Regional Haze

State Implementation Plan

December 2009

Minnesota Pollution Control Agency

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Executive Summary

The state of Minnesota is home to two federal Class I areas, the Boundary Waters Canoe Area Wilderness (BWCAW) and Voyageurs National Park (VNP), located along the state's border with Canada. In compliance with the Regional Haze Rule promulgated in 1999, the Minnesota Pollution Control Agency (MPCA) is submitting to the U.S. Environmental Protection Agency (EPA) this State Implementation Plan (SIP) to reduce haze and meet the goal of no man-made visibility impairment in the Class I areas by 2064.

Current visibility conditions, in deciviews, are:

	Baseline Conditions		Natural Conditions	
Class I area	20% Worst Days	20% Best Days	20% Worst Days	20% Best Days
BWCAW	19.9	6.4	11.6	3.4
VNP	19.5	7.1	12.2	4.3

The main pollutants contributing to visibility impairment in Minnesota's Class I areas are ammonium sulfate, ammonium nitrate, and organic carbon. Modeling indicates that the organic carbon is biogenic, so the MPCA chose to focus control measures on the anthropogenic emissions of nitrogen oxides (NO_X) and sulfur dioxide (SO_2) that lead to formation of nitrate and sulfate. The main contributors of SO_2 are electric generating units (EGUs), while the main contributors of NO_X are motor vehicles, both on and off road. The main states whose emissions contribute to visibility impairment in BWCAW and VNP are: Minnesota, Wisconsin, Illinois, Iowa, Missouri, and North Dakota.

Minnesota has several sources subject to Best Available Retrofit Technology (BART) requirements, namely EGUs and taconite pellet furnaces. Many of Minnesota's EGUs are planning or have begun emission reduction projects. The MPCA made BART determinations for each subject-to-BART EGU, though in many cases already planned controls were deemed equivalent to BART. For the taconite furnaces, BART for NO_X is an operating standard of good combustion practices in combination with some proposed process changes, while BART for PM is equivalent to the taconite Maximum Available Control Technology (MACT) standard, and BART for SO_2 is generally existing particulate scrubbers optimized for SO_2 removal. The MPCA is also requiring application of better emission measurement systems to set a NO_X BART emission limit, SO_2 limits at lines that burn high sulfur fuels, and determine compliance. Final BART emission limits, where not already available, will be submitted prior to the Five Year SIP Assessment.

Minnesota's long-term strategy includes the implementation of several federal programs, including BART and the Clean Air Interstate Rule (CAIR), over the next several years in Minnesota and the surrounding states. It also includes a target for a 30% reduction in combined NO_X and SO_2 emissions by 2018 from point sources in Northeastern Minnesota that emit over 100 tons per year of either NO_X or SO_2.

Based on the emission reductions currently known to be reasonable, Minnesota has established the following reasonable progress goals, in deciviews:

Class I area	20% Worst Days	20% Best Days
BWCAW	18.6	6.4
VNP	18.9	7.1

Minnesota will continue to evaluate control strategies that have shown the potential to result in reasonable emission reductions, and expects the contributing states to do the same. Due to this ongoing evaluation, Minnesota expects to submit additional control strategies and a revised reasonable progress goal in the Five Year SIP assessment.

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Regional Haze Glossary of Terms

- 20% Best Days – The days with the best visibility over the baseline or future period
- 20% Worst Days – The days with the poorest visibility over the baseline or future period
- BACT – Best Available Control Technology – Required for major sources or modifications under PSD.
- BART – Best Available Retrofit Technology – Requires controls on certain types of sources built between 1962 – 1977 and generally grandfathered under most Clean Air Act programs
- Baseline Conditions – Current visibility conditions, or visibility conditions over the baseline period
- Baseline Period – As required by rule, the years 2000 - 2004
- CAIR – Clean Air Interstate Rule – A cap and trade program covering 27 Eastern states to reduce emissions of NO_X and SO_2 from power plants.
- CAMx – Comprehensive Air quality Model with eXtensions - A computer modeling system for the integrated assessment of gaseous and particulate air pollution.
- CEMs – Continuous Emission Monitoring System
- CENRAP – Central Regional Air Planning Association – Regional planning organization covering the central portion of the U.S, including states and tribal areas of Nebraska, Kansas, Oklahoma, Texas, Minnesota, Iowa, Missouri, Arkansas, and Louisiana
- CIRA – Cooperative Institute for Research in the Atmosphere – Research institute contracted by the National Park Service to work on visibility information, including IMPROVE and VIEWS
- CMAQ – Community Multi-Scale Air Quality model – Air Quality model used by many states and RPOs for estimating visibility conditions.
- Deciview – Visibility unit used in the Regional Haze SIP; similar to a decibel, one deciview is the smallest change in visibility that is perceptive to the human eye.
- EMS – Emissions Modeling System - Generates hourly speciated emissions on a gridded basis for input to an air quality model.
- EGUs – Electric Generating Units – Utility power plants
- HYSPLIT4 - HYbrid Single-Particle Lagrangian Integrated Trajectory – Model for computing simple air parcel trajectories to complex dispersion and deposition simulations.
- IMPROVE – Interagency Monitoring of Protected Visual Environments – Cooperative program to monitor visibility in the Class I areas, http://vista.cira.colostate.edu/improve/
- LADCO – Lake Michigan Air Directors Consortium – Air quality planning organization for Illinois, Indiana, Michigan, Ohio, and Wisconsin; conducts air quality technical assessments
- MM5 – Mesoscale Meteorological Model – A numerical model for weather prediction on scales from continental to one km.
- Model Inventory – The emission inventory used in the atmospheric chemistry and transport modeling, usually different from the emission inventory submitted to the NEI.
- MRPO – Midwest Regional Planning Organization – Regional planning organization for regional haze, covering the Midwest states (Illinois, Indiana, Michigan, Ohio, and Wisconsin)
- Natural Conditions – Estimation of visibility without any man-made influence
- NEI – National Emission Inventory – Compilation of emissions by pollutant, source category, and geographic for each state; required by the EPA on a three-year cycle

- PiG – Plume in Grid – Tool within the modeling system to track individual plume segments from each point source, rather than immediately dispersing the individual point sources emissions into the grid cell.
- PSAT – Particulate Matter Source Apportionment Technology – Part of CAMx that tracks the original source of particulate species by geographic region and source category
- PSD – Prevention of Significant Deterioration – A program established by the Clean Air Act that limits the amount of additional air pollution that is allowed in Class I and Class II areas.
- RPG – Reasonable Progress Goal – Visibility goal for 2018 set by the state in the SIP; usually used to refer to the visibility goal for the 20% worst days
- SCC - Source Classification Code – Code used by EPA to classify different types of air quality inventory emission sources.
- SMOKE – Sparse Matrix Object Kernel Emission – EPA processor for preparation of emission data.
- SMP – Smoke Management Plan – Plan to reduce the impact of prescribed fire on air quality.
- URP – Uniform Rate of Progress – The constant rate of visibility improvement needed to meet natural conditions on the 20% worst days in 2064
- VIEWS – Visibility Information Exchange Web System – Web repository of visibility information, http://vista.cira.colostate.edu/views/

For a more detailed haze glossary, see:
http://vista.cira.colostate.edu/improve/Education/Glossary/glossary.htm

Chapter 1. Background and Overview

General Background / History of Federal Regional Haze Rule

In amendments to the Clean Air Act (CAA) in 1977, Congress added Section 169 (42 U.S.C. § § 7491), setting forth a national visibility goal of restoring pristine conditions in national parks and wilderness areas. These areas were designated as Class I areas, because of their general nature as areas most free from air pollution and visibility problems. Section 169 states:

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

Over the following years modest steps were taken to address the visibility problems in Class I areas. The control measures taken mainly addressed "plume blight," the visual impairment of air quality that manifests itself as a coherent plume from specific pollution sources, such as a power plant smoke stack, emitting pollutants into a stable atmosphere. These plume blight control measures did little to address regional haze issues in the Eastern United States.

When the CAA was again amended in 1990, Congress added Section 169B (42 U.S.C. § § 7492), authorizing further research and regular assessments of the progress made towards visibility goals. In 1993, the National Academy of Sciences concluded "current scientific knowledge is adequate and control technologies are available for taking regulatory action to improve and protect visibility."[1]

Section 169B(f) of the CAA authorized creation of visibility transport commissions and set forth their duties, and specifically mandated creation of the Grand Canyon Visibility Transport Commission (GCVTC) to make recommendations to the U.S. Environmental Protection Agency (EPA) for the region affecting visibility in Grand Canyon National Park. After four years of research and policy development, GCVTC submitted its report to EPA in June 1996.[2] This report, as well as other research reports prepared by GCVTC, contributed information to EPA's development of the federal Regional Haze Rule (RHR).

EPA's Regional Haze Rule was adopted July 1, 1999, and went into effect on August 30, 1999. The RHR is intended to achieve national visibility goals by 2064. The rulemaking addressed the combined visibility effects of various pollution sources over a wide geographic region, meaning that many states – even those without Class I areas – are required to participate in haze reduction efforts. EPA designated five Regional Planning Organizations (RPOs) to assist with the coordination and cooperation needed to address visibility and haze issues. Those states and tribes that make up the midsection of the contiguous United States, including Minnesota, were designated as the Central Regional Air Planning Association (CENRAP).

On May 24, 2002 the U. S. Court of Appeals, D. C. Circuit Court, ruled on a challenge to the RHR brought by the American Corn Growers Association. The Court denied industry's challenge to the rule's goals of natural visibility and no degradation, and remanded to EPA the Best Available Retrofit Technology (BART) provisions of the rule.[3]

EPA proposed rule revisions pursuant to the remand, and final amendments to the Regional Haze Rule and guidelines for BART were finalized on June 15, 2005. In the initial rule, EPA had required states to consider the collective impact of BART sources on visibility. The Court ruled that this unfairly

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[1] National Research Council, Commission on Geosciences, Environment and Resources, 1993.
[2] GCVTC, 1996.
[3] American Corn Growers Association v. EPA.

constrained the states' otherwise broad authority to make BART determinations, and so subsequent revisions give states more discretion and provide a process for states to consider BART determination on a facility-by-facility basis.

Minnesota's Class I areas

Minnesota has two Federal Class I areas within its borders: the Boundary Waters Canoe Area Wilderness and Voyageurs National Park.

The Boundary Waters Canoe Area Wilderness (BWCAW) is part of the Superior National Forest, which was established by Presidential proclamation in 1909. BWCAW is a 1-million acre federally designated wilderness; it is the only wilderness of substantial size east of the Rocky Mountains and north of the Everglades and is the most heavily used wilderness area in the United States with about 200,000 annual visitors. The Boundary Waters Canoe Area Wilderness Act, which banned logging and mining, phased-out snowmobiling, and limited motorboat use in BWCAW, was signed by President Jimmy Carter on October 21, 1978.[4]

Voyageurs National Park (VNP) is a water-based park named for the French-Canadian voyageurs that traveled through the area in canoes while trading fur and other goods. Designation as a National Park was first proposed in 1891, and Voyageurs was officially established as a National Park in 1975. VNP covers 218,054 acres on the northern border of Minnesota, abutting BWCAW and sharing 55 miles of the Canadian border.[5]

Minnesota has not had an approved Visibility Plan for its Class I areas, and has b een under a federal implementation plan for visibility as designated in 40 CFR 52.26, 52.28 and 52.29.

In accordance with the Regional Haze Rule, Minnesota has determined that emission sources within Minnesota have or may have impacts both on the Class I areas within Minnesota (BWCAW and VNP) and on the Isle Royale Class I area in the state of Michigan. Therefore, Minnesota submits this SIP to fulfill the requirements of the Regional Haze Rule and help reduce visibility impairment in the Northern Class I areas mentioned above.

In addition, Minnesota believes that improved visibility and the removal of haze-causing particles from the atmosphere in order to promote increased visibility in Class I areas will result in environmental and economic benefits and improved health for Minnesota's citizens and those in areas downwind of Minnesota. Benefits of improved visibility can be found in Appendix 1.1.

To facilitate the review of this State Implementation Plan (SIP) by the EPA, Federal Land Managers (FLMs), stakeholders and the public, Appendix 1.2 provides a modified version of EPA's SIP submittal checklist, which serves as a guide to locating 40 CFR 51.308 requirements.

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[4] BWCAW and U.S.D.A., Forest Service. *Boundary Waters Canoe Area Wilderness* and *Superior National Forest* (web pages)

[5] U.S. National Park Service, Voyageurs National Park (webpage)

Chapter 2. General Planning Provisions

Pursuant to the requirements of 40 CFR 51.308(a) and (b), Minnesota submits this SIP to comply with the Regional Haze Rule, adopted to meet the requirements set forth in the Clean Air Act. Elements of this plan address the core requirements pursuant to 40 CFR 51.308(d) and the Best Available Retrofit Technology (BART) components of 40 CFR 51.308(e). In addition, this SIP addresses Regional Planning, state and FLM coordination, and contains a commitment to provide ongoing plan revisions and adequacy determinations.

The Minnesota Pollution Control Agency (MPCA) has the legal authority to adopt this SIP revision and has done so in accordance with state laws and rules. MPCA's legal authority and compliance with state procedures is documented through a letter from the Minnesota Attorney General's office, attached as Appendix 2.1.

Minnesota provided multiple opportunities for stakeholders to comment on the technical background and other issues regarding the development of this SIP, both informally and through the formal public notice and comment period. The following table lists non-mandatory stakeholder meetings held by the MPCA, along with the public meeting. Stakeholders were encouraged to comment informally throughout the SIP development process, and updates were posted on the MPCA's Minnesota Regional Haze Plan webpage.[6]

Table 2.1: Stakeholder and Public Meetings

Date	Subject and Content
January 31, 2007	Review of Technical Information
April 12 – April 27, 2007	Meetings with individual stakeholder groups concerning long-term strategy (Northeast Minnesota Plan)
May 15, 2007	Update of technical information Control Strategy Analysis Long-term Strategy
October 23, 2007	Draft Regional Haze SIP is Information Item at MPCA Citizens' Board
April 10, 2008	Official public meeting on Draft Regional Haze SIP.
May 7, 2008	Stakeholder conference call on Draft Regional Haze SIP
June 24, 2008	Final Initial Regional Haze SIP Information Item at MPCA Citizens' Board
September 22, 2009	Revised Draft Regional Haze SIP Information Item at MPCA Citizens' Board
October 27, 2009	Revised Draft Regional Haze SIP Decision Item at MPCA Citizens' Board
December 15, 2009	Continuation of Revised Draft Regional Haze SIP Decision Item at MPCA Citizens' Board

A public notice of the opportunity to comment on the SIP was published on February 25, 2008 in the Minnesota State Register and contained notice of a public meeting to be held on April 10, 2008, with the comment period to close on April 16, 2008. The comment period was later extended to May 16, 2008.

[6] Addresses for all web pages referenced in this document can be found the in "References and Guidance Documents" section.

During the initial public notice period, the draft SIP document was made available on the MPCA's Regional Haze webpage. In addition, a copy was made available at MPCA's Headquarters, 520 Lafayette Road N., Saint Paul, Minnesota and at MPCA's regional office in Duluth.

Copies of the initial public notice and the notice of extension are attached in Appendix 2.2. A notice of the SIP revision and public comment period was also emailed to the MPCA's list of stakeholders interested in regional haze and placed on MPCA's public notice and Regional Haze web pages. Minnesota held an official public meeting regarding the SIP revision on April 10, 2008; the meeting was based in St. Paul with videoconferencing to Duluth. Documentation of the public meeting is included in Appendix 2.3.

Public comments made during the notice period and at the public meeting are included in Appendix 2.4. MPCA's response to the comments is also provided, which describes how MPCA considered and incorporated public comments into this final SIP document.

The MPCA's response to comments, along with Minnesota's proposed removal from the Clean Air Interstate Rule, necessitated several changes to the SIP. The MPCA communicated with the stakeholders, including the Federal Land Managers, who had made the most extensive comments on the initial draft SIP. These stakeholders made some interim comments, and requested that the MPCA place the SIP back on public notice. The interim comments are included in Appendix 2.5, along with the MPCA's response, and were included in the public notice of the revised SIP. The second public notice is included in Appendix 2.2. Comments received on the revised SIP and the MPCA's response are included in Appendix 2.6.

Chapter 3. Regional Planning and State Consultation

Because regional haze is caused by a wide variety of pollution sources dispersed over a large geographic area, the Regional Haze Rule places specific emphasis on having states work collaboratively through regional planning and consultation processes.

Regional Planning

In 1999, EPA and affected states/tribes agreed to create five RPOs to facilitate interagency coordination on Regional Haze implementation plans. Minnesota is a member of the Central Regional Air Planning Association (CENRAP). MPCA has also worked extensively with the Lake Michigan Air Directors Consortium/Midwest Regional Planning Organization (LADCO/MRPO),[7] because several states in MRPO have emissions that impact Minnesota's Class I areas and Minnesota has emissions that impact a Class I area located in Michigan.

