indicate that the construction of three new generating units at Holcomb will not result in a decrease in visibility at any Class I area in excess of the accepted detectability threshold of 0.5 deciviews. The study described below examined the effect of Holcomb emissions on Class I areas at distances of 380 to 940 km from Holcomb. As shown in Table 2, the worst-case 98th percentile visibility impact is predicted to be 0.480 deciviews, which is below the BART-exemption threshold, and is predicted to occur with 2002 meteorology at the Wichita Mountains Wildlife Refuge in Oklahoma, located south-southeast of Holcomb. Class I areas to the east and west of Holcomb are shown to receive much lower impacts, well below the 0.5 deciview threshold.

It is stated in EPA's Regional Haze Guidelines for BART (Federal Register, July 6, 2005) that a change in visibility is perceptible to most people somewhere in the range of a 0.5 to 1.0 deciview change, although there is disagreement on the exact perceptibility threshold. Given that the model results for a conservative (high) emissions case are below the lower end of this threshold, it is expected that the three proposed new units at Holcomb would not cause a perceptible change in visibility at any Class I areas in the region.

The techniques and protocols used for this modeling analysis follow those prescribed for the analysis of Best Available Retrofit Technology under recent EPA "regional haze" rules, and can be used for the analysis of new generating units which are proximate to Class I areas.

The nearest Class I area to the Holcomb site is the Great Sand Dunes National Monument, approximately 380 kilometers west of Holcomb Station. Under both EPA guidance (1990 New Source Review Workshop Manual) and Federal Land Manager guidance (December 2000 Federal Land Managers' Air Quality Related Values Workgroup (FLAG), Phase I Report), visibility impact analysis is expected to be provided in a complete PSD permit application for a major source or major modification within 100 km of a Class I area. The FLAG guidance states that very large sources located at distances beyond 100 km from a Class I area may be requested to provide analysis on a case-by-case basis. Although such analysis was not requested for the proposed facility, Sunflower elected to produce this analysis in the interests of providing a complete examination of potential air quality effects of the Holcomb expansion project, so that the Kansas Department of Health and Environment (KDHE) may utilize this information in their required growth impacts evaluation within their Regional Haze State Implementation Plan (SIP) submittal to EPA.

The region examined in this analysis and the locations of the Class I areas are illustrated in Figure 1 below.

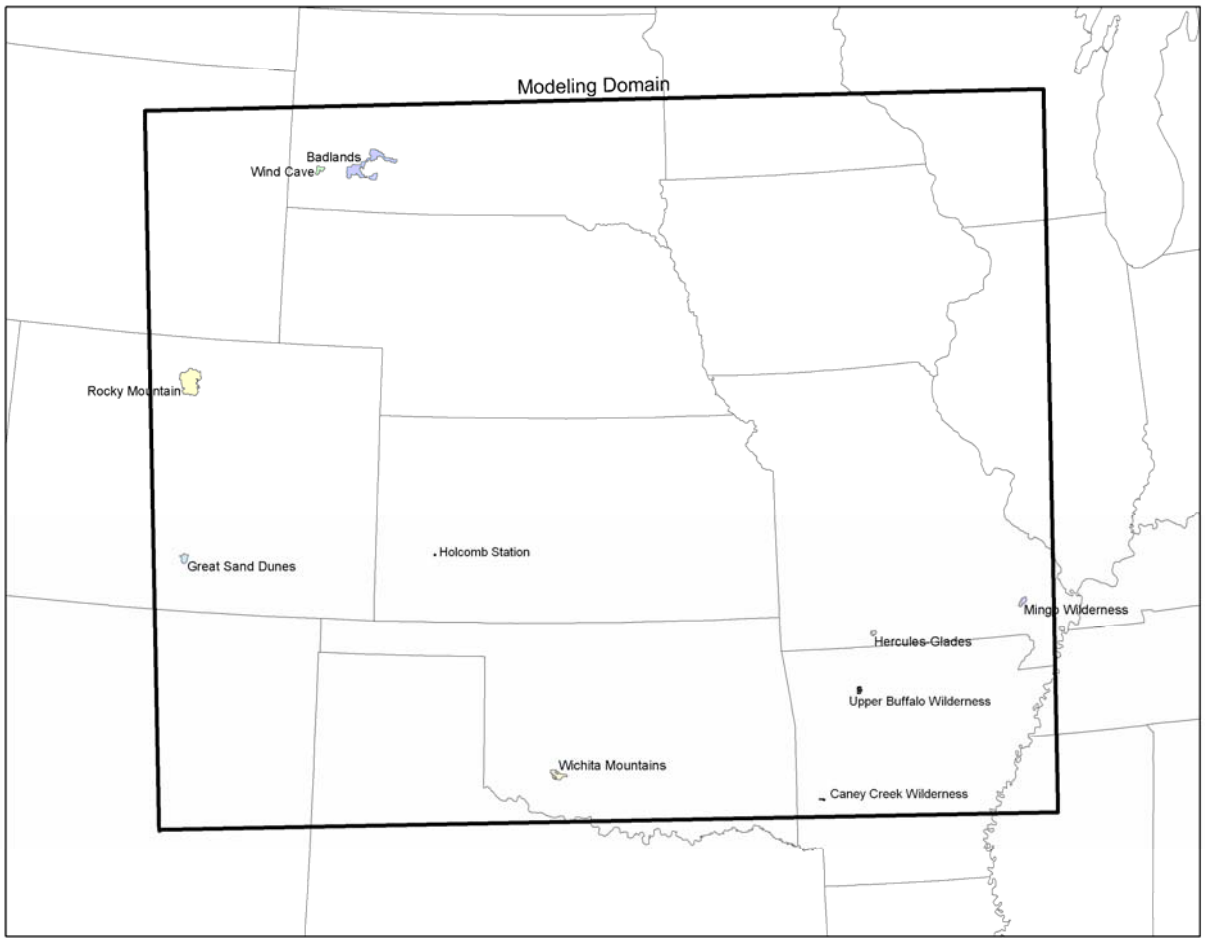

Figure 1. Modeling Domain and Class I Areas.

In addition to the examination of effects on visibility of the Holcomb Project, HDR also prepared an estimate of the effects of Holcomb emissions on concentrations of fine particulate matter (referred to as $PM_{2.5}$) in relation to recently-revised standards for such particulates soon to come into effect. These estimates were made for the urban areas of eastern Kansas (Topeka, Lawrence, Kansas City), where there is perhaps the greatest potential for elevated $PM_{2.5}$ concentrations, due to combustion sources and urban area emissions sources. As indicated in Table 3, the predicted $PM_{2.5}$ impacts are all well below the applicable National Ambient Air Quality Standards (NAAQS) for both annual and 24-hour time averaging periods. Furthermore, the predicted impacts are so far below the current and new standards that it is clear that the Holcomb expansion would result in an insignificant change in $PM_{2.5}$ concentrations in the areas evaluated.

Basis for Analysis Methods

On July 6, 2005, the U.S. Environmental Protection Agency (EPA) published final amendments to its 1999 regional haze rules in the Federal Register, including Appendix Y, the final guidance for Best Available Retrofit Technology (BART) determinations (70 FR 39104-39172). The regional haze rules requires the installation of BART on emission sources that are:

1) BART-eligible based on their having begun operation after August 8, 1962, and being "in existence" before August 8, 1977, which includes sources that had received a construction permit by the latter date, and

2) which "may reasonably be anticipated to cause or contribute" to visibility impairment in any Class I area.

While the BART rules apply only to certain existing sources meeting the above criteria, states have a general SIP requirement under the Regional Haze program to account for growth in managing visibility impacts at Class I areas. While the three proposed new units at Holcomb are not subject to review under the Regional Haze program, Sunflower has voluntarily chosen to have HDR perform a visibility impact analysis to assess the potential impacts of this growth. This analysis has been completed in conformance with EPA's BART guidelines so as to make the information most useful to the agency in their SIP preparation.

Under the EPA's BART guidelines, air quality modeling is used to determine whether a given source is causing or contributing to visibility impairment in any Class I area within a prescribed distance (generally 150 kilometers). The air quality modeling software used to make the assessment of visibility impacts for the three proposed new units at Holcomb is the CALMET/CALPUFF modeling system. It is important to note that the closest Class I area is nearly 400 kilometers from the Holcomb site.

As described previously, the protocol followed in preparation of the dispersion modeling analysis of the new Holcomb units conforms to EPA BART guidelines. For reference purposes, a detailed protocol prepared by HDR for modeling of similar utility sources in Nebraska under the Regional Haze program has been provided as Attachment 1 of this letter report. The reference protocol is essentially identical to the protocol followed for the Holcomb study with the exception of the inclusion of two additional Class I areas: Upper Buffalo Wilderness Area and Caney Creek Wilderness Area, both located in Arkansas.

II. EMISSIONS BASIS

The mass emission rates used for this modeling are estimates of actual 24-hour maximum emission rates, to be consistent with guidance for Regional Haze modeling analyses. The

maximum allowable emissions for the facility are equivalent to 0.095 lb/mmBtu for sulfur dioxide (SO_2), 0.07 lb/mmBtu for nitrogen oxides (NO_x), and 0.035 lb/mmBtu for particulate matter (PM). Actual emissions are expected to be somewhat lower than these emission rates for a number of reasons. Two primary reasons include demand load and operating margin. Firstly, load conditions typically vary somewhat with electrical demand on an annual and on a diurnal basis. The diurnal load swings usually mean lower unit capacity utilization during nighttime hours. Secondly, plant owners must design and operate their pollution control systems to maintain some compliance margin below the maximum allowable limits/capacity, so that they can minimize the risk of violating their permits. Together, these factors generally result in 24-hour maximum emissions that are significantly below the allowable limits. To provide a conservative (upper) estimate of the actual emission rates, it was assumed that the above factors result in emissions that are 95% of the limits listed above.

Emission of PM were input to the CALPUFF model in two components: coarse particulate matter (PMC), which is defined as particulate matter between 2.5 microns and 10 microns in diameter, and fine particulate matter (PMF), which is defined as particulate matter smaller that 2.5 microns in diameter (also known as $PM_{2.5}$).

The filterable PM was apportioned to PMC and PMF fractions based on the AP-42 size distribution (AP-42, Chapter 1, Table 1.1-6) for a fabric filter-controlled wall-fired boiler burning subbituminous coal. In addition to the filterable component, permitted/allowable condensable emissions were assumed to be entirely in the $PM_{2.5}$ size range. Thus, all condensable PM emissions were added to the PMF filterable component to obtain total PMF emission rates for model input.

The emissions from the three new unit stacks were combined and modeled as one source, using stack parameters for a single one of these stacks[1]. Total maximum heat input for the three units is 19,503 mmBtu/hr. The emission factors and total (3-stack) mass emission rates input to CALPUFF are summarized in Table 1.

Table 1. Emission rates input to CALPUFF analysis.

Pollutant	Allowable Emission Factor (lb/mmBtu)	Allowable Emission Rate (lb/hr)	Estimated Actual Emission Rate (lb/hr)	Modeled Emission Rate (grams/sec)
SO_2	0.095	1852.8	1760.2	221.8
NOx (as NO_2)	0.07	1365.2	1296.9	163.4
PMC	0.0051	99.5	94.5	11.9
PMF	0.0299	583.1	553.9	69.8

[1] This was done to prevent an overestimation of available ambient background compounds (i.e. ammonia) that contribute to secondary fine particulate formation. The model individually evaluates each plume with respect to total available background compounds with no consideration to simultaneous plumes consuming and reducing available background compounds.

III. METEOROLOGICAL DATA PROCESSING

The Central Regional Air Planning Association (CENRAP) has processed a 2001-2003 meteorological data set for use in the CALPUFF model for regional haze analyses in the central region of the United States. Subsequent to CENRAP's preparation of this database, EPA Region VII determined that a bias in cloud cover amount (too low) existed in the parent MM5 data input to CENRAP's preprocessing using the CALMET program. Therefore, HDR has re-processed a meteorological data set for the Central Plains region with CALMET (see Attachment 1), using the option to "reintroduce" surface observations along with the MM5 data fields, which presumably eliminates this bias. The re-processing of the meteorological data to eliminate the cloud cover bias is a means of assuring the impacts resulting from the modeling analysis are consistent with Region VII BART guidance.