Members of CENRAP include the states of Arkansas, Iowa, Kansas, Louisiana, Minnesota, Missouri, Nebraska, Oklahoma, and Texas; Tribes whose lands are within the geographical borders of these states are also members. Figure 3.1 shows a map of all five regional planning organizations.

Figure 3.1: Geographical Areas of Regional Planning Organizations

The governing body of CENRAP is the Policy Oversight Group (POG). The POG is made up of 18 voting members representing the states and tribes within the CENRAP region and non-voting members representing local agencies, EPA, the Fish and Wildlife Service, Forest Service, and National Park Service. The POG facilitates communication with Federal Land Managers (FLMs), stakeholders, the public, and with CENRAP staff.

Since its inception, CENRAP has established an active committee structure to address both technical and non-technical issues related to regional haze. This includes five standing workgroups: Data Analysis and

[7] LADCO was formed to provide air quality technical assessments and assistance for Illinois, Indiana, Michigan, Ohio and Wisconsin; MRPO was formed to coordinate Regional Haze planning for those same states. LADCO was designated to receive federal funds on behalf of MRPO.

Monitoring; Emission Inventory; Modeling; Communications; and Implementation and Control Strategies. Participation in workgroups is open to all interested parties. Ad hoc workgroups may be formed by the POG to address specific issues. Ultimately, policy decisions are made by the POG.

Consultation Across RPOs

CENRAP has adopted the approach that the RHR requires the "states to establish goals and emission reduction strategies for improving visibility in all 156 mandatory Class I parks and wilderness areas," and has provided a forum and structure for states to work together to achieve these goals.

Minnesota also believes that the RHR encourages states and tribes to work together in regional partnerships beyond the RPOs when necessary, to ensure that each Class I host state consults with all those states whose emissions impact its Class I areas.

Technical Consultation

Minnesota participated in extensive consultation on technical work, both with CENRAP and MRPO. Like CENRAP, MRPO decisions and directions are established by the Air Directors from each state and are carried out by the technical workgroups. Although Minnesota does not actively participate in MRPO decision-making or communication processes, Minnesota staff members have actively participated in MRPO technical committees.

CENRAP has an administrative director and a technical director. The technical committees are run by co-chairs, which are staff volunteers from CENRAP affiliated states and Tribes, or representatives from industry with interests within the geographic area. Nearly all CENRAP technical work is conducted through contracts; mainly by ENVIRON and University of California-Riverside.

MRPO has an administrative/technical director. The technical committees are run by MRPO staff. All technical work is coordinated by MRPO staff, and much of the technical work is conducted by MRPO staff with assistance from both member state staff and contractors. Table 3.1 lists the technical committee structure and Minnesota staff that actively participated in each technical committee. Technical committees in both organizations include representatives from states, EPA, FLMs, tribes and industry.

Table 3.1: Technical Committee Structure for CENRAP and MRPO, and Minnesota Participants

CENRAP: Administrative Director- Annette Sharp, Technical Director – Jeff Peltola*		
Committee	**Leader (co-chair)**	**Minnesota Participant**
Data Analysis and Monitoring	Brandon Krogh* (Minnesota Power) Scott Weir (Kansas)	Gordon Andersson gordon.andersson@pca.state.mn.us
Emission Inventory	Wendy Vit (Missouri)	Michael Smith michael.smith@pca.state.mn.us
Modeling	Lee Warden (Oklahoma)* Calvin Ku (Missouri)	Margaret McCourtney margaret.mccourtney@pca.state.mn.us
Implementation and Control Strategies	Mark McCorkle (Arkansas) John Seltz (Minnesota)	John Seltz john.seltz@pca.state.mn.us
MRPO: Administrative/Technical Director- Mike Koerber		
Committee	**Leader**	**Minnesota Participant**
Data Analysis and Monitoring	Donna Kenski	N/A
Emission Inventory	Mark Janssen	Chun Yi Wu chunyi.wu@pca.state.mn.us Margaret McCourtney margaret.mccourtney@pca.state.mn.us
Modeling	Kirk Baker*	Margaret McCourtney margaret.mccourtney@pca.state.mn.us

*These leaders no longer hold the position, but had either significant or sole contribution to the work.

Communication among technical committee members to develop consensus on various issues was conducted through conference calls and meetings during SIP development as follows:

CENRAP calls and meetings:

- Data Analysis and Monitoring – Monthly conference calls;
- Emission Inventory – Calls on an as needed basis; no calls from May 2005 through May 2007. Met in joint conference call with modeling from June – September 2007;
- Modeling – Bi-weekly conference call.

Meetings are scheduled for all CENRAP participants and the POG two to four times per year as funding allows.

MRPO calls and meetings:

- Data Analysis and Monitoring – Not applicable. Minnesota is not an active participant;
- Emission Inventory – Monthly and/or as needed depending on needs for project input;
- Modeling – Monthly and/or as needed depending on needs for project input.

Meetings are scheduled separately for each technical committee, as new technical information is made available where sharing information is best done in person. The emissions inventory technical committee has exclusively shared information by conference call and e-mail. The modeling technical committee meets up to two times per year. Because of its centrally located staff, MRPO also communicates and provides data, tools and information individually to states based on specific needs.

This SIP mainly utilizes modeling inputs and results developed by MRPO, along with some MRPO data analysis and technical support work. It also includes modeling and data analysis generated by the MPCA. The SIP also includes data analysis and other technical support documents prepared for CENRAP, and CENRAP modeling work primarily as supporting information.

CENRAP data analyses, modeling results and other technical support documents were provided to CENRAP members through either CENRAP's website or through a file transfer protocol (ftp). Similar information sharing was done using the LADCO website and LADCO agreed to house documents related to the Northern Class I area consultation process on its website.

State Consultation

A chief purpose of the RPO is to provide a means for states to confer on all aspects of regional haze, including consulting on reasonable progress goals and long-term strategies based on determinations of baseline and natural visibility conditions. CENRAP has provided a forum for the member states and Tribes to consult on the determination of visibility conditions in each of the Class I areas.

Minnesota has worked with states that are members of CENRAP, MRPO, and the Western Regional Air Partnership (WRAP) to convene meetings of representatives from the states and Tribes that impact visibility in the four Northern Class I areas – BWCAW and VNP in Minnesota along with Isle Royale National Park and Seney Wilderness in Michigan – along with FLMs and EPA representatives involved with the Northern Class I areas. This group engaged in extensive consultation about visibility conditions and control strategies needed to improve visibility at these four Class I areas.

By coordinating with CENRAP, MRPO and the other states whose emissions impact visibility in our Class I areas, Minnesota has worked to ensure that our BART determinations and the control strategies that comprise our long-term strategy provide sufficient reductions to mitigate the impact of emissions from sources inside Minnesota on affected Class I areas, as well as to encourage other states to take necessary measures to help improve visibility in the Class I areas located within Minnesota.

Northern Class I Area Consultation

As described above, consultation among states is a requirement of the Regional Haze Rule. As part of the long-term strategy for regional haze, a state whose emissions are "reasonably anticipated" to contribute to impairment in other states' Class I area(s) must consult with those states; likewise, a Class I host state must consult with those states whose emissions affect its Class I area(s) (40 CFR 51.308(d)(3)). Because many states that impact visibility in BWCAW and VNP are located outside of CENRAP, the MPCA helped convene the Northern Class I area Consultation process to ensure that Minnesota met the requirement of consulting with all states whose emissions may impact visibility in our Class I areas.

Participants

The Northern Class I areas consultation process concerned visibility in BWCAW and VNP along with Isle Royale National Park and Seney Wilderness in Michigan, and included the states of Minnesota, Michigan, North Dakota, Wisconsin, Iowa, Illinois, Indiana, and Missouri. The consultation process also included representatives from other governments, such as the Ontario Ministry of the Environment and Tribes including the Leech Lake Band of Ojibwe, Mille Lacs Band of Ojibwe, Fond du Lac Band of Lake Superior Chippewa, Grand Portage Band of Chippewa, Upper/Lower Sioux, and Huron Potawatomi.

The Northern Class I consultation process included representatives from federal agencies, including Federal Land Managers from the U.S. Department of the Interior National Park Service and U.S.D.A Forest Service, as well as representatives from EPA. Along with participation in CENRAP, this partially fulfills Minnesota's requirement under 40 CFR 51.308(i) to coordinate and consult with FLMs on areas such as implementation, assessment of visibility impairment, and recommendations regarding the reasonable progress goal and strategies for improvement. More specifics on Minnesota's consultation with FLMs are treated in Chapter 4.

Process

In 2004 and 2005, a number of discussions were held between state and tribal representatives in the upper Midwest concerning air quality planning to address regional haze in the four Class I areas in Michigan and Minnesota. This process included several conference calls and a meeting in Madison, Wisconsin held on May 24, 2005.

Formal discussions geared toward specific SIP requirements began in July 2006, when Minnesota met in conference call with representatives from North Dakota, Iowa, Wisconsin, Michigan, the Mille Lacs and Leech Lake bands of Ojibwe, and FLMs, RPO and EPA representatives. This group determined that additional parties should be added to the process and that this group should continue to meet through conference calls approximately every three weeks during the development of the regional haze SIPs.

The first several months of calls focused on developing an agreed-upon technical base of information about the visibility conditions in the four Class I areas. This included documenting baseline and natural visibility conditions, and determining the chemical constituents of haze and key contributors of visibility-impairing emissions (geographical and sources and source categories). The shared technical work is documented in a technical memo "Regional Haze in the Upper Midwest: Summary of Technical Information," which is attached as Appendix 3.1.

The consultation group also shared modeling results, discussed visibility improvement expected to result from on-the-books controls, and discussed BART and other control strategies. As part of the consultation process, LADCO managed a contract where various control strategies were evaluated based on the designated four factors; the consultation group provided input to LADCO on each part of the project. The control strategies that were evaluated included: on-the-books controls (as a reference point for reasonableness under the four factors), various sector level controls, and some facility specific control measures. (See Chapter 10 and Appendix 10.5).

The states involved in the consultation group also collaborated to ensure that a consistent future year scenario was used by all states. For example, the states agreed to use version 3.0 of EPA's Integrated Planning Model (IPM) as the basic prediction for EGU emissions in 2018. Further information is provided in Chapters 8 and 10.

In September 2007 the MPCA sent a letter to the states involved in the Northern Class I areas consultation process. This letter contained formal notification of the states that Minnesota is listing in this SIP as causing or contributing to visibility impairment in VNP and BWCAW. It also contained information on Minnesota's proposed process for setting the Reasonable Progress Goals (RPG) for its Class I areas, and asked states and tribes to formally respond with an acknowledgement of their participation in the consultation process and their belief that the consultation process could be successfully concluded or an indication of what other issues should be discussed.

Although Minnesota had not yet set the RPGs for VNP and BWCAW when the consultation letter was sent out, the MPCA's letter indicated that additional control measures (beyond on-the-books controls, BART, CAIR, and the Northeastern Minnesota plan) were likely to be reasonable for both Minnesota and the contributing states. Minnesota committed to evaluating additional control measures and including a plan for implementing reasonable controls in the Five Year SIP Assessment. The MPCA requested that the five contributing states (Illinois, Iowa, Missouri, North Dakota, and Wisconsin) make the same commitment. In particular, Minnesota asked Iowa, Missouri, North Dakota and Wisconsin to evaluate the reasonableness of reductions of SO_2 from EGUs to reach a statewide rate of 0.25 lbs/MMBtu, and asked North Dakota to evaluate NO_X emission reductions from EGUs.

In response, the Missouri DNR indicated that they do not believe they are significant contributors to visibility impairment in Minnesota's Class I areas, and that evaluation of additional controls would not be reasonable. Iowa indicated that they cannot commit to controls beyond CAIR, and that the cost in $/ton of additional reductions is greater than the cost of complying with CAIR and therefore not cost-effective for visibility improvement. North Dakota provided only an informal response, but indicated that a lb/MMBtu comparison for EGUs is not reasonable, and that Minnesota should demonstrate that its EGUs have spent an equivalent amount (on a $/dv basis) as is being requested from out of state sources.

A copy of Minnesota's letter (and the responses received) can be found in Appendix 3.2. More information on the RPG and the state responses is in Chapter 10. The MPCA continues to believe that our request that the contributing states at least evaluate control measures beyond CAIR, BART and on-the-book controls, report on that evaluation in the Five Year SIP Assessment, and undertake reasonable additional controls, is a reasonable request. The MPCA requests that EPA take this into consideration when reviewing the SIPs of contributing states.

All documentation of the Northern Class I areas consultation process can be found on the LADCO/ MRPO website.[8] This webpage includes documentation of the minutes from each group conference call, including a list of participants, as well as various other documents related to the Northern Class I consultation process. These minutes and documents will show the major decisions that the members of the Northern Class I consultation process felt were important to discuss and document at the group level.

8 MRPO, *Regional Haze Consultation – Northern Class I areas*.

Chapter 4. State and Federal Land Manager Coordination

Coordination between states and the Federal Land Managers (FLMs) is required by 40 CFR 51.308(i). Minnesota's Class I areas are managed by the National Park Service (VNP) and the U.S. Forest Service (BWCAW). FLMs are an integral part of CENRAP's POG and have membership on standing committees, and have therefore contributed to both the technical and non-technical work used in the development of this SIP. In addition, opportunities have been provided by CENRAP for FLMs to review and comment on each of the technical documents developed by CENRAP and included in this SIP. FLMs were also key participants in the Northern Class I consultation calls. Minnesota provided agency contacts to the FLMs as required by 40 CFR 51.308(i)(1).

Consultation During SIP Development

In development of the SIP, the FLMs were consulted in accordance with the provisions of 40 CFR 51.308(i)(2). The MPCA provided FLMs an opportunity for consultation, in person and at least 60 days prior to holding any public hearing on the implementation plan.

The MPCA consulted with the FLMs to discuss the land managers':

- Assessment of the impairment of visibility in any Class I areas;
- Recommendations on the development of reasonable progress goals; and
- Recommendations on the development and implementation of strategies to address visibility impairment.

In addition to discussions on the SIP through the RPO framework, Minnesota and the other states involved in consultation about visibility in the four Northern Class I areas included FLMs in the ongoing discussions. FLMs were therefore able to give their comments about the technical work and control strategies under discussion by the states throughout the period of regional haze SIP development, as well as the determination of the reasonable progress goals. The decisions made and documented in the Northern Class I calls (see Chapter 3) included FLM input, as can be seen in the minutes and documentation of call participants.

The MPCA also extended invitations to several FLMs to participate in informal stakeholder meetings in January and May 2007, and several did take the opportunity to attend those meetings and hear about the MPCA's haze SIP development.

The MPCA also consulted with the FLMs on BART and the BART strategy for Minnesota as published in the State Register (see Appendix 9.2). Consultation between the MPCA and the FLMs continued as BART analyses prepared by facilities were made available online and the MPCA began the process of BART determinations.

The MPCA also had direct and extensive consultation with FLMs from the National Park Service and Forest Service in developing a strategy to address visibility impairment resulting from emissions from new and existing sources in the geographic area of Minnesota in closest proximity to the Class I areas. MPCA staff members met in conference calls over the course of several months beginning in the spring of 2007 with a small group of FLMs involved with Minnesota's Class I areas. The FLMs involved included: Bruce Polkowsky, Don Shepherd, John Bunyak, David Pohlman, and Chris Holbeck of the National Park Service and Trent Wickman of the Forest Service.

This consultation process resulted in the plan for Northeast Minnesota that is part of Minnesota's long-term strategy for reducing regional haze (Chapter 10, Appendix 10.4), which will be implemented through this SIP and a Memorandum of Understanding between Minnesota and the federal land management agencies. The MPCA and the FLMs also worked together to share the plan with stakeholders through the early summer of 2007.

MPCA provided the FLMs with early drafts of portions of this SIP submittal, particularly the portions concerning the RPG and long-term strategy. An informal draft of much of the SIP was provided to several of the FLMs mentioned previously during a face-to-face meeting between MPCA staff members and the FLMs at VNP on September 20 and 21, 2007, and emailed at that time to the Regional Haze Coordinators for the Forest Service and Fish and Wildlife Service. The MPCA invited comments on the early draft SIP.

Official Notice and Consultation

MPCA sent the full draft SIP to the FLMs on February 4, 2008. Minnesota notified the FLMs of all stakeholder meetings, and the official public meeting held on April 10, 2008.

Comments received from the FLMs are included in with the public comments in Appendix 2.4. Minnesota considered and incorporated the FLMs comments on the SIP draft as described in the Response to Comments documents, also in Appendix 2.4. All FLM comments received prior to the public meeting were discussed, along with MPCA's initial response, at the public meeting.