To provide the needed data to accomplish the processing of meteorological data using CALMET, HDR obtained the 2001-2003 MM5 model output data from CENRAP's contractor, Alpine Geophysics. The 2001 MM5 data were provided in 12 km horizontal resolution, while the 2002 and 2003 MM5 data were provided in 36 km resolution. HDR also obtained the surface station observations from Bowman Environmental, which extracted these data from National Climatic Data Center (NCDC) databases. The surface stations included in this database, which are listed in the second draft protocol in Attachment 1, covered the entire modeling domain.

The MM5 data sets for input to CALMET were very large, and needed to be shipped to HDR on five 300 gigabyte external disk drives (1,500,000 megabytes). Because of the large file sizes, MM5 data files were processed either a month at a time (2002 and 2003) or a third of a month at a time (2001) by CALMET. Thus, the number of meteorological data files input to each yearly CALPUFF run ranged from 12 to 36 files.

With the exception of the re-processing of meteorological data using the procedures described above, the technical options for application CALMET and CALPUFF to this project are those recommended by the CENRAP modeling guidance (CENRAP BART Modeling Guidelines, December 15, 2005). This same meteorological data set is being used for Regional Haze/BART modeling analyses for several BART-eligible facilities in Nebraska.

IV. MODEL RESULTS

IV.1 Visibility Impact Modeling

The CALPUFF model results, based on a protocol similar to that provided as reference in Attachment 1, are summarized in Table 2. Based on the Regional Haze/BART criteria, these results indicate the new units at Holcomb, if they were subject to Regional Haze

modeling requirements, would have impacts below the exemption threshold that is used to determine whether an existing facility is exempt from BART requirements. The BART exemption threshold recommended by EPA, and being used by most states, is a 98th percentile incremental visibility impact of 0.5 deciviews.

As shown in Table 2, the worst-case 98th percentile visibility impact is predicted to be 0.480 deciviews, which is below the BART-exemption threshold, and is predicted to occur with 2002 meteorology at the Wichita Mountains Wildlife Refuge in Oklahoma, located south-southeast of Holcomb. Class I areas to the east and west of Holcomb are shown to receive much lower impacts, well below the 0.5 deciview threshold. This is not unexpected, because wind patterns in the area tend to blow north and south, as shown in Attachment 2, which is a wind rose for Dodge City, Kansas, based on 9 years of meteorological data (1984-1992) collected at a height of 26 feet above ground level. The nine years of data were selected for this wind rose because they were freely available from the web site: http://www.webmet.com/State_pages/SURFACE/13985_sur.htm. The wind rose shows that the predominant winds are from the south, with a secondary predominance of winds from the north.

Table 2. Predicted Impact Changes, in Deciviews, at Class I Areas.

Class I Area	Year of Meteorology					
	2001		2002		2003	
	# Exceed.	8th-High	# Exceed.	8th-High	# Exceed.	8th-High
Badlands (SD)	4	0.381	2	0.212	5	0.293
Buffalo (AR)	0	0.135	1	0.125	0	0.109
Caney (AR)	0	0.094	0	0.089	0	0.074
Great Sand Dunes (CO)	0	0.049	0	0.150	2	0.109
Hercules Glades (MO)	0	0.146	1	0.125	0	0.140
Mingo (MO)	0	0.115	0	0.066	0	0.089
Rocky Mountain (CO)	0	0.064	1	0.105	0	0.130
Wichita Mountains (OK)	0	0.306	6	0.480	3	0.312
Wind Cave (SD)	3	0.258	2	0.198	3	0.179

[A] Exceedances are the number of annual values exceeding the threshold of 0.5 deciviews.
[B] The 8th-high values represent the 98th percentile value in a year, and are reported in units of incremental deciviews.

The impact predictions in Table 2 are based on the use of maximum estimated "actual" 24-hour emission rates, which are assumed to occur 24 hours per day and every day of the year. The maximum estimated emission rates provide a conservative assessment of emissions and impacts that will clearly tend to overestimate actual emissions, which would be used as the basis for Regional Haze/BART analyses. Factors contributing to the overestimate of emissions and impacts include the facility design capacity factor and load demand, as well as the compliance margin between maximum allowable emissions and actual emission rates. Most of the year the emission units will incur greater load reductions on a diurnal basis than assumed in this analysis. Furthermore, compliance margins will also tend to reduce actual emissions below permitted limits. For both of these reasons, the actual 98th percentile impact, assuming the model provides reasonably

accurate results for locations as distant as the Class I areas from Holcomb, would clearly be significantly below the modeled results provided in Table 2.

Finally, it is stated in EPA's Regional Haze Guidelines for BART (Federal Register, July 6, 2005) that a change in visibility is perceptible to most people somewhere in the range of a 0.5 to 1.0 deciview change, although there is disagreement on the exact perceptibility threshold. Given that the model results for a conservative (high) emissions case are below the lower end of this threshold, it is expected that the three proposed new units at Holcomb would not cause a perceptible change in visibility at Class I areas in the region.

IV.2 Predicted $PM_{2.5}$ (PMF) Impacts

Concerns about impacts of fine particulate matter ($PM_{2.5}$) have been elevated recently, with EPA's announcement that they are issuing a revised, lower National Ambient Air Quality Standard for $PM_{2.5}$. The 24-hour average $PM_{2.5}$ NAAQS is being reduced from the current value of 65 ug/m^3 to a value of 35 ug/m^3, both on a 98th percentile basis, effective in December 2006. This means that under the new standard, the 8th highest 24-hour concentration annually cannot exceed a level of 35 ug/m^3. The EPA has projected which areas of the country will not be in compliance with the new standard. These are primarily urban areas in the eastern United States and California.

No areas of Kansas are projected by EPA to be out of compliance with the new $PM_{2.5}$ standard. However, to provide an assessment of the proposed facility's incremental impact in the urban areas of Kansas, CALPUFF model results were obtained for $PM_{2.5}$ concentrations in the northeastern Kansas urban areas of: Kansas City, Lawrence, and Topeka. These results are summarized in Table 3.

Table 3. Predicted $PM_{2.5}$ impacts in units of µg/m^3.