As the MPCA worked to respond to FLM comments, such as a request that BART determinations be made for EGUs, the MPCA continued to share information with the FLMs. This included draft and revised BART determinations for Minnesota's subject-to-BART EGUs. FLM comments on these BART determinations are included in Appendix 2.5, under the heading "Response to Interim Comments on Revised Regional Haze SIP." These comments and the MPCA's response were included in the public notice period of the revised SIP.

Minnesota will continue to coordinate and consult with the FLMs during the development of future progress reports and plan revisions, as well as during the implementation of programs having the potential to contribute to visibility impairment in the mandatory Class I areas.

The plan for Northeast Minnesota and the MPCA's agreement with the FLMs specifically require consultation in order to ensure that the long-term strategy goals are being met.

The FLMs must continue to be consulted in the following instances:

- Development and review of implementation plan revisions;
- Review of 5-year progress reports; and
- Development and implementation of other programs that may contribute to impairment of visibility in Class I areas.

Coordination and consultation will continue to occur, as needed, through CENRAP and the Northern Class I consultation process, and the MPCA will continue to consult with the FLMs directly.

Chapter 5. Assessment of Visibility Conditions in Class I areas

Baseline, Natural and Current Conditions

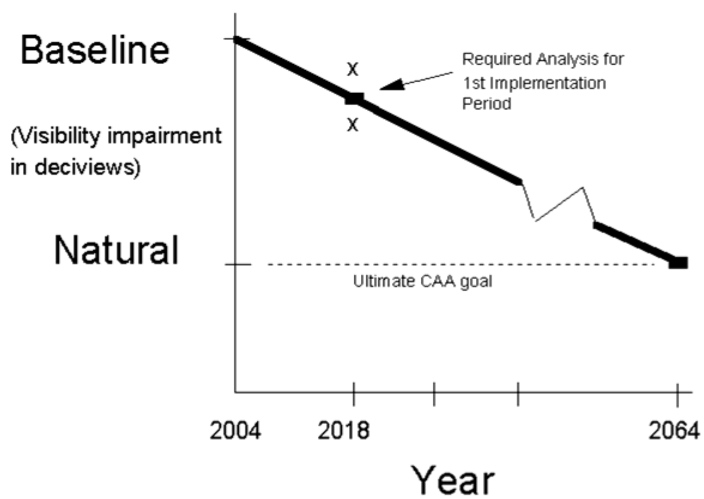
The goal of the RHR is to restore natural visibility conditions to the 156 Class I areas identified in the 1977 Clean Air Act Amendments by mitigating all human-caused impairment of visibility. As stated in the rule, "natural conditions includes naturally occurring phenomena that reduce visibility as measured in terms of light extinction, visual range, contrast, or coloration" (40 CFR 51.301(q)). Regional Haze SIPs must contain measures that make "reasonable progress" toward the natural visibility goal by reducing anthropogenic emissions that cause haze. For each Class I area, there are three visibility metrics that are part of determining reasonable progress:

- Baseline conditions
- Natural conditions
- Current conditions

Each of the three metrics includes the concentration data of the visibility pollutants as individual terms in the light extinction algorithm, with respective extinction coefficients and relative humidity factors. Total light extinction when converted to deciviews (dv) is calculated for the average of the 20 percent best and 20 percent worst visibility days. Most information on visibility data, including calculations of conditions, is housed on the web through the Visibility Information Exchange Web System (VIEWS).

"Baseline" visibility is the starting point for the improvement of visibility conditions. It is the average of the Interagency Monitoring of Protected Visual Environments (IMPROVE) monitoring data for 2000 through 2004 and can be thought of as "current" visibility conditions for this initial period. The comparison of initial baseline conditions to natural visibility conditions indicates the amount of improvement necessary to attain natural visibility by 2064. If states achieve visibility improvement at a constant rate over 60 years, visibility conditions will improve along the glide slope shown in Figure 5.1.

Figure 5.1: Uniform Rate of Progress (URP) to Achieve Natural Conditions in 60 Years



Natural visibility is determined by estimating the natural concentrations of visibility impacting pollutants and then calculating total light extinction with the light extinction algorithm. Each state must estimate natural visibility levels for Class I areas within its borders in consultation with FLMs and other states (40 CFR 51.308(d)(2)). After the initial baseline (2000 – 2004) period, "current conditions" are to be assessed every five years as part of the SIP review where actual progress in reducing visibility impairment is compared to the goals set in the SIP.

Default and refined values for natural visibility conditions

EPA guidance provides states with a "default" estimate of natural visibility.[9] The default values of concentrations of visibility impairing pollutants are based on a 1990 National Acid Precipitation Assessment Program report.[10] In the guidance, the United States is divided into "East" and "West" along the western boundary of the states one tier west of the Mississippi River. This divides the CENRAP states between the two areas: "East" which includes Arkansas (AR), Iowa (IA), Louisiana (LA), Minnesota (MN), and Missouri (MO) with seven Class I areas, and "West" which includes Kansas (KS), Nebraska (NE), Oklahoma (OK), and Texas (TX) with three Class I areas.

In the guidance, EPA also provides that states may use a "refined approach" to estimate the values that characterize the natural visibility conditions of the Class I areas. The purpose of refinement would be to provide more accurate estimates with changes to the extinction algorithm that may include concentration values; factors to calculate extinction from a measured particular species and particle size; extinction coefficients for certain compounds; geographical variation (by altitude) of a fixed value; and/or the addition of visibility pollutants. States can choose between the default and refined equations.

One equation is used to calculate baseline and current conditions of visibility due to haze-causing pollutants; using natural concentrations of the same pollutants, the same equation is used to calculate natural visibility.

The original (default) algorithm:

$$\begin{aligned} b_{ext} \approx\ & 3\times f(RH)\times [Sulfate] \\ & + 3\times f(RH)\times [Nitrate] \\ & + 4\times [Organic\ Carbon] \\ & + 10\times [Elemental\ Carbon] \\ & + 1\times [Fine\ Soil] \\ & + 0.6\times [Coarse\ Mass] \\ & + 10 \end{aligned}$$

The new (refined) algorithm:

$$\begin{aligned} b_{ext} \approx\ & 2.2\times f_S(RH)\times [Small\ Sulfate] + 4.8\times f_L(RH)\times [Large\ Sulfate] \\ & + 2.4\times f_S(RH)\times [Small\ Nitrate] + 5.1\times f_L(RH)\times [Large\ Nitrate] \\ & + 2.8\times [Small\ Organic\ Carbon] + 6.1\times [Large\ Organic\ Carbon] \\ & + 10\times [Elemental\ Carbon] \\ & + 1\times [Fine\ Soil] \\ & + 1.7\times f_{SS}(RH)\times [Sea\ Salt] \\ & + 0.6\times [Coarse\ Mass] \\ & + Rayleigh\ Scattering\ (site\ specific) \\ & + 0.33\times [NO_2\ (ppb)] \end{aligned}$$

[9] U.S. EPA, 2003a.
[10] Trijonis, 1990.

The New (or refined) IMPROVE equation is nonlinear in sulfate (SO_4), nitrate (NO_3) and organic mass carbon (OMC) concentrations, accounting for the different light scattering efficiency characteristics as a function of concentrations for these three species. The total sulfate, nitrate and organic mass are each split into two fractions, representing small and large size distributions of those components. New terms have been added for Sea Salt (important for coastal areas) and for light absorption by NO_2, where NO_2 observations are available. (These observations are not available for Minnesota, so this component was not used; it is also not included in the original IMPROVE equation.) Site-specific Rayleigh scattering for each IMPROVE monitoring site is used in the new equation, as compared to a constant value assumed in the original equation.

The choice between use of the default or the refined equation for calculating the visibility metrics for each Class I area is made by the state in which the Class I area is located. According to 40 CFR 51.308(d)(2), the state will make the determinations of baseline and natural visibility conditions. It is with these calculations and in consultation with other states whose emissions affect visibility in that Class I area (40 CFR 51.308(d)(1)(iv)) that the state develops a reasonable progress goal for each Class I area.

Because the refined equation better fits the observed light extinction values, Minnesota has used the refined IMPROVE equation to calculate visibility metrics and develop its reasonable progress goals. This is consistent with the approach taken by surrounding states; the CENRAP states and those participating in the Northern Class I area consultation process have also elected to perform their primary visibility projections using the new IMPROVE equation. For comparison, calculations based on the old IMPROVE equation are shown in Appendix 5.3.

Using the refined equation, the MPCA has determined that natural visibility conditions for BWCAW are best represented by an average of 11.6 deciviews for most impaired days and 3.4 deciviews for the least impaired days. Natural visibility conditions for VNP are best represented by 12.2 deciviews for most impaired days and 4.3 deciviews for the least impaired days.

Consultation regarding the visibility metrics

As mentioned previously, Minnesota consulted with the states that impact BWCAW and VNP on the visibility metrics in those Class I areas. The states discussed which equation to use to calculate the visibility conditions as well as which values to use for baseline and natural conditions, particularly due to some data substitution done on the monitored data, described later. This consultation process is documented in Chapter 3.

Baseline Visibility Conditions

Baseline conditions represent visibility for the 20% best (B20%) and 20% worst (W20%) visibility days for the initial five-year baseline period of the regional haze program. Baseline conditions are calculated using IMPROVE monitor data collected during 2000-2004 and are the starting point in 2004 for the 2018 uniform rate of progress (URP) goal and 2018 visibility projections.

Baseline conditions were calculated as follows:[11]

<u>A. Using monitored data, rank baseline visibility for each day with PM_{10}, $PM_{2.5}$ and speciated $PM_{2.5}$ measurements within a Class I area.</u>

1. Obtained $PM_{2.5}$ speciated monitored data from VIEWs with inclusion of missing data from MRPO;

[11] U.S. EPA, OAQPS. 2007a.

2. Estimate extinction coefficient for each day using the new IMPROVE equation[12] adopted by the IMPROVE Steering Committee in December 2005:[13]

b_{ext} = 2.2 * f_S(RH) * [small sulfate] + 4.8 * f_L(RH) * [large sulfate]
+ 2.4 * f_S(RH) * [small nitrate] + 5.1 * f_L(RH) * [large nitrate]
+ 2.8 * [small organic mass] + 6.1 * [large organic mass]
+ 10 * [elemental carbon]
+ 1 * [fine soil]
+ 1.7 * f_{SS}(RH) * [sea salt]
+ 0.6 * [coarse mass]
+ Rayleigh scattering (site specific—BOWA1= 11, VOYA2 = 12)
+ 0.33 * [NO_2 (ppb)]

where:

b_{ext} is calculated total light extinction in inverse megameters
f_S(RH) is the relative humidity adjustment factor for small particles;
f_L(RH) is the relative humidity adjustment factor for large particles;
f_{SS}(RH) is the relative humidity adjustment factor for sea salt; and
The apportionment of the total concentration of sulfate compounds into the concentrations of the small and large size fractions is accomplished using the following equations:

[large sulfate] = ([total sulfate]/20µg/m³) * [total sulfate], for [total sulfate] < 20 µg/m³;
[large sulfate] = [total sulfate], for [total sulfate] ≥ 20 µg/m³; and
[small sulfate] = [total sulfate] – [large sulfate]

The same equations above for large sulfate, are also used to apportion total nitrate and total organic mass concentrations into the large and small size fractions.

NO_2 is not currently measured at the IMPROVE monitors in Minnesota, so this factor is not included. It also is not part of the "old" IMPROVE equation.

Table 5.1: Monthly fS(RH) and fL(RH) values [14,15]

Class I	*f*(RH)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
BOWA1	f_S(RH)	3.24	2.84	2.99	2.64	2.93	3.21	3.44	3.67	3.80	3.07	3.50	3.49
	f_L(RH)	2.50	2.26	2.32	2.09	2.22	2.42	2.57	2.69	2.76	2.37	2.65	2.65
	f_{SS}(RH)	3.74	3.37	3.34	2.92	3.03	3.43	3.68	3.85	3.95	3.44	3.89	3.92
VOYA2	f_S(RH)	3.16	2.77	2.82	2.59	2.65	3.28	3.25	3.48	3.66	3.02	3.37	3.32
	f_L(RH)	2.46	2.22	2.22	2.07	2.09	2.46	2.46	2.59	2.70	2.35	2.58	2.55
	f_{SS}(RH)	3.69	3.31	3.20	2.90	2.89	3.46	3.55	3.71	3.87	3.42	3.83	3.80

[12] IMPROVE Steering Committee, January 2006.
[13] VIEWS Website, Regional Haze Rule Planning Documents.
[14] VIEWS Website.
[15] Hand and Malm, March 2006.

3. Convert b_{ext} to decivews (dv) using the following equation:

   Haze Index (dv) = 10 $ln(b_{ext}/10)$

   Where: b_{ext} and light scattering due to Rayleigh scattering (i.e. the "10" in the denominator) are both expressed in inverse megameters (Mm^{-1}). In order to be consistent across all Class I areas, the U.S. EPA prescribed that the Rayleigh Scattering in the denominator of the conversion of the extinction value to deciviews should always be 10 instead of using site-specific Rayleigh Scattering values.[16]

4. Order the deciview values for all days at each Class I area for each of the 5-years of the baseline period from worst (highest deciview value) to best (lowest deciview value).

<u>B. Calculate the average baseline deciview for the 20 percent worst (highest deciview values) and for the best (lowest deciview value).</u>

1. Calculate the arithmetic mean deciview value for the 20 percent worst and best visibility values for each year;
2. Average the resulting 5-year mean deciview values reflecting worst visibility for each of the years; and
3. Average the 5-year mean deciview values reflecting best visibility for each of the years.

BWCAW has a baseline visibility of 6.4 deciviews for the cleanest 20 percent of the sample days and 19.9 deciviews for the 20 percent worst visibility days. The average visibility for all days across the baseline period is 12.3 deciviews. This is based on sampling data collected at the BWCAW IMPROVE monitoring site (BOWA1). A five year average (2000 to 2004) was calculated for each value (both best and worst) in accordance with 40 CFR 51.308(d)(2).

Note that the air monitors at BOWA1 had a long-term malfunction from 2002 through 2004, which resulted in missing monitoring data for certain chemical species. Data for sulfate and nitrate, the main contributors to visibility impairment, were valid for these days, but data for other species was missing. Data for BWCAW has therefore been "patched" for the invalid chemical species by using data from the VNP IMPROVE monitor (VOYA2) adjusted based on the usual relationship between the concentrations of those chemical species between the two monitors when both captured valid data (determined through a regression analysis).

VNP area has baseline visibility of 7.1 deciviews for the cleanest 20 percent of the sample days and 19.5 deciviews for the 20 percent worst visibility days. The average visibility for all days across the baseline period is 12.6 deciviews. This is based on sampling data collected at the VOYA2 IMPROVE monitoring site. A five year average (2000 to 2004) was calculated for each value (both best and worst) in accordance with 40 CFR 51.308(d)(2).

For all four Northern Class I areas, and others around the country, several cases arise where days were excluded from the calculation of light extinction because some measured components were missing[17] and therefore the data did not meet EPA's guidelines for visibility monitoring data.[18] The most frequently missing components were coarse mass and soil; however, these two species account for a very small fraction of light extinction in the Northern Class I areas and, despite the missing components on these

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[16] U.S. EPA, OAQPS, 2007a.

[17] Donna Kenski of the Midwest RPO brought this issue to the attention of the Northern Class I consultation group and did extensive data analysis on this issue.

[18] U.S. EPA, 2003b.

days, the light extinction from the sum of the measured species exceeds the 80th percentile. Additional information on this issue is included in Appendix 5.2.

Including these days in the baseline calculations has a small but measurable effect on the average deciviews for the 20% worst days. Minnesota has decided to include these days in our baseline calculations, even though the guidance calls for them to be excluded, because they appear to be largely dominated by anthropogenic sulfate and nitrate sources. Because these are the types of poor visibility days that need to be targeted by regional haze control strategies they were retained in order to assure that they receive adequate scrutiny.

Natural Visibility Conditions

Minnesota relied on natural visibility conditions calculated with the new IMPROVE algorithm by the VIEWS staff. Errors in the original calculations of natural conditions, impacting sites at high altitude and sites with substituted data (such as BWCAW) were found, and Minnesota used corrected natural conditions distributed by email from the Cooperative Institute for Research in the Atmosphere (CIRA) in August 2007.[19] MPCA understands that these data will be posted on the VIEWS website, but they are not yet available. Nonetheless, Minnesota has relied on these data as we believe they offer the best picture of the natural conditions. The calculation method for natural conditions is provided in "Calculation Method for Natural Conditions with the New IMPROVE algorithm," presented to the Air and Waste Management Association specialty conference "Aerosol and Atmospheric Optics: Visual Air Quality and Radiation" in Moab, Utah, April 28, 2008 through May 2, 2008.