Location	Year of Meteorology					
	2001		2002		2003	
	Max. Annual	8th-High 24-Hour	Max. Annual	8th-High 24-Hour	Max. Annual	8th-High 24-Hour
Lawrence	0.0030	0.032	0.0032	0.033	0.0029	0.032
Kansas City	0.0051	0.042	0.0047	0.045	0.0048	0.051
Topeka	0.0034	0.030	0.0037	0.036	0.0032	0.035

As indicated in Table 3, the predicted $PM_{2.5}$ impacts are all well below the applicable NAAQS standards for both annual and 24-hour time averaging periods. Furthermore, the predicted impacts are so far below the current standards that it can be reasonably expected that Holcomb Station would result in an insignificant change to $PM_{2.5}$ concentrations in the areas evaluated.

ATTACHMENT 1

Best available Retrofit Technology (BART)

Dispersion Modeling Protocol for Selected Nebraska Utilities

prepared for:

City of Grand Island
Hastings Utilities
Nebraska Public Power District
Omaha Public Power District

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October 31, 2006

Best available Retrofit Technology (BART)

Dispersion Modeling Protocol for Selected Nebraska Utilities

1.0 INTRODUCTION

1.1 Objectives & Approach

This dispersion modeling protocol describes the procedures proposed for use in applying the CALMET/CALPUFF modeling system (Earth Tech 2000) to certain Nebraska utility plants subject to Regional Haze rules. This protocol proposes the use of the following model, preprocessor and postprocessor versions for the facilities listed herein:

SMERGE: Version 5.61 (060309)
CTGPROC: Version 2.66 (060202)
TERREL: Version 3.681 (060202)
MAKEGEO: Version 2.26 (041230)
CALMET: Version 5.53a (Level 040716)
CALPUFF: Version 5.754 (Level 060202)
POSTUTIL: Version 1.52, Level 060412
CALPOST: Version 5.6393 (Level 060202)

The purpose of the Regional Haze rules is to help remedy any existing impairment of visibility in Class I designated National Parks, Wilderness Areas, and Wildlife Refuges, in an attempt to bring visibility back to its presumed level in prehistoric times. The procedures herein are consistent with EPA's Regional Haze guidance provided under 40 CFR 51, Appendix Y, and with *CENRAP BART Modeling Guidelines* (Dec. 15, 2005).

The primary objective of this analysis is to determine whether several Nebraska facilities which are "eligible" for Best Available Retrofit Technology (BART) emission controls, are also BART-subject, meaning they would need to undergo a BART technology analysis to help establish whether and what type of emissions controls are needed to meet Regional Haze requirements.

This protocol is being submitted to the Nebraska Department of Environmental Quality (NDEQ) for its review and approval, for use in determining which BART-eligible sources are BART-subject. Also, if approved by the NDEQ, this protocol will be used to estimate the relative Class I area visibility improvements associated with various candidate emission control options for any BART-subject sources addressed in this protocol.

In general, the technical approach used here is consistent with the CENRAP BART Modeling Guidelines. To the extent that important technical options differ from the CENRAP-recommended defaults, such differences will be addressed in this protocol. To

the extent that this protocol is silent on specific model input settings, one can assume that the parameter setting will either be consistent with CENRAP defaults (see tables in Appendices B, C, and D of CENRAP BART Modeling Guidelines), is not relevant to this particular modeling exercise, or has no effect on modeled predictions (e.g., certain model diagnostic output settings).

1.2 Identification of Sources and Relevant Class I Areas

The sources (and operators) covered by this protocol, along with their general locations, include the following:

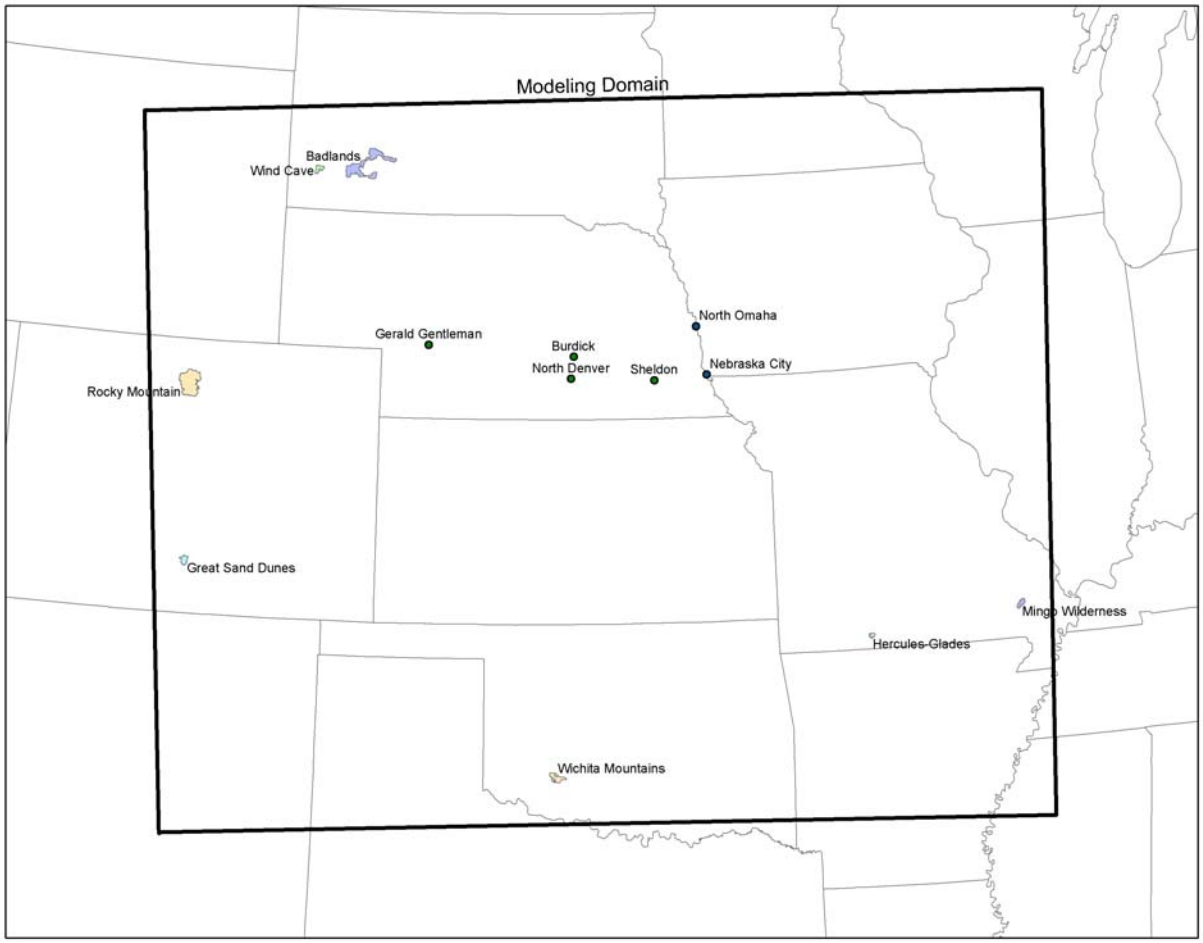
- Gerald Gentleman Station, Units 1 & 2 (Nebraska Public Power District), near North Platte,
- Sheldon Station, Unit 1 (Nebraska Public Power District), near Hallam,
- Nebraska City Station Unit 1 (Omaha Public Power District), near Nebraska City,
- North Omaha Station Units 4 & 5 (Omaha Public Power District), in Omaha,
- C.W. Burdick Station Units 3 & 4 (City of Grand Island), in Grand Island, and
- North Denver Station Unit 5 (Hastings Utilities), in Hastings.