Table 5.2, below, gives a summary of the visibility metrics for Minnesota's Class I areas; these metrics include all substituted data and the re-inclusion of the dropped days as described above. The baseline and natural condition values in Table 5.2 are those used by the MPCA in developing this SIP and the RPG for Minnesota's Class I areas.

Table 5.2: Visibility Metrics for Minnesota's Class I areas[20]

Natural Background Conditions[21]				
Class I area	Average for 20% Worst Days (dv)	Natural Conditions for 20% Best Days (dv)	Average for 20% Worst Days B_{ext} (Mm^{-1})	Average for 20% Best Days B_{ext} (Mm^{-1})
BWCAW	11.6	3.4	33	14
VNP	12.1	4.3	35	15
Baseline Visibility Conditions 2000-2004				
Class I area	Average for 20% Worst Days (dv)	Average for 20% Best Days (dv)	Average for 20% Worst Days B_{ext} (Mm^{-1})	Average for 20% Best Days B_{ext} (Mm^{-1})
BWCAW	19.9	6.4	76.0	19.2
VNP	19.5	7.1	72.5	20.5

19 Copeland, 2007. (Email)

20 This table shows the official visibility conditions used by the MPCA in developing this SIP. It includes all substituted data for BWCAW and the re-inclusion of all sample days that were previously dropped. Note that some days that were previously dropped did not include measurements for all components, therefore B_{ext} cannot be calculated for those days. The B_{ext} values in the table, then, are an average of only those in the 20% best or worst where light extinction can be calculated.

21 Natural background conditions were not recalculated with the inclusion of the previously dropped days, due to the time necessary to do these calculations and the belief that the resulting change would be very small.

Table 5.3 shows the yearly visibility metrics for all four Northern Class I areas, with the same algorithm and data adjustments as made for Table 5.2. Table 5.3 calculates the URP for all four Northern Class I areas with the adjusted data.

Table 5.3: Adjusted Visibility Metrics in dv for Northern Class I areas

		2000	2001	2002	2003	2004	Baseline (Average)	Natural Conditions
BWCAW	20% Worst	20.2	20.2	20.8	20.1	18.2	19.9	11.6
	20% Best	6.0	6.9	6.9	6.5	5.8	6.4	3.4
VNP	20% Worst	19.6	18.6	20.1	20.3	18.9	19.5	12.1
	20% Best	7.0	7.0	7.5	7.6	6.3	7.1	4.3
Isle Royale	20% Worst	20.5	23.1	22.0	22.3	20.0	21.6	12.5
	20% Best	6.5	7.1	7.0	7.1	6.1	6.8	3.7
Seney	20% Worst	22.9	25.9	25.4	24.5	23.2	24.4	12.8
	20% Best	6.6	6.8	7.8	8.0	6.6	7.2	3.7

As this table shows, visibility conditions in Minnesota's Class I areas have been relatively consistent over the baseline period. Preliminary indications are that this trend has continued. Although not used in calculating the baseline, in 2005 the average conditions at BWCAW for the 20% worst days was 21.3 dv and for the 20% best days was 6.3 dv. For VNP, it appears that the average condition for 20% worst days in 2005 was 20.3 dv and for the 20% best days the average conditions were 6.8 dv.

Table 5.4 lays out the URP that would result in Minnesota's Class I areas meeting natural conditions by 2064 and shows the deciview improvement needed to meet natural conditions for both best and worst 20% days and to meet the URP glide path for 20% worst days in 2018.

Table 5.4: Northern Class I areas URP in dv; Adjusted Data

	Annual URP (W20%)	2018 URP Goal (W20%)	Improvement from Baseline URP Requires by 2018 (W20%)	Improvement from Baseline to Meet Natural Conditions (W20%)	Improvement from Baseline to Meet Natural Conditions (B20%)
BWCAW	0.14	17.9	2.0	8.3	3.0
VNP	0.12	17.8	1.7	7.3	2.8
Isle Royale	0.15	19.5	2.1	9.1	3.1
Seney	0.19	21.7	2.7	11.6	3.5

Figures 5.2 and 5.3 graphically show the URP for VNP and BWCAW, respectively. Baseline conditions shown include the visibility conditions for each individual year of the baseline period, designated with the smaller points; the URP line is drawn from the average over the baseline period for both best and worst days. The graphs also visually show both the improvement that would be needed to meet natural conditions on the 20% best days as well as the requirement for no degradation on the 20% best days.

Figure 5.2: Uniform Rate of Progress for BWCAW

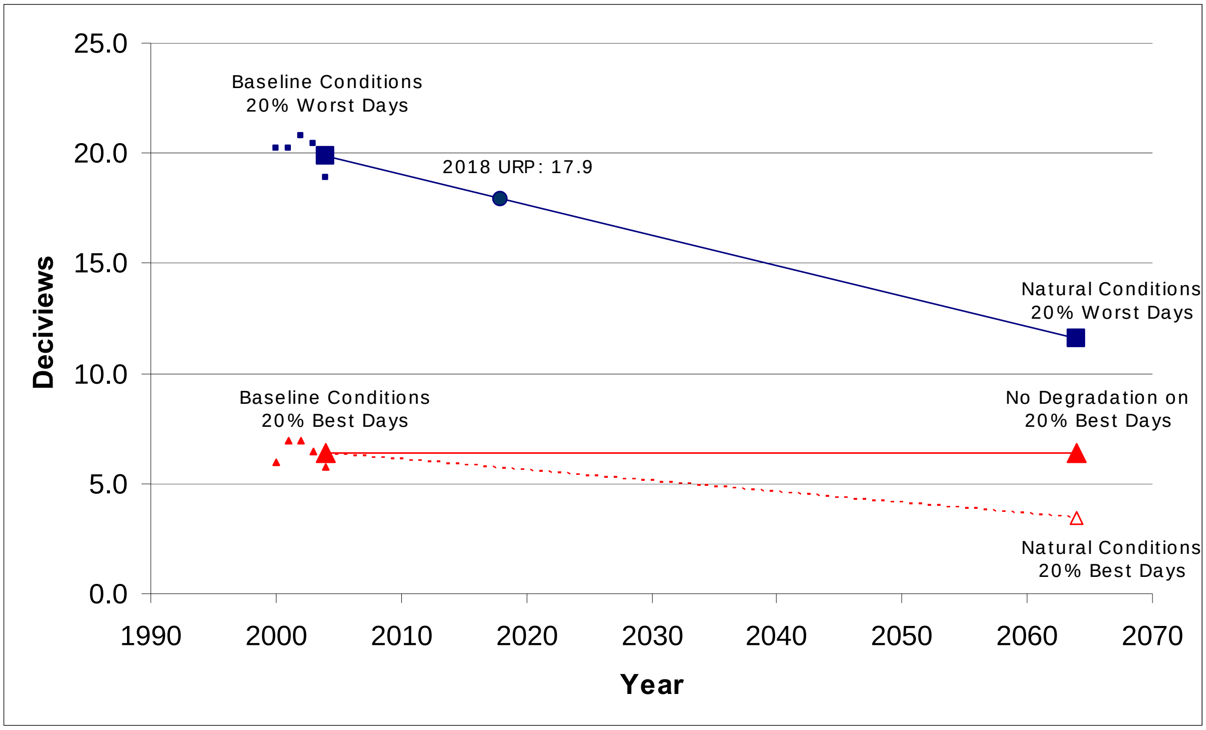
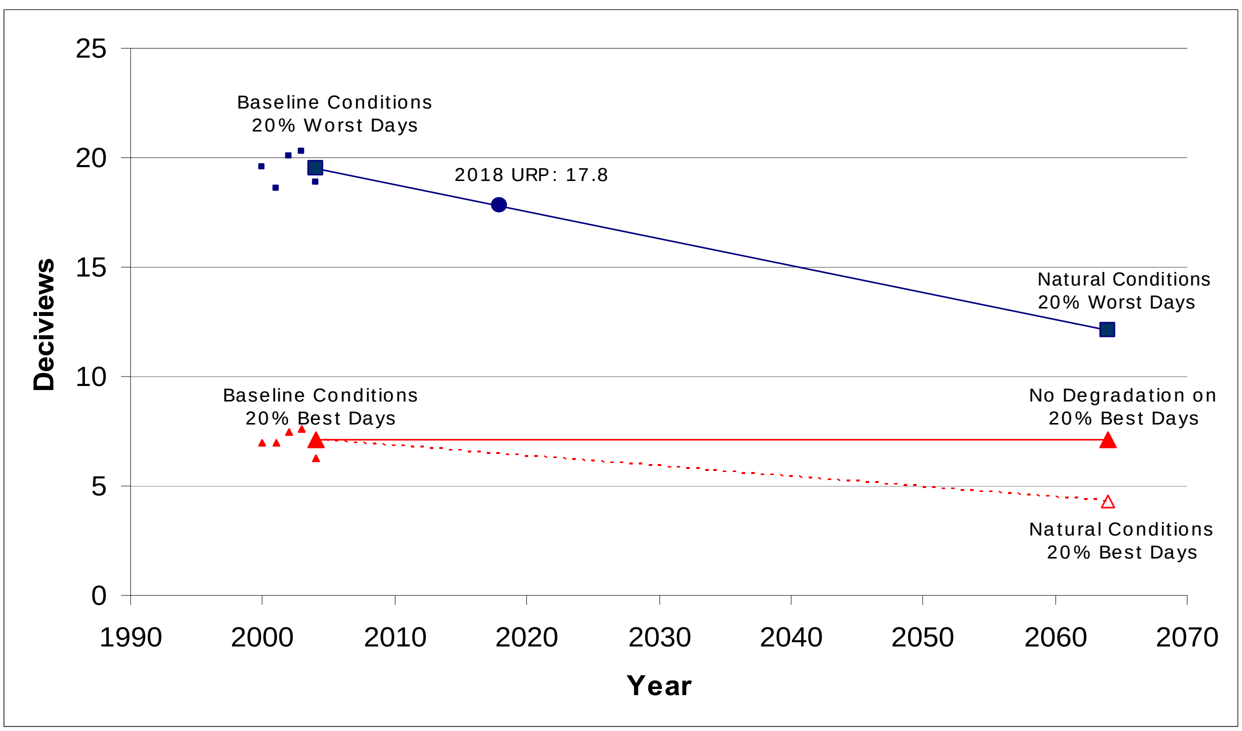


Figure 5.3: Uniform Rate of Progress for VNP



Updated Visibility Conditions

Since 2004, additional data on visibility conditions in the Class I areas has become available. Table 5.5, below, shows visibility conditions from 2005 through 2007 at the Class I areas impacted by Minnesota (BWCAW, VNP, and Isle Royale). Data from 2005 through 2007 was taken from the VIEWS Regional Haze Rule dataset, posted on the VIEWS webpage. The baseline conditions from 2000 through 2004, an average since 2000, and natural conditions are included for reference.[22]

Table 5.5: Visibility Conditions 2005 - 2007

Site	Days	2005	2006	2007	Baseline (Average 2000 - 2004)	2000 - 2007 Average	Most Recent Five Year Average (2003 - 2007)	Natural Conditions
BWCAW	20% Worst	21.3	19.6	19.8	19.9	20.0	19.8	11.6
	20% Best	6.3	5.8.	5.8	6.4	6.3	6.1	3.4
VNP	20% Worst	19.9	20.5	19.2	19.5	19.6	19.8	12.1
	20% Best	6.8	6.5	6.7	7.1	6.9	6.8	4.3
Isle Royale	20% Worst	23.8	21.9	21.7	21.6	21.9	21.9	12.5
	20% Best	7.1	6.4	6.4	6.8	6.7	6.6	3.7

[22] Note that the 2005 through 2007 data has not been adjusted. The data has not been checked for days were excluded from the calculation of light extinction because some measured components were missing but where the light extinction from measured species exceeds the 80th percentile. Therefore, data may not be directly comparable to the 2000 – 2004 average, but should still provide a snapshot of visibility trends in the Class I areas impacted by Minnesota.

Chapter 6. Monitoring Strategy

Part 40 CFR 51.308(d)(4) of the federal Regional Haze Rule requires a monitoring strategy for measuring, characterizing, and reporting regional haze visibility impairment that is representative of all mandatory Class I areas within Minnesota. The monitoring strategy relies upon participation in the IMPROVE network.

Minnesota's participation in the IMPROVE monitoring network largely meets the requirements of subsections (i) and (iv). The IMPROVE network began in 1988 with 42 sites at or near Class I areas. At the time of promulgation of the Regional Haze Rule in 1999, there were 80 monitors. In 2000 and 2001, an additional 30 sites were added to Class I areas, and 34 to non-Class I areas. (IMPROVE monitors operated outside of Class I areas are "Protocol" monitors, operated for FLMs, states, and tribes). Another 18 IMPROVE Protocol monitors were added in 2002, 13 of which went into CENRAP state and Tribal lands. Today there are 110 Class I area IMPROVE monitors and 52 non-Class I area (IMPROVE Protocol) monitors in the country.

In the language of subsection (i), these additional monitors were established in order to measure visibility pollutants in areas outside of national parks and wilderness areas, to understand the concentrations, sources and transport of regional haze that affects the Class I areas. Subject to continued EPA funding, these same monitors will be used to assess progress in attaining the reasonable progress goals in subsequent SIP reviews and revisions.

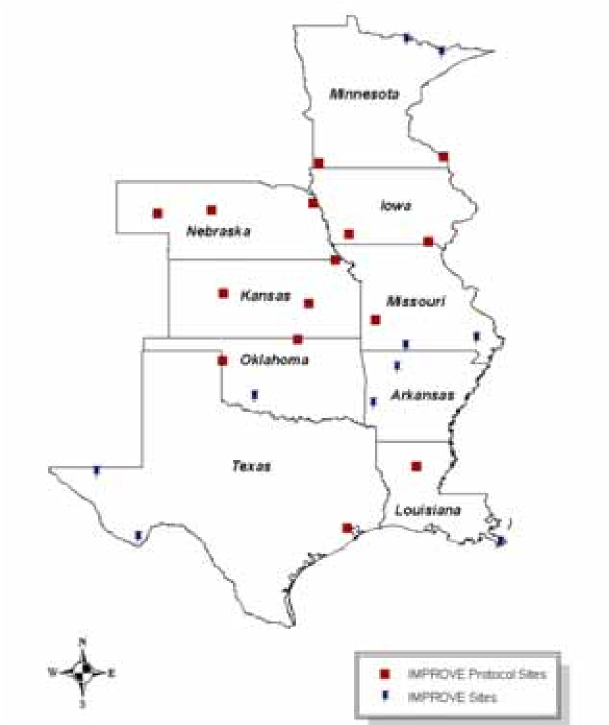
Current Monitoring Strategy

Upon the creation of CENRAP, the Monitoring Workgroup identified large visibility data voids for Southern Arkansas, Iowa, Kansas, Southern Minnesota, Nebraska, and Oklahoma. Only five IMPROVE sites were located in the CENRAP region. Between 2000 and 2003, five more IMPROVE sites and 15 IMPROVE Protocol Sites were installed.

In Minnesota, IMPROVE sites are located in the two Class I areas, at BWCAW (monitor BOWA1) and VNP (monitor VOYA2). IMPROVE Protocol sites are located in the southern areas of the state, in Blue Mounds and Great River Bluffs. Minnesota commits to meeting the requirements under 40 CFR 51.308(d)(4)(iv) to report to EPA visibility data for each of Minnesota's Class I areas annually.

The filter samples from the IMPROVE modules are sent for analysis to the Crocker Nuclear Laboratory of the University of California in Davis and the analysis data is posted to the IMPROVE website and the VIEWS website. This fulfills Minnesota's requirement for electronic reporting of visibility data under subsection (iv).

Figure 6.1 CENRAP IMPROVE and IMPROVE Protocol Sites



In addition to the four IMPROVE sites, Minnesota also has several monitoring stations for fine and coarse particulate matter located across the state, which can be used to gather additional information about the concentrations, sources, and transport of particulate matter. For fine particulate matter, the MPCA has three monitoring networks: Federal Reference Method (FRM), continuous, and speciation networks. There are currently 29 $PM_{2.5}$ sites in Minnesota operating as part of one of these networks. The speciation network, used to gather data on the species composition of fine particulate matter, includes the four IMPROVE monitors and two additional Speciation Trends Network (STN) sites operated by the MPCA, in Minneapolis and Rochester.[23]

The location of these monitors, for those active as of January 2008, is shown in the tables below:

Table 6.1: Active Minnesota $PM_{2.5}$ Monitoring Sites

Site Name	City	County
Dlth Lincoln Park Sch	Duluth	St. Louis
WDSE	Duluth	St. Louis
37W/I35	Duluth	St. Louis
Virginia	Virginia	St. Louis
Ely	Fall Lake	Lake
Detroit Lakes	Detroit	Becker
Brainerd Airport	Oak Lawn	Crow Wing
Fond Du Lac	Cloquet	Carlton
Mille Lacs	Kathio	Mille Lacs
St. Cloud Talahi Sch	St. Cloud	Stearns
St. Michael School	St. Michael	Wright
Anoka Airport	Blaine	Anoka

[23] MPCA, 2008.

Site Name	City	County
Wenonah School	Minneapolis	Hennepin
MSP Airport	Fort Snelling	Hennepin
Putnam School	Minneapolis	Hennepin
Phillips	Minneapolis	Hennepin
Richfield	Richfield	Hennepin
NE Fire Station	Minneapolis	Hennepin
Humboldt	Minneapolis	Hennepin
St. Louis Park	St. Louis Park	Hennepin
Harding HS	St. Paul	Ramsey
St. Paul Hlth Dept	St. Paul	Ramsey
Red Rock Road	St. Paul	Ramsey
Apple Valley	Apple Valley	Dakota
Shakopee	Shakopee	Scott
Marshall Airport	Fairview	Lyon
ROCHESTER	Rochester	Olmsted

Table 6.2: Active Minnesota PM_{10} Monitoring Sites

Site Name	City	County
Dlth Lincoln Park Sch	Duluth	St. Louis
WDSE	Duluth	St. Louis
37W/I35	Duluth	St. Louis
Virginia	Virginia	St. Louis
DM&IR Cemetery	Two Harbors	Lake
Mille Lacs	Kathio	Mille Lacs
St. Cloud Talahi Sch	St. Cloud	Stearns
St. Michael School	St. Michael	Wright
St. Paul Park 3	St. Paul Park	Washington
Mpls downtown	Minneapolis	Hennepin
Humboldt	Minneapolis	Hennepin
St. Louis Park	St. Louis Park	Hennepin
Harding HS	St. Paul	Ramsey
St. Paul Hlth Dept	St. Paul	Ramsey
Red Rock Road	St. Paul	Ramsey
Ross Av/St Paul Fire	St. Paul	Ramsey
Vandalia	St. Paul	Ramsey
Apple Valley	Apple Valley	Dakota
Wicker	Rosemount	Dakota
MPCA	Rosemount	Dakota
ROCHESTER	Rochester	Olmsted

Future Monitoring Strategy

In order to assess progress in reducing visibility impairment in Class I areas, the existing IMPROVE and IMPROVE Protocol sites should be maintained. Operation is contingent upon continued federal funding to measure, characterize and report regional haze visibility impairment.

The MPCA believes that maintenance of the IMPROVE monitoring network is critical to the long-term success of the Regional Haze program. In the event of a complete loss of federal funding, the MPCA will attempt to provide support for the operation of at least one of the two IMPROVE sites.

Should the IMPROVE monitoring network be disbanded, Minnesota could use information from other $PM_{2.5}$ monitoring sites to make some estimates of $PM_{2.5}$ concentrations, and thus visibility impairment, in the Class I areas. Minnesota evaluates the monitoring network periodically, including evaluation of technology changes and the need for new monitors. More information about the monitoring networks in place in Minnesota, and any future planned changes, can be found in the *Annual Air Monitoring Network Plan for the State of Minnesota.*[24] Further details regarding Minnesota's ambient air monitors (location, date of installation etc.) and monitoring data can also be found online through the MPCA's Environmental Data Access System.[25]

Special Monitoring Studies

As funding permits, CENRAP, in cooperation with states and tribes, intends to study the impact of ammonia and carbon on visibility impairment in the CENRAP region. Preliminary monitoring studies and monitoring data analysis suggests that these two air constituents contribute to a large portion of visibility impairment in the CENRAP geographical area.

[24] MPCA, 2008.
[25] MPCA, *Environmental Data Access System - Air Quality Data*. (webpage)

Chapter 7. Emission Inventory

40 CFR 51.308(d)(4)(v) requires a statewide emission inventory of pollutants that are reasonably anticipated to cause or contribute to visibility impairment in any mandatory Class I area. As specified in the applicable EPA guidance, the pollutants inventoried by Minnesota include volatile organic compounds (VOC), nitrogen oxides (NO_X), fine particulate ($PM_{2.5}$), coarse particulate (PM_{10}), ammonia (NH_3), and sulfur dioxide (SO_2).

Minnesota rules require point sources to submit reports of their emissions to the MPCA each year, and an annual point source emission inventory is produced. Minnesota compiles a full statewide emission inventory every three years, and submits this data to the National Emission Inventory (NEI). Minnesota will continue to update the full emission inventory on this three-year cycle.

State Inventory – 2002

The MPCA's most recent complete statewide emission inventory is from 2002. A summary of the inventory results is shown below in Table 7.1.

Table 7.1: Minnesota 2002 Baseline Emissions Inventory Summary (tpy)[26]

	VOC	NO_X	SO_2	PM_{10}	$PM_{2.5}$	NH_3
Point Sources	29,000	150,000	130,000	31,000	13,000	1,300
Area Sources	160,000	57,000	17,000	730,000	150,000	170,000
Mobile Sources						
On-Road	91,000	170,000	3,000	3,800	2,800	5,400
Non-Road	84,000	100,000	9,100	9,700	8,900	97
TOTAL	366,000	485,000	160,000	779,000	169,000	179,000

Because the 2002 emission inventory is critical as a baseline for comparing future emissions and application of control strategies, MPCA felt it was important to understand if 2002 was a representative year, or if the emissions tended to be high or low when compared to other recent years. If 2002 emissions were high, for example, future year emissions might show decreases that might be wrongly attributed to the implementation of control strategies.

In order to gain a more complete understanding of the 2002 inventory, MPCA staff compared point source emissions in the 2002 inventory to point source emissions from surrounding years. In general, although there is certainly some variation, the 2002 inventory was found to be largely representative of annual emissions from large point sources, particularly for the key haze causing pollutants of SO_2 and NO_X.[27]

MPCA's emission inventory staff has recently completed compiling the 2005 emission inventory.

[26] The emission inventory is presented to two significant digits. Totals might not add due to rounding.
[27] Information on Minnesota's emission inventory is available in the air quality section of the MPCA's Environmental Data Access system.

The 2005 inventory figures are shown in the table below.

Table 7.2: Minnesota 2005 Emissions Summary (tpy)

	VOC	NO_X	SO_2	PM_{10}	$PM_{2.5}$	NH_3
Point Sources	26,000	150,000	130,000	30,000	13,000	2,000
Area Sources	130,000	34,000	17,000	740,000	140,000	170,000
Mobile Sources						
On-Road	93,000	140,000	2,600	3,500	2,400	5,700
Non-Road	96,000	100,000	9,600	8,400	8,000	64
TOTAL	349,000	422,000	159,000	778,000	166,000	180,000

Inventory Methodology

The MPCA EI staff compiled the 2002 Minnesota Point Source Inventory using acceptable, established methodologies, which are ranked by preference. This hierarchy of methodologies and use are required by Minnesota's Air Emission Inventory Rule, Minn. R. 7019.3000, for facilities submitting an air emission inventory. All air permit holders are required to submit an annual air emission inventory.

The following are the accepted methodologies in order of preference:

1) Continuous Emission Monitor (CEM) Data
2) Performance Test Data
3) Volatile Organic Compound (VOC) or Sulfur Dioxide (SO_2) Mass Balance
4) Emission Factors – EPA published generic factors from documents such as AP-42 or FIRE database.

Methodologies that can reflect site and process specific data are always preferable to a default, generic emission factor. AP-42 emission factors represent averaged emission factors for the entire industry or type of equipment. Appendix 7.1 contains additional information on how Minnesota compiles its emissions inventory.

Modeling Inventory

Although the statewide inventory forms the basis of the emissions that are input into the atmospheric chemistry and transport models that ultimately predict visibility conditions, substantial work is needed to process the emissions for modeling purposes. Therefore, the specifics of the emissions used in the modeling work, known as the modeling inventory, are detailed in Chapter 8.

Chapter 8. Modeling

The Regional Haze rule requires states to "establish goals (expressed in deciviews) that provide for reasonable progress toward achieving natural visibility conditions for each Class I area within a state," improving visibility on the most impaired days and not degrading visibility on the least impaired days.[28] The core of the visibility assessment – the baseline and natural conditions based on observed data – is fully described in Chapter 5.

The baseline conditions are developed from five years of monitoring data, and represent the starting point from which reasonable progress is measured. The Regional Haze Rule prescribes the baseline period as the years 2000-2004, and defines baseline visibility conditions as the average of the most visibility impaired days (the 20 percent worst days), and the average of the least visibility impaired days (the 20 percent best days) calculated from the monitoring data for each year of the baseline, and then averaged over the 5-year baseline period.[29] The ultimate goal is to reach natural visibility conditions in 2064, and reasonable progress goals are interim goals representing progress toward that end. The year 2018 is the initial year for developing a reasonable progress goal.

Models are used to establish a reasonable progress goal (RPG) by simulating the future visibility conditions that will result from future emission estimates. A set of EPA developed guidelines[30] outline the methodology for modeling future conditions and applying modeled results to develop reasonable progress goals.

Emissions from a "base," or known, year (i.e. 2002) representing the baseline period and from a year in the future (i.e. 2018) are each modeled. The model results are used to estimate the air concentration change from base year to future year. These air concentration changes are in the form of ratios of the future year air concentrations to the base year concentrations predicted near a monitor location and averaged over the same 20 percent worst and 20 percent best days in the base year that were used to establish baseline visibility conditions. A ratio is developed for each specie comprising $PM_{2.5}$ (sulfate, nitrate, organic carbon, elemental carbon, fine soil [≤2.5 µm diameter], and coarse particulate matter [>2.5 µm, but ≤10 µm diameter]). The ratio is called a Relative Response Factor (RRF), calculated as follows:

$$RRF_{[SO4]} = \text{Modeled Future Mean}_{[SO4]} / \text{Modeled Base Year Mean}_{[SO4]}$$

Where: RRF is the relative response factor (unitless);

Future Mean and Base Year Mean are the modeled base year (2002) and the future year (2018) concentrations at the Class I area monitor location averaged for the 20 percent worst days (and 20 percent best days) as determined by the base year (2002) monitor data; and

The same equation above for sulfate is also used for nitrate, organic carbon, elemental carbon, fine soil and coarse particulate matter.

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[28] 40 CFR 51.308(d)(1).
[29] 40 CFR 51.308(d)(2).
[30] U.S.EPA, OAQPS, 2007a

Applying the RRFs to baseline monitoring conditions, for each species comprising $PM_{2.5}$, provides the estimate of future visibility conditions (described below):

- Multiply each species specific RRF, developed from the 2002 and 2018 modeling data, by the corresponding measured species concentration for all of the 20 percent worst (and 20 percent best) days over the 5-year baseline period. (example for sulfate below);

$$[SO_4]\text{future} = RRF_{(SO4)} * [SO_4]\text{baseline (daily value)}$$

- Estimate extinction coefficient for each of the 20 percent worst (and 20 percent best) days using the IMPROVE equation (detailed in Chapter 5, Baseline Visibility Conditions, calculations, Section A.2.), and convert to deciviews (detailed in Chapter 5, Baseline Visibility Conditions, calculations, section A.3); and

- Calculate the average future year deciview for the 20 percent worst (and 20 percent best) days.
    1. Calculate the arithmetic mean deciview value for the 20 percent worst and best visibility values for each year in the baseline period; and
    2. Average the resulting 5-year mean deciview values (for the 20 percent worst, and for the 20 percent best).

Recognizing the intense resources required to conduct modeling analyses of this nature, EPA guidelines for regional haze do not suggest modeling the multiple years comprising the 5-year baseline period, but discuss modeling one full year as a "logical goal". The methodology in the EPA guidelines attempts to take into account the year-to-year variability of the meteorology in the monitored baseline. The middle year (2002) will have more weight due to the fact that the 2002 emissions and meteorology are used in the modeling to develop the RRF applied to the baseline conditions. This application of the model results is intended to balance the resource limitations of conducting multiple years of modeling, and to "help reduce the impact of possible over-or under-estimations by the dispersion model due to emissions, meteorology, or general selection of other model input parameters".

The resource requirements for conducting regional scale modeling make it necessary to consolidate resources and develop the modeling analyses through the RPO process. Regional haze modeling at BWCAW and VNP was performed by CENRAP, MRPO and by Minnesota; MRPO conducted modeling using both a 2002 base year and 2005 base year. Minnesota supplemented the RPO modeling by focusing on the two Minnesota Class I areas and the visibility impacts of nearby point sources located within Minnesota. Minnesota's modeling uses MRPO-developed emissions and meteorological data inputs from the 2002 base year and 2018 future year, with some modifications, and is referred to throughout this chapter as the $\text{Minnesota}_{(MRPO)}$ case.

The reasonable progress goals for BWCAW and VNP are set using the $\text{Minnesota}_{(MRPO)}$ case; however, the other analyses are valuable for assessing uncertainty in the modeling analysis and helping to determine whether the model likely overpredicts, underpredicts, or accurately predicts the reasonable progress goal associated with the long-term strategy. As part of the weight-of-evidence supporting the Minnesota RPG, the end of this chapter contains a summary of differences in the modeling results by CENRAP, MRPO (2002) and MRPO (2005) as compared to the $\text{Minnesota}_{(MRPO)}$ case.

The modeling described herein supports the policy decisions made in this Regional Haze SIP. Details on the modeling analyses conducted are in a separate document titled "Minnesota Technical Support Document for the Regional Haze State Implementation Plan" (TSD). This document is available at http://www.pca.state.mn.us/publications/rhsip-tsd.pdf. The sections below summarize the methods and inputs used for the regional modeling.

The Modeling System

The modeling system is composed of an atmospheric transport and chemistry model, also known as the "air quality model," an emissions model and a meteorological model. The emissions and meteorology models create inputs for use by the air quality model.

One of the criteria considered when choosing a system was its ability to allow Minnesota to conduct modeling to assess visibility impacts from Minnesota sources near the Class I area, as this type of modeling falls outside the scope of RPO modeling work, which focuses on the larger, more regional visibility impacts. The MRPO supports contributing states in conducting modeling and uses an air quality model whose resource requirements are reasonable for Minnesota. For this reason, Minnesota chose to use the modeling system chosen by MRPO. The modeling system[31],[32] is made up of the following:

- **Air Quality Model:** Comprehensive Air Quality Model (CAMx). CAMx simulates atmospheric and surface processes affecting the transport, chemical transformation and deposition of air pollutants and their precursors. Some advantages of CAMx are two-way nesting, which "allows CAMx to be run with coarse grid spacing over a wide regional domain in which high spatial resolution is not particularly needed, while within the same run, applying fine grid nests in specific areas where high resolution is needed",[33] a subgrid scale plume-in-grid module to treat the early dispersion and chemistry of point source plumes, a fast chemistry solver increasing processing speed allowing overall timely model results, and Particulate Source Apportionment Technology (PSAT) that tracks the original source of particulate species by geographic region and source category. CAMx is an Eulerian model that computes a numerical solution on a fixed grid. Minnesota used CAMx version 4.42.
- **Meteorological Model:** The Pennsylvania State University/National Center for Atmospheric Research (PSU/NCAR) Mesoscale Meteorological Model (MM5). The MM5 model simulates mesoscale and regional scale atmospheric circulation.[34] MM5 output data is used in the emissions model and in the air quality model.
- **Emissions Model:** Emissions Modeling System (EMS-2003). EMS-2003 generates hourly speciated emissions on a gridded basis for mobile, nonroad, area, point, natural (biogenic) and fires. The emissions are input to an air quality model.

Model Year Chosen

Regional haze issues appear throughout the year in the Minnesota Class I areas, which made it necessary to model a full year rather than a shorter episode period. A model year must coincide with a year scheduled for emissions inventory development. As noted in Chapter 7, states develop full emissions inventories every three years, the most recent being the fully completed 2002 inventory. The 2005 inventory was still in development during the SIP modeling process. EPA guidance suggests choosing a model year that has monitoring data available that straddles the model year. Minnesota has selected 2002 as the base year for modeling.

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[31] The MRPO conducted modeling for a 2005 base year analysis using CAMx version 4.50, a combination of EMS-2003 and Concept (for mobile source), and MM5 run by Alpine Geophysics.
[32] CENRAP chose the Community Multiscale Air Quality Model (CMAQ) as its air quality model, the Sparse Matrix Operator Kernel Emissions (SMOKE) model as its emissions model, and MM5 as its meteorological model.
[33] ENVIRON, 2006.
[34] MM5 Community Model Homepage.