The relevant Class I areas selected for this analysis include the nearest Class I areas in several general directions from the facilities. None of these Class I areas are in Nebraska. The selected Class I areas are located at distances of 300 to 600 kilometers or more from the above sources, and are within the CENRAP-prepared meteorological grid representing the central CENRAP region. Many more Class I areas lie at greater distances from the sources of interest, but it is not expected that the more distant Class I areas would be areas of worst-case impact. The Class I areas selected for this analysis include:

- Wind Cave National Park, in western South Dakota,
- Badlands National Monument, in western South Dakota,
- Hercules-Glades Wilderness, in southern Missouri,
- Mingo National Wildlife Refuge, in southern Missouri,
- Wichita Mountains National Wildlife Refuge, in southern Oklahoma,
- Great Sand Dunes National Monument, in south-central Colorado, and
- Rocky Mountain National Park, in north-central Colorado.

Shown in Figure 1 is a graphic depicting the locations of the sources and Class I areas proposed to be addressed in this analysis. The rectangular box covering this region shows the boundaries of the modeling domain for the proposed analysis, over which puffs will be transported, dispersed, and chemically converted, as calculated by the CALPUFF model and post-processors.

Figure 1. Modeling Domain for BART Analyses



1.3 Source Impact Evaluation Criteria

As directed by the NDEQ, the evaluation criteria for determining whether individual facilities contribute to adverse impacts are consistent with suggested levels in EPA guidance (40 CFR 51, Appendix Y). An impact level of 1.0 deciview or more by BART-eligible units (collectively) at a single facility means that the affected source by itself is causing adverse visibility impact. An impact level of 0.5 deciviews or more by BART-eligible units (collectively) at a single facility means that the affected source is reasonably anticipated to contribute to adverse visibility impact.

In accordance with Appendix Y, the 98th percentile of the daily deciview impacts, within each year of meteorology modeled, evaluated separately at each Class I area, will be the criteria to establish a contribution to adverse visibility impact. For a year of 365 days, this means that any exceedances over 0.02*365 = 7.3 are over the allowable threshold. Thus, seven (7) 24-hour periods in a year exceeding 0.5 deciviews are acceptable to exempt a source from BART, while eight 24-hour periods exceeding 0.5 deciviews mean a source is BART-subject.

One additional specification is that an exceedance of the 0.5 deciviews threshold can occur at any receptor point within a given Class I area, to count as a day over the 0.5 threshold for that Class I area. This is consistent with modeling guidance developed by the VISTAS Regional Planning Organization, which covers states in the southeastern US (VISTAS 2006).

1.4 Modeling Study Participants

As listed above, the modeling study participants include four public utilities in Nebraska (NPPD, OPPD, City of Grand Island, and Hastings Utilities), with a total of six facilities containing BART-eligible emission units. The modeling study will be completed by HDR, Inc.

1.5 Protocol Review Process

The protocol review process will begin upon submittal of this proposed protocol to the NDEQ, which will distribute it for comment to appropriate agencies, including EPA Region VII and various Federal Land Managers. Protocol review and approval are expected to be expedited due to the fact that this protocol relies heavily on the CENRAP-recommended modeling protocol, which has already undergone review by many interested agencies. Upon approval of this protocol, with any needed revisions, HDR will apply it to the subject sources and provide a report documenting model results for NDEQ review and approval, to determine which facilities are BART-subject.

2.0 SOURCE DESCRIPTION

2.1 Unit-Specific Source Data

In general, the emission rates to be used for this analysis will be representative of 24-hour (calendar day) maximum emission rates for the baseline period of 2001-2003. However, there are some exceptions. For emission units that can routinely operate on more than one fuel (fuels used for start-up are not considered), the worst-case fuel will be assumed for emissions input purposes, even if it was not used during the 24-hour maximum facility operating rate (in million Btu/hr, or MMBtu/hr). This is consistent with recommendations in the CENRAP modeling guidance.

For example, C.W. Burdick Station used only natural gas during the baseline period. However, because the affected units at this facility can also burn No. 6 fuel oil, the modeled emissions for this facility will represent 24-hour maximum load for the period, with calculated emissions as if that load was achieved using No. 6 fuel oil, and fuel sulfur and heating value specifications of the on-hand fuel. Because the maximum combined (Units 2 & 3) load for Burdick Station was achieved with only Unit 3 in operation, only Unit 3 will be modeled for this study.

Also, because North Denver Station #5 (Hastings Utilities) was used only very sparingly in the baseline period (2001-2003), its 24-hour maximum emissions for the baseline/modeled period would be minimal. However, at Hasting Utilities' request, to conservatively assess potential impacts, it will be modeled at its maximum potential load condition, using the current worst-case fuel, which is No. 2 fuel oil with a maximum allowable sulfur content of 0.5%.

The SO_2 and NOx baseline emission rate inputs for the affected coal-fired units are determined from Continuous Emission Monitor (CEM) data. These CEMs are used for monitoring of emissions as required under the Acid Rain program. The PM emission rates for these units are based on the maximum 24-hour estimated heat input rate over the 2001-2003 period, together with an emission factor (lb/MMBtu) determined from the latest stack testing. For oil and gas-fired units, the emission rates will be calculated based on either AP-42 emission factors (NOx and PM) or sulfur mass-balance (SO_2), based on fuel sulfur specifications and measured fuel flows.

For facilities with multiple, BART-eligible emission units (Gerald Gentleman, North Omaha, Burdick), the combined maximum 24-hour emissions from the BART-eligible units at the facility will be used to determine modeled emission rates. Because stack heights for the multiple units at these facilities are identical or nearly so, and other stack parameters do not vary greatly, emissions for the multiple stacks at a facility will be summed and modeled as coming from one stack, the one that would generate slightly lower plume rise, to conservatively estimate Class I area impacts while minimizing computer time for CALPUFF runs. For stacks that are only a few meters apart, the separation of a few meters would have negligible effects on predicted impacts when those impacts are occurring several hundred kilometers away. A sensitivity analysis for one

facility will be provided along with final modeling to substantiate that combining stacks does not have an appreciable effect on dispersion, compared with modeling the stacks separately.

Estimated particulate matter (PM) emissions will be allocated into PM-coarse (PMC, particles from 2.5 to 10 microns in diameter) and PM-fine (PMF, particles below 2.5 microns in diameter) portions, based on size distribution data for filterable PM as provided in the latest sections of AP-42 (USEPA, 1998a). Also, condensable PM emissions will be estimated from AP-42 emission factors, and all of the condensable emissions will be assumed to form particles in the PMF size range. While some condensable emissions may form particles larger than 2.5 microns in diameter, or may agglomerate onto particles already larger than 2.5 microns in diameter, it is conservative to assume all the condensable material forms the smaller particles, which are more important in generation of regional haze. In any case, for power plant sources at significant distances from Class I areas, the direct PM emissions are typically responsible for a very small portion of the total modeled visibility impacts, based on prior CALPUFF modeling experience in other states. Thus, speciation and size distribution of PM emissions is not considered to be a significant issue in driving model results.

Emissions of other potential visibility-impairing pollutants, namely volatile organic compounds (VOCs) and ammonia (NH3), will not be considered as emitted for this analysis, due to their negligible importance for the types of sources (utility boilers) to be modeled. Also, minor emissions from intermittent sources (auxiliary boilers, emergency generators, minor PM sources, including fugitives) will not be assessed in this study, given that these types of sources will emit little, if any, emissions of visibility-impairing pollutants in comparison to the primary electric generating units being modeled for this study.

Stack parameters that vary with time (i.e., exit velocity and temperature) will be based on measurements corresponding with maximum 24-hour emissions determined from CEM data, or where no CEM data exist, will be based on either measured flows and temperatures from stack testing, or lastly in priority, from design maximum values.

2.2 Nearby Sources Affecting Same Class I Areas

Because the BART-eligible emission units included in this analysis will be analyzed facility-by-facility with respect to the 0.5 deciview threshold, to determine if they "reasonably contribute" to Class I area visibility impairment, the presence or lack of nearby sources is not especially relevant to this analysis. However, Nebraska may need to consider this issue in preparing its State Implementation Plan submittal to evaluate whether the collective emission reductions proposed will be effective in improving visibility at Class I areas.

3.0 OTHER MODEL & PROCESSOR INPUT DATA

3.1 Modeling Domain

The modeling domain proposed for this analysis (see Figure 1) covers a large portion of the CENRAP central region, as described previously. The modeling domain will extend from 50-80 km or more beyond the farthest extent of each Class I area to be analyzed, in accordance with recommendations provided in the *Interagency Workgroup on Air Quality Modeling (IWAQM) Phase 2 Summary Report and Recommendations for Modeling Long Range Transport Impacts*, U.S. Environmental Protection Agency, EPA–454/R–98–019, December 1998 (USEPA, 1998b). Given that the BART-eligible sources in Nebraska are relatively well centered within the meteorological and computational domains, these domains are expected to provide a good representation of emissions transport between sources and receptors.

3.2 Terrain and Land Use

Terrain data files were obtained through Bowman Environmental, and represent 30-meter resolution Digital Elevation Model (DEM) US Geological Survey data. Land use data files with 30-meter resolution were downloaded from the National Land Cover Dataset (NCLD) files available from the US Geological Survey at http://edcsgs9.cr.usgs.gov/pub/data/landcover/states/.

3.3 Meteorological Data Processing

The meteorological data base proposed for this study includes the same CALMM5 database of 2001, 2002, and 2003 data used by CENRAP for producing its meteorological databases with CALMET. However, in producing its meteorological database CENRAP used the NOOBS=2 option in CALMET, which does not re-introduce meteorological observations into the MM5 data fields. For the proposed BART analyses of Nebraska sources, HDR will use the NOOBS=1 option. This means that the CALMET runs will re-introduce surface observations, which will tend to bias the MM5 meteorological grids in favor of individual station data for grid nodes nearer the station observation points. The re-introduction of surface observation is intended to compensate for an apparent underestimate of total cloud cover in the MM5 model output, among other concerns expressed by Region 7 EPA.

For precipitation, the MM5 data fields will be used as they are, without re-introducing observations. Thus, the CALMET input parameter NPSTA will be set to -1.

In producing its databases, CENRAP prepared three separate data sets with CALMET, covering three prospective modeling domains: a north-central domain, a central domain, and a south-central domain. The “central domain” MM5 (CALMM5 format) meteorological data obtained from Alpine Geophysics (which processed the original meteorological data fields for CENRAP) will be used, together with the re-introduced observations, for this study.

A total of fifty (50) surface stations will be used for CALMET meteorological data processing. These stations are well distributed across the entire modeling domain and are listed in Table 1.