During the iterative process of regional scale modeling, MRPO decided to switch to a 2005 base year. Although Minnesota still uses MRPO inputs in its $Minnesota_{(MRPO)}$ model analyses, they remain the 2002 base year, with some adjustments. The 2002 base year allows Minnesota to better correlate results with CENRAP, which also uses 2002 as its base year, and allows for using monitoring data that straddles the inventory year (2000-2004) to establish baseline conditions. The state of Iowa developed the meteorological data inputs for the 2002 base year.[35]

Conceptual Description

As described above, visibility is a year-round issue in the upper Midwest Class I areas. Observed values indicate that the 20 percent worst days are spread across all months of the year except February in 2002 (see Appendix 5.2). During the warmer months several days are influenced by wildfires,[36] which can contribute large amounts of organic carbon that significantly affect extinction. Wildfire emissions are uncontrollable. Natural (biogenic) emissions are another uncontrollable source that impact visibility, i.e. volatile organic compounds (VOC) from trees that form secondary organic aerosols.

Throughout the year, but especially in the warmer months, the controllable emissions of sulfur dioxide (SO_2) and nitrogen oxides (NO_X) have the most impact on visibility at BWCAW and VNP. These emissions are controllable because their release results from human activities. SO_2 emissions impact visibility year-round, while NO_X emissions contribute the most impact on visibility in the colder months. This happens because nitrate formation occurs in the colder months, as in the warmer months NO_X will remain in the gas phase as nitric acid. Ammonia preferentially reacts with SO_2, so nitrate forms only when there is enough ammonia left over after forming ammonium sulfate by reacting with SO_2. While particulate sulfate can form whether there is ammonia present or not, particulate nitrate needs ammonia to form.

Ammonia is released primarily from animal farms throughout the year, peaking in the warmer months, and additionally from agricultural practices in the Spring and Fall. Ammonia is critical to formation of ammonium sulfate and ammonium nitrate, the main controllable species contributing to visibility issues in the Class I areas. Ammonium nitrate and ammonium sulfate need time to form in the atmosphere and are understood to travel large distances

Modeling/Analysis Protocol

A protocol details and formalizes the procedures for conducting all phases of the modeling study, including the methodology (grid projections, domains, meteorological inputs, emissions inputs, the configuration of the model), the evaluation of model performance against observed data, and how the visibility analysis will be conducted. Minnesota did not prepare its own regional modeling protocol, relying instead on the meteorological and air quality modeling protocols prepared by the MRPO. Minnesota explored answers to questions specific to Minnesota beyond the scope covered by the air quality modeling protocol prepared by the MRPO. For example, Minnesota is interested in the visibility impact of sources located near BWCAW and VNP. This resulted in a modeling analysis using a 12km nested grid and a plume-in-grid tool for individual elevated point sources located within a certain distance of the Class I areas. Plume-in-grid tracks individual plume segments from each point source, rather than immediately dispersing the individual point sources emissions into the grid cell. Therefore, it can treat the early dispersion and chemistry of point source plumes. In order to use the plume-in-grid module properly, some modifications to the air quality modeling input files were required. For example, stack parameter and location information has greater importance when plume-in-grid is employed. The TSD provides the protocol for implementing features not covered in the MRPO protocol.

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[35] Both $Minnesota_{(MRPO)}$ and CENRAP used the same meteorological data inputs developed by the state of Iowa for 2002.
[36] MRPO, 2007b.

Emissions Preparations & Results

Emissions were combined into sectors based on the similarity of the techniques used to process the emissions. Sectors are:

- Point or industrial sources that are identified by locational coordinate and stack parameters (i.e. facilities with state permits);
- Mobile Onroad or automobile and truck traffic on paved roadways;
- Nonroad or mobile equipment not traveling on roadways (i.e. recreational vehicles, construction and agricultural equipment);
- Marine vessels, airplanes and locomotives (also considered "nonroad" sources although techniques vary);
- Area or stationary sources that are not identified by locational coordinate and stack parameters (e.g. agricultural processes like fertilizer use and livestock operations, residential heating); and
- Biogenic or natural emissions (i.e. trees are an important biological emissions source).

Emissions modeled for regional haze are sulfur dioxide (SO_2), nitrogen oxides (NO_x), Volatile Organic Compounds (VOC), ammonia (NH_3), fine particulate ($PM_{2.5}$) and coarse particulate mass.

The Base Year Inventory – 2002

For the most part, base year inventories are developed by each individual state. These are essentially the same inventories states submit to the EPA for the National Emissions Inventory (NEI). For some sectors, methods initially available to states for inventory development were inadequate for air quality modeling. For these sectors, the RPOs have independently, and in some cases cooperatively, hired contractors to develop emissions data to support improvement of state-developed inventories where the other methodology, insufficient for modeling purposes, was used. For example, it is important to have accurate ammonia emissions because ammonia combines with sulfuric and nitric acid to form aerosol sulfate and nitrate, significant components of $PM_{2.5}$ and of visibility impairment. Also, states do not create inventories for biogenic sources, so these inventories had to be created for modeling purposes.

Although an inter-RPO technical consultation mechanism was in place, the timing of individual RPO inventory improvements results in some variation in the emissions characterization of a state among the RPO in which it is a member, and other RPOs. Minnesota worked closely with both CENRAP and MRPO to ensure Minnesota's sources were characterized as accurately and with as much scrutiny as possible; the two RPOs independently developed a modeling inventory for Minnesota. In the TSD, Minnesota summarizes overall differences between the CENRAP and MRPO inventories and how these differences might impact the model results.

The Future Year Inventory – 2018

The Economic Growth Analysis System (EGAS) model was used to estimate the growth of emissions from 2002 to 2018 for all source categories, except on-road mobile sources and EGUs. EGAS is a forecast model based on the premise that growth in emissions largely depends on the growth in economic activity, particularly changes in sales forecasts, in an area. On-road mobile sources were grown with MOBILE6. EGU emissions were grown using the Integrated Planning Model (IPM). IPM predicts future EGU emissions assuming an energy balance throughout electricity supply grids.

The RPOs agreed to use IPM to predict future EGU emissions during the technical consultation process. The consulting firm ICF International developed the IPM model, which EPA uses to evaluate the future impact of policies and regulations, in combination with projected energy needs, on EGUs. For example, EPA used IPM to develop the Clean Air Interstate Rule (CAIR). The IPM model output presumes CAIR is implemented. The modeling that supports Minnesota's reasonable progress goals incorporated IPM version 3.0.

The MPCA believes IPM 3.0 predictions for Minnesota in 2018 are much improved over previous versions of IPM simulations. Other RPOs, such as CENRAP, use an earlier IPM version 2.1.9(VISTAS).[37] Upon review of the IPM 3.0 predictions, MPCA staff found some adjustments to the output were necessary to reflect staff knowledge of Minnesota EGUs and future projections, but many more adjustments would be needed to IPM 2.1.9(VISTAS). Both versions of IPM presume CAIR is implemented, but they make different assumptions in other areas, such as fuel cost estimates.

The MRPO modified the IPM 3.0 future year estimates with information submitted by its member states plus Minnesota, North Dakota, Iowa and Missouri. For example, Minnesota made a correction to the emissions for Minnesota Power-Boswell to account for an underestimation of the facility's capacity in IPM. Further adjustments were limited to committed control projects that occurred after the deadline for submission of such projects to EPA for inclusion in IPM 3.0. All corrections and adjustments made to Minnesota EGUs were done in consultation with industry representatives. Table 8.1 summarizes Minnesota's adjustments and corrections to IPM 3.0.

Table 8.1: Minnesota Adjustments and Corrections to IPM Version 3.0

Facility Name	Basis for Correction/Adjustment	Unit #	IPM base Total Emissions (Mton)		IPM "will do" Total Emissions (Mton)	
			NO_x	SO_2	NO_x	SO_2
Minnesota Power-Boswell	Unit 3 adjusted to reflect NO_X permit limit, SO_2 decreased with addition of Fabric Filter/Flue Gas Desulfurization	3	0.79	6.11	0.93	1.19
	Unit 4 capacity increased from 425 MW to 535 MW	4	3.75	4.00	4.72	3.22
Xcel - A.S. King	Adjusted based on permit limit.	1	1.43	1.87	2.08	2.49
Xcel - Black Dog	Adjusted upward based on current performance in response to Xcel Energy comments.	3 4	1.17 1.63		3.92 5.47	
Minnesota Power-Taconite Harbor	Furnace Sorbent Injection on Units 1 through 3.	1 2 3		1.56 1.39 1.37		0.67 0.68 0.67

The combination of IPM 3.0 with these modifications results in a scenario called IPM 3.0 "will do." Table 8.2, prepared by MRPO, shows the overall difference in emissions among IPM 2.1.9(VISTAS), IPM 3.0, and IPM 3.0"will do" scenarios for each state in the upper Midwest.

Concerns have been raised as to whether adjusting IPM output compromises the integrity of the predictions. IPM assumes an energy balance throughout the EGU sector, and the concern is that modifications at a handful of facilities can throw the system off-balance. However, Minnesota views IPM as one method for predicting future EGU emissions and if states and affected industry believe that the predicted emissions are incorrect, they should change them in order to get the most accurate estimate of future emissions in the state. The corrections and adjustments made by Minnesota should not throw the system off-balance, as they generally address only changes in the performance of equipment, resulting in emission changes, and not overall energy balance.

VISTAS states have also made post-IPM model adjustments for their states to the IPM 2.1.9(VISTAS) output. CENRAP has not made adjustments to the IPM 2.1.9(VISTAS) output used in their modeling.

[37] This IPM version is called IPM2.1.9(VISTAS) because the VISTAS RPO coordinated an IPM run based on EPA's IPM version 2.1.9; but with CENRAP, MRPO and VISTAS member state modifications to the IPM input parameters related to committed (i.e. permitted) control projects at various EGUs that were not covered by the initial IPM version 2.1.9 run by EPA.

CENRAP intended to switch to IPM 3.0, but did not due to timing and financial reasons. The Minnesota$_{(MRPO)}$ modeling was able to easily include the revised IPM 3.0 EGU emissions in the future year inventory because, unlike other sectors, EGU emission projections with IPM are calculated independent of the base year inventory.

Table 8.2: IPM2.1.9 (VISTAS), and IPM3.0 "base" and "will do" Alterations

State	Heat Input (MMBtu/year)	Scenario	SO_2 (tons/year)	SO_2 (lb/MMBtu)	NO_X (tons/year)	NO_X (lb/MMBtu)
IL	980,197,198	2001 - 03 (average)	362,417	0.74	173,296	0.35
		IPM 2.1.9 (VISTAS)	241,000		73,000	
	1,310,188,544	IPM3.0 (base)	277,337	0.423	70,378	0.107
		IPM3.0 - will do	140,296	0.214	62,990	0.096
IN	1,266,957,401	2001 - 03 (average)	793,067	1.25	285,848	0.45
		IPM 2.1.9 (VISTAS)	377,000		95,000	
	1,509,616,931	IPM3.0 (base)	361,835	0.479	90,913	0.120
		IPM3.0 - will do	628,286	0.832	128,625	0.170
IA	390,791,671	2001 - 03 (average)	131,080	0.67	77,935	0.40
		IPM 2.1.9 (VISTAS)	147,000		51,000	
	534,824,314	IPM3.0 (base)	115,938	0.434	59,994	0.224
		IPM3.0 - will do	115,938	0.434	59,994	0.224
MI	756,148,700	2001 - 03 (average)	346,959	0.92	132,995	0.35
		IPM 2.1.9 (VISTAS)	399,000		100,000	
	1,009,140,047	IPM3.0 (base)	244,151	0.484	79,962	0.158
		IPM3.0 - will do	244,151	0.484	79,962	0.158
MN	401,344,495	2001 - 03 (average)	101,605	0.50	85,955	0.42
		IPM 2.1.9 (VISTAS)	86,000		42,000	
	447,645,758	IPM3.0 (base)	61,739	0.276	41,550	0.186
		IPM3.0 - will do	54,315	0.243	49,488	0.221
MO	759,902,542	2001 - 03 (average)	241,375	0.63	143,116	0.37
		IPM 2.1.9 (VISTAS)	281,000		78,000	
	893,454,905	IPM3.0 (base)	243,684	0.545	72,950	0.163
		IPM3.0 - will do	237,600	0.532	72,950	0.163
ND	339,952,821	2001 - 03 (average)	145,096	0.85	76,788	0.45
		IPM 2.1.9 (VISTAS)	109,000		72,000	
	342,685,501	IPM3.0 (base)	41,149	0.240	44,164	0.258
		IPM3.0 - will do	56,175	0.328	58,850	0.343
SD	39,768,357	2001 - 03 (average)	12,545	0.63	15,852	0.80
		IPM 2.1.9 (VISTAS)	12,000		15,000	
	44,856,223	IPM3.0 (base)	4,464	0.199	2,548	0.114
		IPM3.0 - will do	4,464	0.199	2,548	0.114
WI	495,475,007	2001 - 03 (average)	191,137	0.77	90,703	0.36
		IPM 2.1.9 (VISTAS)	155,000		46,000	
	675,863,447	IPM3.0 (base)	127,930	0.379	56,526	0.167
		IPM3.0 - will do	150,340	0.445	55,019	0.163

Minnesota Growth Changes in Minnesota(MRPO) 2018 Modeling Inventory

Minnesota removed the EGAS estimated growth from taconite facilities in Northeast Minnesota and replaced it with MPCA generated growth estimates. The $Minnesota_{(MRPO)}$ 2018 inventory growth consists of three new taconite facilities in Northeast Minnesota; Mesabi Nugget, and a proposed "east mine" and "west mine" that reflect emissions projections for Polymet Mining and Minnesota Steel Industries. Emission units that did not operate in 2002 (and so were not in the 2018 inventory) were also added at two existing plants: United Taconite (Line 1), and Northshore Mining Silver Bay (Furnace 5). These emissions are present only in the $Minnesota_{(MRPO)}$ modeling.

Controls on Future Year Inventory

Control factors that reduce emissions are applied after growth and may be due to the addition of physical controls to a process. These controls may be voluntary or due to regulatory requirements. Controls also reflect federal and state regulations, legislation and permit actions. MRPO contracted with E.H. Pechan and Associates to identify controls to be implemented – termed "on-the-books" controls – between 2002 and 2018 in source sectors except EGUs. In the MRPO inventory, the controls on all sectors (including EGUs) are:

On-Highway Mobile Sources
- Tier II/Low sulfur fuel;
- Inspection/Maintenance programs in nonattainment areas (does not apply in Minnesota); and
- Reformulated gasoline in nonattainment areas (does not apply in Minnesota).

Off-Highway Mobile
- Federal control programs incorporated into NONROAD model (e.g. nonroad diesel rule), and the evaporative Large Spark Ignition and Recreational Vehicle standards;
- Heavy-duty diesel (2007) engine standard/Low sulfur fuel;
- Federal railroad/locomotive standards; and
- Federal commercial marine vessel engine standards.

Electric Generating Units[38]
- Title IV Acid Rain Program (Phases I and II);
- NO_X SIP Call (does not apply in Minnesota);
- Clean Air Interstate Rule.

Other Point Sources
- VOC 2-, 4-, 7-, and 10-year Maximum Achievable Control Technology (MACT) standards;
- Combustion turbine MACT; and
- Industrial boiler/process heater/RICE MACT.
- The MRPO also included control factors to reflect settlement agreements for petroleum refineries and other non-EGU sources in MRPO states plus Minnesota.[39]

The $Minnesota_{(MRPO)}$ 2018 inventory includes the MRPO listed controls on the future year inventory.

Minnesota emissions totals for 2002 and 2018 from the $Minnesota_{(MRPO)}$ inventory are shown in Table 8.3. Emissions totals for states surrounding Minnesota are provided in the TSD.

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[38] These controls are included in the IPM3.0 projections.
[39] MACTEC, 2006.

Table 8.3: Annual Minnesota 2002 and 2018 Emissions Totals in Tons[40]

2002

Source Group		SO_2	NO_X	NH_3	PM_{25}	PM_{10}	VOC
Point		131,000	155,000	2,310	12,500	31,100	33,700
Area		22,800	58,100	175,000	19,500	72,200	133,000
Mobile	**On-road**	29	172,000	7,200	2,200	2,200	97,600
	Non-road	9,210	102,000	98	5,600	6,380	96,800
Biogenics		0	28,700	0	0	0	698,000
Minnesota TOTAL:		**163,000**	**516,000**	**185,000**	**39,900**	**112,000**	**1,060,000**

2018

Source Group		SO_2	NO_X	NH_3	PM_{25}	PM_{10}	VOC
Point		83,500	117,000	3,420	25,100	47,900	42,800
Area		22,700	62,100	239,000	19,500	72,400	129,000
Mobile	**On-road**	2	31,400	10,100	514	514	20,000
	Non-road	2,170	76,900	125	4,410	5,030	86,700
Biogenics		0	28,700	0	0	0	698,000
Minnesota TOTAL:		**108,000**	**317,000**	**253,000**	**49,600**	**126,000**	**977,000**

Alternative EGU Emission Projections without CAIR.

As described above, the on-the-books controls for EGUs presume CAIR is in effect. In July 2008, after the end of the initial public notice period for this SIP, the D.C Circuit Court of Appeals issued an opinion pointing out several "fatal flaws" with CAIR, and vacated the rule. The EPA petitioned for rehearing which included changing the remedy from vacatur to a remand. On December 23, 2008, the Court remanded CAIR to the EPA to be rewritten to address the flaws identified in the July ruling. This action means that CAIR is in effect while the flaws are addressed.

One issue the EPA must address on remand is whether Minnesota should continue to be included in CAIR. The Court ruled in July that the EPA did not adequately respond to claims made by Minnesota Power that data on Minnesota emissions were inaccurate, and that by using better data Minnesota would fall below the threshold impact on a nonattainment area that was used for inclusion.

In a letter dated October 31, 2008, from the EPA to Minnesota Power counsel, the EPA indicated its intent "to publish in the Federal Register a rule amending CAIR to stay the effectiveness of the rule with respect to sources located in the State of Minnesota. That administrative stay will remain in effect until such time as EPA determines through a rulemaking under the Clean Air Act whether Minnesota should be included in the CAIR region for fine particulate matter. EPA believes that in light of the Court's decision, sources in Minnesota should not be required to make any additional expenditures to comply with CAIR prior to the expiration of the administrative stay of the rule."[41] A proposed rule to stay application of CAIR in Minnesota was published on May 12, 2009.[42]

At the time CAIR was vacated by the courts, the MRPO developed future year EGU emissions without CAIR in place. Rather than use the IPM model, which was used to model CAIR, the emissions without-CAIR were developed using electricity generation forecasts from the Department of Energy's Electricity Market Module Supply Regions by fuel type, and then applying known controls. Details on how the future year projections were estimated are in the TSD.

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[40] To three significant digits. Totals may not add due to rounding.
[41] Meyers and Nakayama, 2008.
[42] 74 FR 22147

Minnesota has determined that the known controls in 2018 with CAIR in place – as modeled in the IPM 3.0 “will do” scenario and used to establish the RPG – and without CAIR in place – as shown in the MRPO Case B 2018 – are nearly identical for Minnesota. The resulting emissions projections are also very similar. Dissimilarities in emissions projections are attributed to differences in emission projection methods. The control assumptions in the IPM 3.0 “will do” scenario (with CAIR in place) and the controls without CAIR are shown in Table 8.4.

Because of the similarities in EGU emissions projected in Minnesota, both with and without CAIR, the MPCA has continued to use the modeling including the IPM 3.0 “will do” projections for EGUs.

Table 8.4: Future Year Control Assumptions with and without CAIR

Facility Name	Facility ID	Stack ID	Emission Unit ID	Pollu-tant	Controls Without CAIR: Case B: Legally Enforceable		Controls With CAIR: Modeled in SIP (IPM v3.0"will do")	
					2018 Control EF	Control Type	2018 Control EF	Control Type*
Xcel Energy - Riverside Generating Plant	2705300015	SV001	EU001	NO_X	100%	removed	100%	removed
				SO_2	100%	removed	100%	removed
			EU002	NO_X	100%	removed	100%	removed
				SO_2	100%	removed	100%	removed
		SV003	EU003	NO_X	100%	removed	100%	removed
				SO_2	100%	removed	100%	removed
			EU009	NO_X	*	new unit natural gas	*	new unit natural gas
				SO_2	*	new unit natural gas	*	new unit natural gas
		SV008	EU010	NO_X	*	new unit natural gas	*	new unit natural gas
				SO_2	*	new unit natural gas	*	new unit natural gas
		SV009	EU011	NO_X	100%	removed	100%	removed
				SO_2	100%	removed	100%	removed
Minnesota Power Inc - Boswell Energy Ctr	2706100004	SV003	EU003	NO_X	80%	SCR	80%	SCR
				SO2	85%	FGD	85%	FGD
Rochester Public Utilities - Silver Lake	2710900011	SV003	EU004	NO_X	40%	SNCR	**	**
				SO_2	85%	SCRUBBER	95%	SCRUBBER
Xcel Energy - High Bridge Generating	2712300012	SV001	EU001	NO_X	100%	removed	100%	removed
				SO_2	100%	removed	100%	removed
			EU002	NO_X	100%	removed	100%	removed
				SO_2	100%	removed	100%	removed
			EU003	NO_X	100%	removed	100%	removed
				SO_2	100%	removed	100%	removed
			EU004	NO_X	100%	removed	100%	removed
				SO_2	100%	removed	100%	removed
		SV008	EU010	NO_X	*	new unit natural gas	*	new unit natural gas
				SO_2	*	new unit natural gas	*	new unit natural gas
		SV009	EU011	NO_X	*	new unit natural gas	*	new unit natural gas
				SO_2	*	new unit natural gas	*	new unit natural gas

Facility Name	Facility ID	Stack ID	Emission Unit ID	Pollu -tant	Controls Without CAIR		Controls With CAIR	
					Case B: Legally Enforceable		Modeled in SIP (IPM v3.0"will do")	
					2018 Control EF	Control Type	2018 Control EF	Control Type*
Xcel Energy - Sherburne Generating Plant	2714100004	SV001	EU001	NO_X	50%	LNB	**	**
				SO_2	85%	SCRUBBER	**	**
			EU002	NO_X	50%	LNB	**	**
				SO_2	85%	SCRUBBER	**	**
		SV002	EU003	NO_X	50%	LNB	**	**
Xcel Energy - Allen S King Generating	2716300005	SV001	EU001	NO_X	80%	SCR	90%	SCR
				SO_2	82%	SCRUBBER	82%	SCRUBBER
Minnesota Power Inc - Taconite Harbor Ctr	2703100001	SV001	EU001	NO_X	50%	ROFA/SNCR	50%	ROFA/SNCR
				SO_2	40%	FSI	40%	FSI
		SV002	EU002	NO_X	50%	ROFA/SNCR	50%	ROFA/SNCR
				SO_2	40%	FSI	40%	FSI
		SV003	EU003	NO_X	50%	ROFA/SNCR	50%	ROFA/SNCR
				SO_2	40%	FSI	40%	FSI
Northshore Mining Silver Bay	2707500003	SV001	EU001	NO_X	40%	LNB		
				SO_2	20%***	Biomass		
		SV002	EU002	NO_X SO_2	40% 20%***	LNB Biomass		

* Additional emissions for new units in the without-CAIR case were projected to be comparable to the IPM 3.0 projections
** These projects became legally enforceable after the IPM 3.0 “will do” case was developed.
***This control, which is part of the BART determination for the unit, was not included in the final “Controls without CAIR” because the BART determination was incomplete at that time.

Biomass: Co-firing biomass with existing fuel
FGD: Fabric Filter/Flue Gas Desulfurization
FSI: Furnace Sorbent Injection
LNB: Low NOx Burner
ROFA: Rotating Opposed Fire Air System
SCR: Selective Catalytic Reduction
SNCR: Selective Non-Catalytic Reduction

MRPO Quality Assurance for Emissions Inventories

While developing the emissions inventory and conducting emissions modeling, Minnesota participated in the MRPO quality assurance for emissions inventories. The MRPO assured the quality of the data through the review of emissions reports and spatial analysis.[43]

- *Emission Reports*: EMS performs a number of checks and generates several reports, as documented in the EMS User’s Guide.[44] The quality assurance checks for point sources, for example, include checks for missing or mislocated location data, missing or invalid state and county designation codes, missing facility name, missing or invalid Standard Industry Classification codes, and missing or out-of-range stack parameters. The reports include tabular summaries of the state- and county-level emissions for point, area, and mobile sources; and various spatial plots of emissions.
- *Spatial Analysis*: A second level of quality assurance is performed by the air quality modelers. The additional checks include evaluating spatial tile plots of total daily SO_2, NO_X, VOC, ammonia, $PM_{2.5}$,

[43] Baker, 2004.
[44] LADCO, 1999a.

and coarse mass emissions, and evaluating plots that show the variation in emissions from month to month, and from hour to hour.

Canada Emissions Inventory

In addition to including emissions from the individual states within the United States, CENRAP and MRPO included emissions from Canada in an attempt to accurately characterize the 2002 base year. Canada's provinces report an emissions inventory to Environment Canada, similar to the states reporting the NEI to the EPA. The Criteria Air Contaminants Emission Inventory, a subset of Canada's overall Pollutant Release and Transfer Register (PRTR), includes the relevant pollutants.

However, Canada does not report emissions on the same schedule as the U.S., and a 2002 inventory was not available for use by the RPOs. The Canadian inventory is confidential and specifics are not shared freely outside the country. This makes it difficult to quality assure the data and understand whether the estimation methods are comparable. The MRPO has been collaborating with environmental staff in Ontario to better understand and implement improvements to the emissions estimates in that province.

For their base year 2002 inventories, CENRAP and MRPO used the Canadian 2000 inventory. During the iterative modeling process, it was determined that much of the emissions in the 2000 Canada inventory were assigned no stack height and as a result were modeled with the emissions released in the surface layer of the atmosphere. These included some very large sources, whose emissions are, in reality, released at much higher elevations. Because of meteorological (i.e. wind direction and speed) differences throughout the various layers, revisions to the release height were required. CENRAP made these changes to the Canadian 2000 inventory based on 2005 data. MRPO, which was in the process of switching to a 2005 base year, chose to use the Canadian 2005 inventory, and with the help of Ontario environmental staff fixed the problems there. The $\text{Minnesota}_{\text{(MRPO)}}$ case replaces the 2000 Canada inventory with the Canada 2005 inventory. Because of the large uncertainties in the Canada inventory, Minnesota elected to use the Canada 2005 inventory for both the base year and future year.

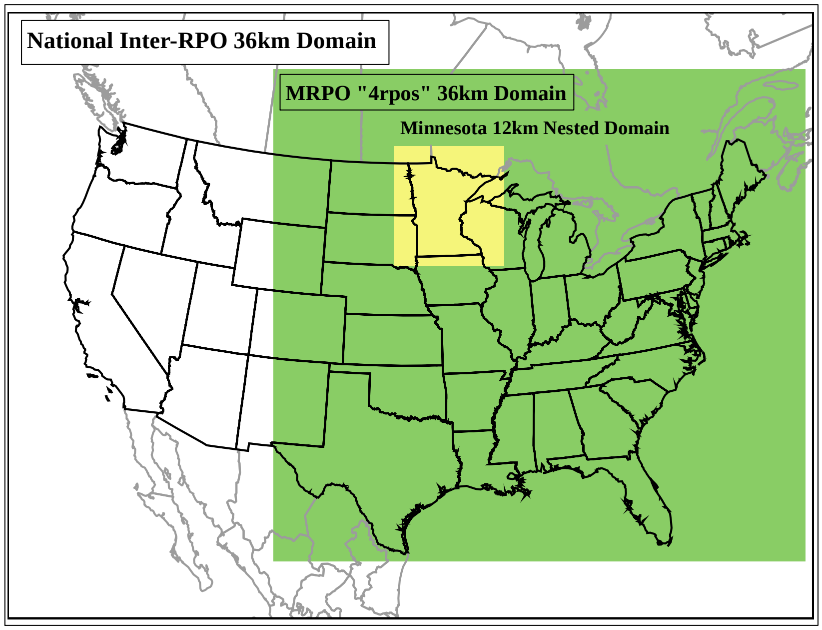
CENRAP used stack information from the Canada 2005 inventory to modify the Canada 2000 inventory, and used a Canada projected inventory from 2000 to 2018. The 2018 Canada inventory was distributed by the EPA and it is not clear whether EPA corrected the stack parameter problems with the 2018 Canada inventory.

Air Quality/Meteorology Preparations and Results

Emissions and meteorology were generated for every hour and allocated to 36km grids over the National Inter-RPO Domain. This domain was agreed upon by all the RPOs as the basic domain from which to model. The MRPO uses a subset of the national RPO domain, called the 4rpos domain, to focus on an area that includes the United States and Canada east of a line dissecting the United States at the western-most tip of Texas.

Both the National Inter-RPO Domain and the MRPO 4rpos domain are shown in Figure 8.1. CENRAP generated modeling emissions in a similar fashion, but encompassing the entire National Inter-RPO 36km domain. In addition to using the MRPO domain, Minnesota created a 12km flexi-nested domain and used the CAMx plume-in-grid tool to evaluate visibility impacts of individual elevated point sources located near the Class I areas.

Figure 8.1: Modeling Domains



Performance Evaluation for Air Quality Models

Meteorological Model Performance for the Base Year (2002) Data

The meteorological data was prepared by Matthew Johnson of the state of Iowa. There are two model performance documents: *Meteorological Modeling Performance Summary for Application to $PM_{2.5}$/Haze/Ozone Modeling Projects*[45]and *Meteorological Model Performance Evaluation of an Annual 2002 MM5 (version 3.6.3) Simulation v2.0.3*.[46] Model performance was deemed good.

Air Quality Model Performance for the Base Year (2002) Inventory

Both CENRAP and MRPO have evaluated model performance over the entire domains they modeled. Because Minnesota is using MRPO inputs with emissions modifications, the state focused its own model performance on BWCAW and VNP. Particular attention was placed on the 20 percent best and worst days in the two Class I areas.

Model performance evaluation is conducted on the base year, 2002, using the 2002 emission inventory (except for Canada) and meteorology. Several iterations of the 2002 base inventory were completed by MRPO, culminating in the final 2002 inventory that serves as the basis for the $\text{Minnesota}_{(\text{MRPO})}$ modeling. Model performance evaluations of these iterations allowed for improving the emissions, meteorology and the CAMx model, resulting in improved model performance. The base year period used to evaluate model performance is the same as the base year used in the modeled attainment test.

Minnesota evaluated performance of the model specifically at BWCAW and VNP; and for the 20 percent worst days. The speciated components used in the $\text{Minnesota}_{(\text{MRPO})}$ evaluation are collected at IMPROVE monitor network sites. This network collects individual $PM_{2.5}$ components at BWCAW and VNP.

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[45] Baker et al., 2005.
[46] Johnson, 2004 – 2007.

EPA guidance recommends considering various statistical assessments and other techniques of model versus observed pairs when conducting a performance evaluation for regional haze. The other techniques include spatial plots, time series plots and qualitative descriptions. Focus for the statistical assessment is on mean fractional bias and error.

The statistical evaluation of the Minnesota$_{(MRPO)}$ modeling performance was done for 24-hour averaging times. Fractional bias and error are evaluated for 36km and 12km (with plume-in-grid) grid scale modeling. There are a total of 32 twenty percent worst days. Eight days are BWCAW only, 10 days are VNP only, and 14 days are shared between the two Class I areas.

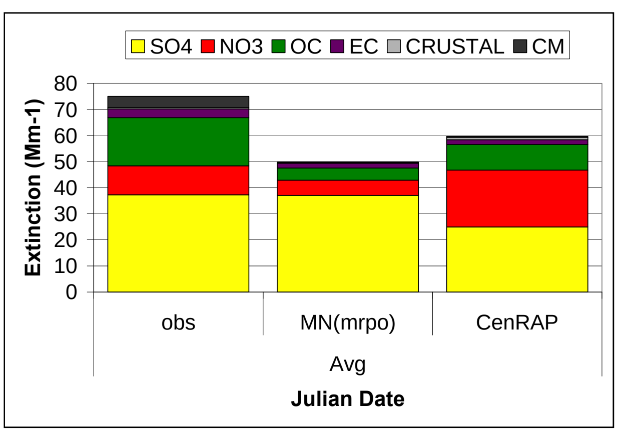
The conclusion of the performance evaluation specifically at BWCAW and VNP indicates model performance for sulfate is good throughout the year for all organizations. Nitrate performance is best in the colder months (quarter 1 and 4), but has some issues; organic carbon performance is good, except for five days associated with wildfires (wildfire emissions were not included in the modeling). Fine soil (crustal), and elemental carbon performance is good. Coarse particulate mass performs poorly, which is expected because coarser primary particles (largely composed of wind borne dust) do not travel far and are influenced by very nearby sources. The grid scale of the modeling cannot account for these local influences. Also, wind borne dust was excluded from the emissions inventory because of concerns about the transportable fraction of fugitive dust.