Table 1. Surface Meteorological Stations

Station #	WMO#	Elev. (m)	Anem. (ft)	Abbrev.	Location	Lat.	Long.
23047	723630	1093.0	32.8	AMA	Amarillo, TX	35.23	-101.7
3935	723489	102.4	**	CGI	Cape Girardeau, MO	37.233	-89.567
24017	725636	1011.3	33.0	CDR	Chadron, NE	42.833	-103.1
24018	725640	1863.9	32.8	CYS	Cheyenne, WY	41.15	-104.8
93037	724660	1884.0	32.8	COS	Colorado Springs, CO	38.817	-104.683
3945	724450	272.2	32.8	COU	Columbia, MO	38.817	-92.217
13984	724580	447.8	32.8	CNK	Concordia, KS	39.55	-97.65
3017	725650	1650.2	32.8	DEN	Denver (Intl. Airport), CO	39.833	-104.65
14933	725460	291.7	32.8	DSM	Des Moines, IA	41.533	-93.65
13985	724510	787.0	26.0	DDC	Dodge City, KS	37.767	-99.967
13964	723440	136.9	32.8	FSM	Fort Smith, AR	35.333	-94.367
13975	723527	667.8	33.0	GAG	Gage, OK	36.3	-99.676
23065	724650	1114.3	32.8	GLD	Goodland, KS	39.367	-101.7
14935	725520	560.8	32.8	GRI	Grand Island, NE	40.967	-98.317
14936	726540	390.1	32.8	HON	Huron, SD	44.4	-98.217
3947	724460	306.3	32.8	MCI	Kansas City (Int'l Airport), MO	39.3	-94.733
14938	724455	294.4	33.0	IRK	Kirksville, MO	40.1	-92.55
14920	726430	198.7	32.8	LSE	La Crosse, WI	43.883	-91.25
3013	724636	1129.0	**	LAA	Lamar, CO	38.067	-102.683
3950	723575	325.8	33.0	LAW	Lawton, OK	34.567	-98.417
23020	724516	875.7	33.0	LBL	Liberal, KS	37.05	-100.967
93010	724665	1695.3	33.0	LIC	Limon, CO	39.183	-103.717
14939	725510	356.6	32.8	LNK	Lincoln, NE	40.833	-96.767
14837	726410	264.0	32.8	MSN	Madison, WI	43.133	-89.35
14940	725485	373.4	33.0	MCW	Mason City, IA	43.15	-93.333
13893	723340	77.4	32.8	MEM	Memphis (Intl. Airport), TN	35.05	-89.983
14923	725440	180.4	32.8	MLI	Moline, IL	41.467	-90.517
53918	723439	282.9	**	BPK	Mountain Home, AR	36.367	-92.467
14941	725560	472.4	32.8	OFK	Norfolk, NE	41.983	-97.433
24023	725620	846.7	32.8	LBF	North Platte, NE	41.117	-100.667
13967	723530	391.7	26.0	OKC	Oklahoma City, OK	35.838	-97.6
14942	725500	299.3	32.8	OMA	Omaha (Eppley Airport), NE	41.317	-95.9
14842	725320	198.1	32.8	PIA	Peoria, IL	40.667	-89.683
24025	726686	531.0	33.0	PIR	Pierre, SD	44.383	-100.283
24090	726620	963.2	32.8	RAP	Rapid City (airport), SD	44.05	-103.05
14925	726440	397.5	32.8	RST	Rochester, MN	43.9	-92.5
94822	725430	222.5	32.8	RFD	Rockford, IL	42.2	-89.1
93997	724585	566.3	33.0	RSL	Russell, KS	38.883	-98.817
24028	725660	1202.4	32.8	BFF	Scottsbluff, NE	41.867	-103.6
14943	725570	333.8	32.8	SUX	Sioux City, IA	42.383	-96.383
14944	726510	435.3	32.8	FSD	Sioux Falls, SD	43.583	-96.733

93822	724390	181.1	32.8	SPI	Springfield, IL	39.85	-89.683
13995	724400	383.7	32.8	SGF	Springfield, MO	37.233	-93.4
13994	724340	161.8	32.8	STL	St. Louis (Lambert), MO	38.75	-90.367
13996	724560	268.5	32.8	TOP	Topeka, KS	39.067	-95.633
23070	724645	1749.9	**	TAD	Trinidad, CO	37.267	-104.333
13968	723560	198.1	32.8	TUL	Tulsa, OK	36.2	-95.883
24032	725670	789.4	32.8	VTN	Valentine, NE	42.883	-100.55
94910	725480	264.6	32.8	ALO	Waterloo, IA	42.55	-92.4
3928	724500	402.6	32.8	ICT	Wichita, KS	37.65	-97.45

**Anemometer height not listed for these stations. Height of 32.8 meters is assumed.

For this analysis, surface station meteorological data (for the re-introduction option) were obtained from the National Climatic Data Center, and were provided to HDR by Bowman Environmental. The MM5 meteorological fields were obtained from Alpine Geophysics in CALMM5 format, covering the same "central region" grid defined in the CENRAP modeling guidance.

3.4 Air Quality Data Base

The background air quality data proposed for use in this study are the CENRAP-recommended values for monthly ozone, ammonia, and peroxide concentrations.

3.5 Receptor Data

The receptors proposed for this analysis are those in each identified Class I area (see Section 1.2 above) as downloaded from the National Park Service Class I receptor database, accessed at the following web site: http://www2.nature.nps.gov/air/Maps/Receptors/index.cfm.

3.6 Relative Humidity Function [*f*(RH)]

The relativity humidity function, *f*(RH) is a parameter that relates to the hygroscopic growth of particles. As relativity humidity increases, certain particles such as sulfates and nitrates begin to agglomerate liquid water at relative humidity below 100%, thus greatly increasing the haziness of the atmosphere. Monthly values of *f*(RH) have been tabulated by EPA for all the Class I areas where visibility is considered an important value. The EPA-tabulated *f*(RH) values found in Appendix A, Table A-3, of *Guidance for Estimating Natural Visibility Conditions Under the Regional Haze Rule*, Publication EPA-454/B-03-005, September 2003, will be used for this study, specific to each Class I area. This means that in post-processing the model results with CALPOST, each individual Class I area will be processed separately, since the *f*(RH) values are input in the CALPOST processing step.

3.7 Natural Conditions at Class I Areas

Natural background visibility at Class I areas is a very important determinant in assessing the level of impact in deciviews from a given source. If the natural background visibility is very good, due perhaps to lower average humidity and other geographic and climate factors, it will not take as large a fine particle concentration to create a 0.5 deciview impact, as in an area that is naturally hazier. Also, in any given area, the haziness will vary considerably from day-to-day, depending on season and synoptic meteorological patterns. It is therefore necessary to describe the background visibility conditions within which a given facility impact will be assessed. For purposes of this protocol, the CENRAP-recommended default values will be used to describe background visibilities for the "east" and "west" Class I areas, as appropriate. For this purpose, "east" and "west" are divided by the eastern edge of the state boundaries of the Dakotas, Nebraska, Kansas, Oklahoma, and Texas.

The CENRAP-recommended defaults for CALPOST processing reflect the use of "average background visibility" conditions. Thus, average background visibility will represent the atmosphere within which the perceptibility of plumes is analyzed using the procedures in this protocol.

4.0 BART CONTROL MODELING RESULTS

Any sources determined to be BART-subject need to be re-modeled to assess the relative visibility improvements that could be attained with each prospective control option. The modeling protocol described in this document will be used for such analysis, unless another protocol is provided to NDEQ and approved for such use.

5.0 REPORTING

A combined BART-subject modeling report will be prepared to concisely summarize model results for all of the facilities covered by this protocol, and will be submitted to NDEQ for review and approval. The modeling report will be accompanied by a compact disk (or disks) containing CALPUFF, POSTUTIL, and CALPOST input and output files. One exception is the CALMM5 meteorological data base, which is too large to efficiently place on CD, but which is available separately from CENRAP.

6.0 REFERENCES

CENRAP, 2005. *CENRAP BART Modeling Guidelines*, Dec. 15, 2005.

Earth Tech, 2000. *A User's Guide to the CALPUFF Dispersion Model* (Version 5), January 2000.

National Park Service, 2006. Class I area receptor information, accessed at http://www2.nature.nps.gov/air/Maps/Receptors/index.cfm.

USEPA, 1998a. *Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources*. Publication AP 42, Fifth Edition, Volume I, Chapter 1: External Combustion Sources. Available on-line at: http://www.epa.gov/ttn/chief/ap42/ch01/index.html.

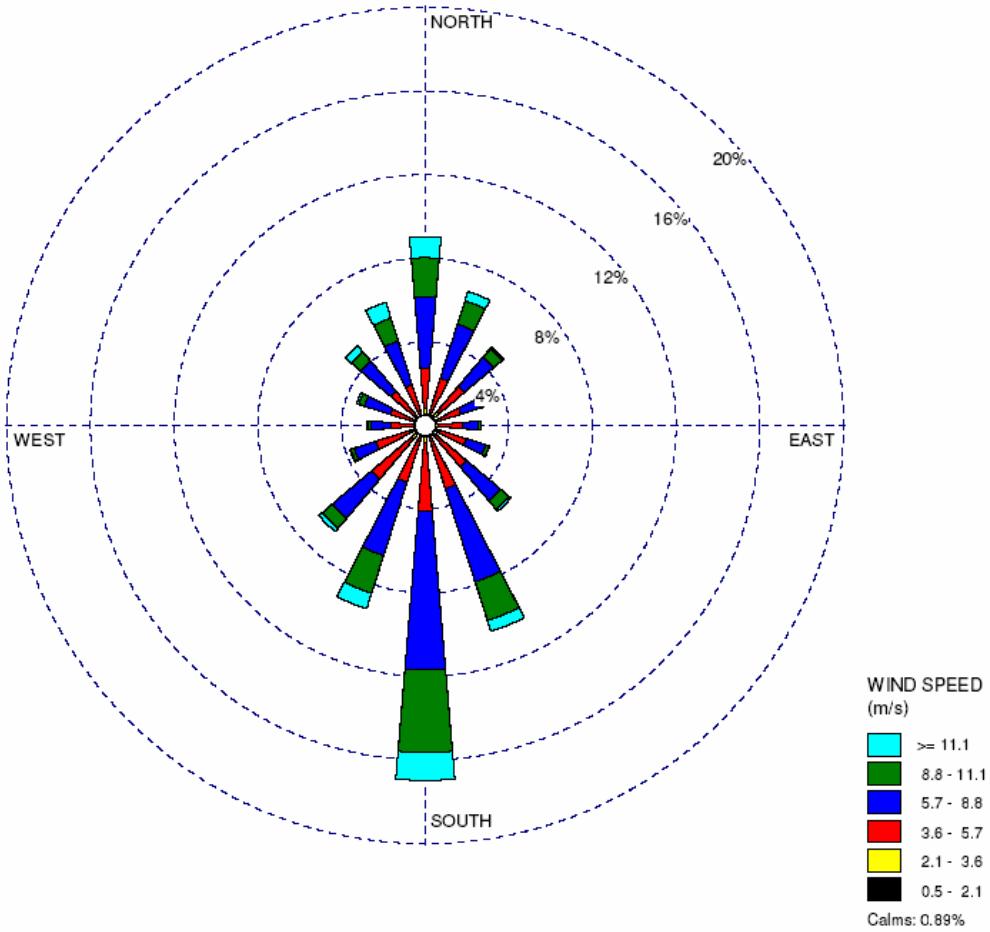
USEPA, 1998b. *Interagency Workgroup on Air Quality Modeling (IWAQM) Phase 2 Summary Report and Recommendations for Modeling Long Range Transport Impacts*, U.S. Environmental Protection Agency, EPA–454/R–98–019, December 1998.

USEPA, 2003. *Guidance for Estimating Natural Visibility Conditions Under the Regional Haze Rule*, Publication EPA-454/B-03-005, September.

VISTAS, 2006. *Protocol for the Application of the CALPUFF Model for Analyses of Best Available Retrofit Technology (BART).* Visibility Improvement State and Tribal Association of the Southeast (VISTAS) December 22, 2005 (Revision 2 – 3/9/06).

ATTACHMENT 2

WIND ROSE PLOT:	DISPLAY:
DODGE CITY REGIONAL AP **Station #13985**	Wind Speed Direction (blowing from)



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
DODGE CITY REGIONAL AP Station #13985	1984 1985 1986 1987 1988 1989 1990 1991 1992 Jan 1 - Dec 31 00:00 - 23:00	MODELER:	
	CALM WINDS: 0.89%	TOTAL COUNT: 78903 hrs.	
	AVG. WIND SPEED: 6.42 m/s	DATE: 10/24/2006	PROJECT NO.:

WRPLOT View - Lakes Environmental Software