Comparison of Minnesota$_{(MRPO)}$ and CENRAP Model Performance Evaluation for Nitrate on Individual Days

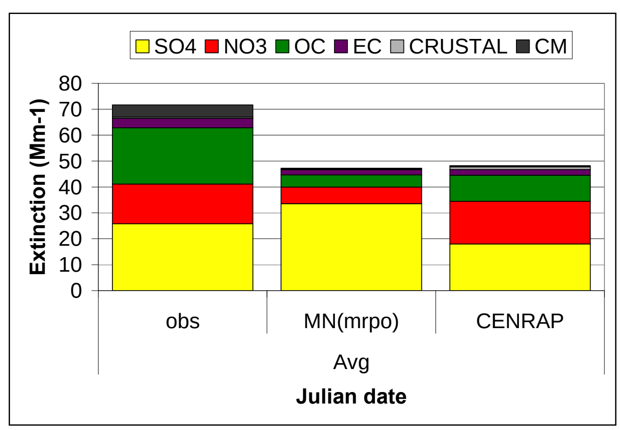
The Minnesota$_{(MRPO)}$ and CENRAP performance evaluations show some conflicting performance results for nitrate. Figure 8.2 depicts the difference between Minnesota$_{(MRPO)}$ modeling and CENRAP averaged over the 20 percent worst days at VNP and BWCAW. The differences appear on some individual of the 20 percent worst days. All these days occur in the winter and with winds traveling toward the Class I areas from the West and Northwest. The TSD contains the individual day model comparisons to observed – along with evidence of the direction of wind origination – for various individual days where the Minnesota$_{(MRPO)}$ modeling and CENRAP modeling perform very differently from one another. These are days where CENRAP overpredicts nitrate and the Minnesota$_{(MRPO)}$ model underpredicts nitrate.

Figure 8.2: Observations and Predictions by Minnesota$_{(MRPO)}$ and CENRAP Extinction by Species at Averaged Over 20 Percent Worst Days

VNP



BWCAW



Implications of the Performance Evaluation

1. **Reasonable Progress Goal Development.** The model performance, especially for sulfate, fits within performance goals for developing regional haze policy.[47] The underprediction of nitrate in the $Minnesota_{(MRPO)}$ modeling appears to be caused by a lack of ammonia available on the high nitrate days in the winter, which is discussed in more detail in the TSD supporting this SIP. This could make the model under-responsive to future NO_X reductions. The CENRAP modeling, which appears to have too much ammonia, may have the opposite response. The reality is likely somewhere in between. The "Supplemental Analysis/Weight of Evidence Determination" section at the end of this Chapter 8 highlights how these model performance discrepancies for nitrate affect the results of the future year visibility conditions used to set reasonable progress goals.

   Poor performance of coarse mass is not a concern as coarse particulate mass is not a prominent component in the extinction calculation, nor is it significant in the extinction calculated at BWCAW and VNP on the 20 percent worst days (see Appendix 5.2), so changes in this component will not affect the resulting future year projection.

2. **Grid Scale Needs.** The performance evaluation at the monitor locations is slightly better at 36km than for the $Minnesota_{(MRPO)}$ 12km(with plume-in-grid) grid for nitrate. Thus, the 36km modeling results are used for establishing the reasonable progress goal in deciviews at the monitor locations in BWCAW and VNP. The 12km (with plume-in-grid) results are used to address local contributions to regional haze impacts throughout each Class I area, but not for setting the RPG.[48] When using 12km (with plume-in-grid) results, the performance evaluation results prompted Minnesota to assess visibility at multiple receptors located throughout VNP, BWCAW, and the western tip of Isle Royale.

3. **Horizontal Extent of Domain.** $Minnesota_{(MRPO)}$ modeling performance for nitrate suggests it could benefit from extending the domain further west to encompass additional sources in Canada. However, because of the uncertainty of Canadian emissions development, Minnesota kept Canadian emissions constant between the base and future year. Thus, extending the domain would have no affect on the reasonable progress goals established in this SIP. Further discussion of Canadian contributions to regional haze is found in the TSD.

4. **Improvements to Emissions Inventory.** Continued emissions/modeling and corresponding performance evaluations conducted by the RPOs have resulted in the best emissions inventory possible to date. Ammonia emissions estimates and response to changes in ammonia levels as it affects NO_X emissions reductions (see #1), and better understanding of Canada's inventory are areas to continue to explore. Based on the fit to model performance goals, and how the model results are applied in the establishment of reasonable progress goals, the MPCA believes that the base year and future year emission estimates used are sufficient to support this SIP.

5. **Modifications of Models**. Model performance evaluations over entire domains have resulted in changes to models, made for some reason other than achieving regional haze goals. An example would be the secondary organic aerosol (SOA) module improvements in CMAQ, and more recently in CAMx. Although overall model performance for organic carbon may improve, model results without those improvements are acceptable in BWCAW and VNP. Also, improved SOA will not affect reasonable progress in BWCAW and VNP because natural biogenic emissions – which are the main source of SOA formation at the Class I areas– remain constant in the baseline and future year. As no controls are proposed for trees, thus they are not accounted for in development of the RRFs.

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[47] U.S. EPA, OAQPS, 2007a.

[48] Minnesota evaluated reasonable progress using the 12km (with plume-in-grid) results for several receptors throughout the Class I areas. The 2018 projected values ranged from 18.3 – 19.0 deciviews, with an average value of 18.7 deciviews in the BWCAW – the largest Class I area – for the 20 percent worst days. The average value is the same as the 36km result at the monitor location. The same is true for the 20 percent best days.

Exploration of Potential Strategies for Demonstrating Reasonable Progress

In addition to the "on-the-books" controls culminating in the 2018 emissions inventory described above, the MPCA explored other control measures, based on initial cost estimates by CENRAP, initial four-factor analyses results from MRPO, and other measures under consideration in Minnesota. The MPCA looked at reductions in emissions resulting in a 0.25 lb/MMBtu limit on EGUs in Iowa, Missouri, North Dakota, and Wisconsin; reductions in SO_2 and NO_X emissions from point sources in Northeast Minnesota equaling a 30 percent reduction from 2002 emissions; and additional controls on a Minnesota utility located in central Minnesota.

The source categories and regions approached while looking for additional reasonable control measures are based on an analysis of the source sectors and pollutant species in various geographic regions contributing to visibility impairment in 2018. The PSAT tool in CAMx was used in this assessment, and the focus was on the 20 percent worst days.

The 2018 projections indicate that Minnesota is by far the largest individual state contributing to light extinction due to nitrate, sulfate and ammonium in the BWCAW and VNP. The next largest individual state contributors at BWCAW are Wisconsin, Iowa, Illinois, Missouri, and North Dakota. The next largest individual state contributors at VNP are North Dakota, Iowa, Wisconsin, and Canada.[49] Figures 8.3 and 8.4 show the percent contributions of these individual states, the remaining states, and Canada to total light extinction in 2018 presuming implementation of "on-the-books" controls.

In the Figures, Boundary Conditions (BC) account for 11% at BWCAW and 15% at VNP of the visibility impairment. Boundary conditions are source contributions outside of the modeling domain. In the case of the regional haze SIP (and ozone and $PM_{2.5}$ attainment modeling), they are the conditions derived from monthly averaged species output from the global scale chemical transport model (GEOS-CHEM) for the year 2002. Essentially, the GEOS-CHEM model is run at a much coarser grid resolution to allow for modeling global emissions. The GEOS-CHEM model output is processed to remove discrepancies between the grid scales, etc., and the GEOS-CHEM and CAMx model are linked at the CAMx domain boundary.

Boundary conditions can transfer into and out of the CAMx modeling domain from the North, South, East and West. Ozone can also enter in from the top of the domain due to stratospheric infusion. Source apportionment techniques can only account for the total contribution of boundary conditions to the overall visibility conditions, which accounts for the conservation of mass in the apportionment modeling.

[49] Canada contributions based on 2005 emissions.

Figure 8.3: Nitrate, Sulfate, Ammonium Contributions to Extinction (Mm^{-1}) in 2018 at BWCAW by Region for W20% Days

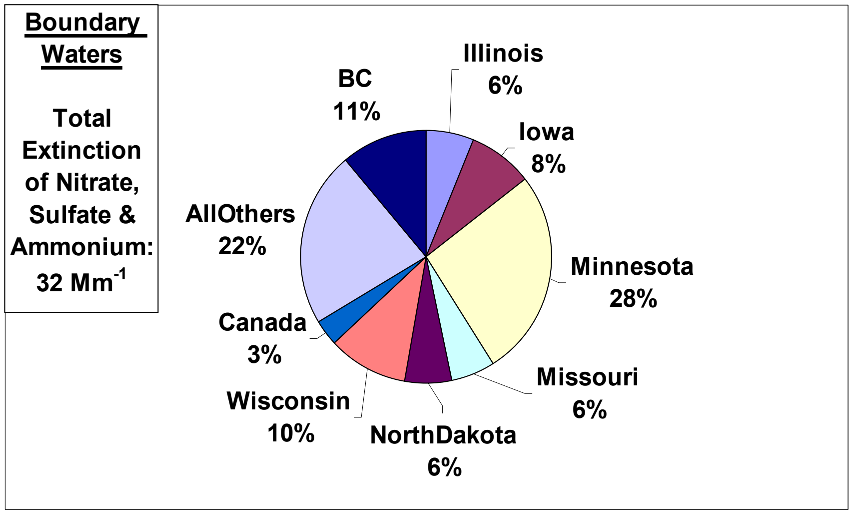
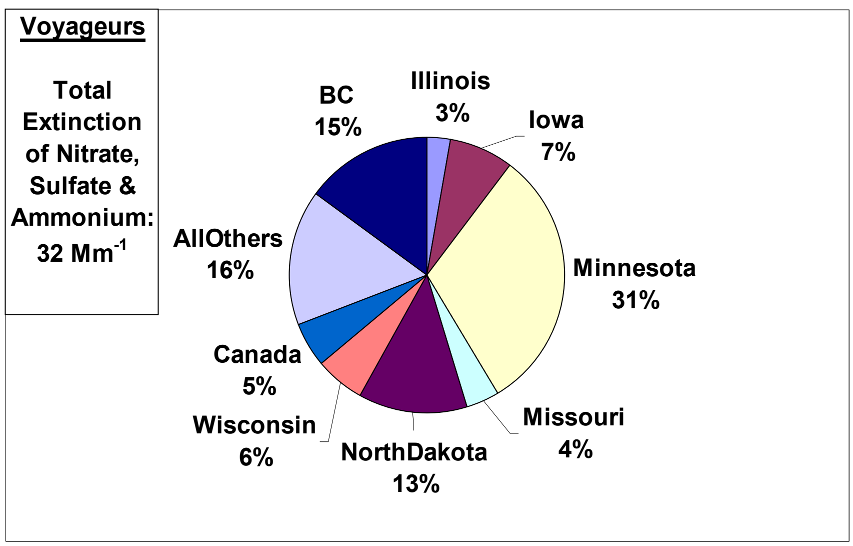


Figure 8.4: Nitrate, Sulfate, Ammonium Contributions to Extinction (Mm^{-1}) in 2018 at VNP by Region for W20% Days



From the base year (2002) to the future year (2018), the regions specified above show less contribution to nitrate, sulfate and ammonium by somewhere between zero and about five percent. For example, Illinois contributes nearly five percent less at BWCAW in 2018 compared to 2002, resulting in a six percent contribution in 2018.

In 2018, Minnesota contributes mainly sulfate, with lesser amounts of nitrate and ammonium; sulfate formation appears to result nearly equally from EGUs and non-EGU point sources. Ammonium is almost exclusively from agricultural ammonia sources. Contributions from other states have a similar makeup, but with less impacts from the non-EGU sector.

The CENRAP case shows a higher contribution from nitrate sources than the Minnesota$_{(MRPO)}$ case and shows much less contribution to nitrate at BWCAW from onroad and nonroad sources in Minnesota, Canada, North Dakota and the western United states in 2018 than 2002. The CENRAP case shows significantly less contribution of point source sulfate from other states, but for Minnesota, there is more contribution from non-EGU point source sulfate from the base year to the future year.

Over the 20 percent worst days, the Minnesota$_{(MRPO)}$ 12km PSAT results for 2018 indicate that Northeast Minnesota contributes 14 percent and the rest of Minnesota contributes 12 percent of total extinction at the BWCAW monitor location. Northeast Minnesota contributes 15 percent and the rest of Minnesota contributes 17 percent of total extinction at the VNP monitor location. Figures 8.5 and 8.6 illustrate the extinction contribution between Northeast Minnesota and the rest of Minnesota relative to contributions from all other geographic areas.

As noted above, the 12km results suggest that contribution assessments should be conducted at several receptor locations throughout the Class I areas, rather than only at the monitor locations. Contributions from local (Northeast Minnesota), mostly point, sources assessed across the Class I areas (VNP, BWCAW, and the tip of Western Isle Royale) range from 4 – 19 percent of total extinction. The four percent appears at the western tip of Isle Royale, while the 19 percent contribution is in BWCAW. Contributions from the rest of Minnesota range from 9 – 17 percent; nine percent at the western tip of Isle Royale and the 17 percent at VNP. Figure 8.6 shows results at the receptor with the maximum (BWCAW, receptor 13) and the minimum (Western tip of Isle Royale) impact from Northeast Minnesota.

Figure 8.5: Percentage Contribution of Northeast and Rest of Minnesota to BWCAW (BOWA1) and VNP (VOYA2) for W20% Days

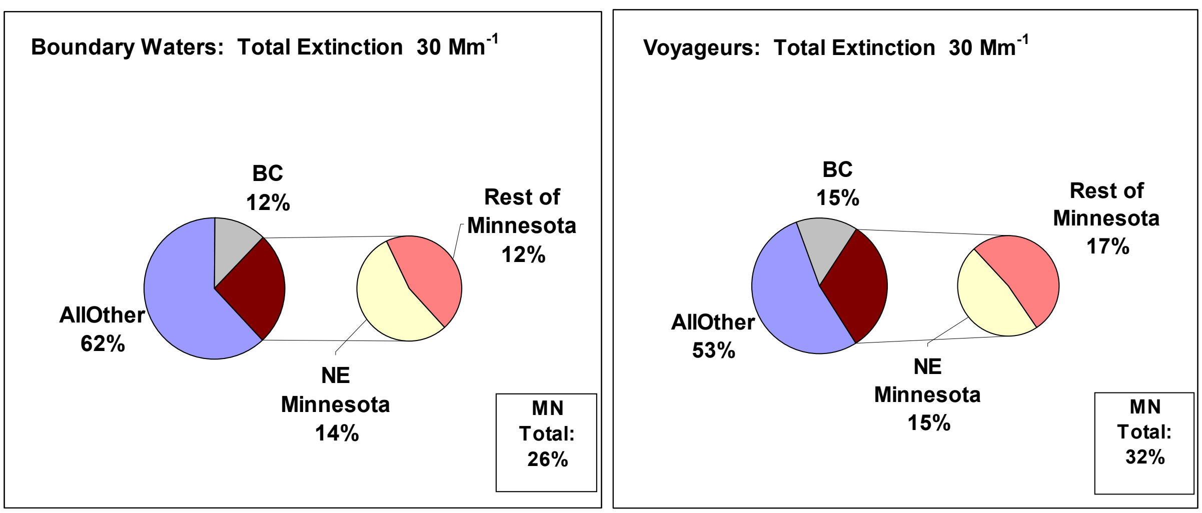
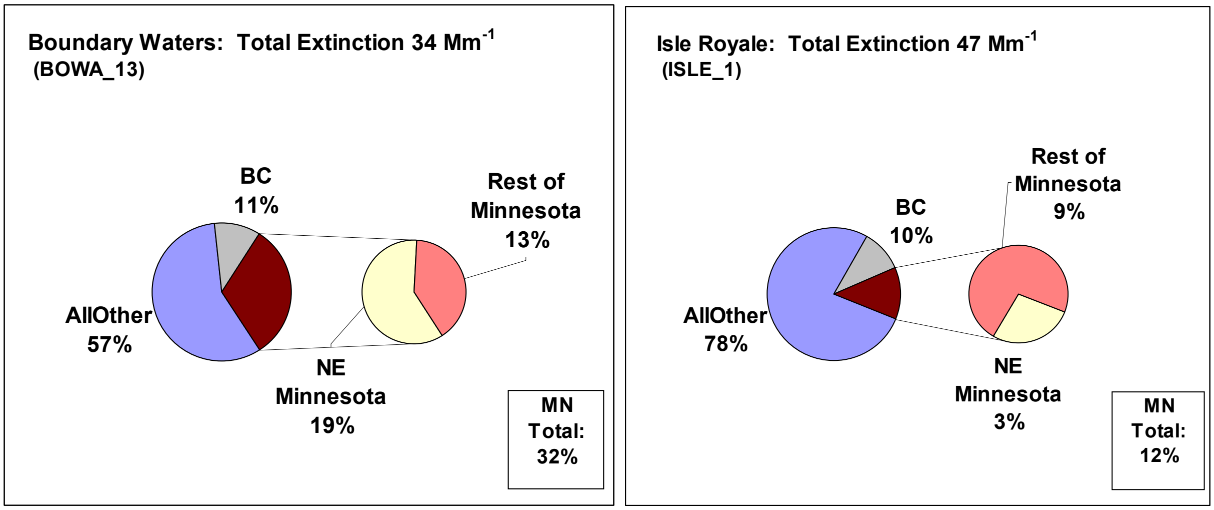
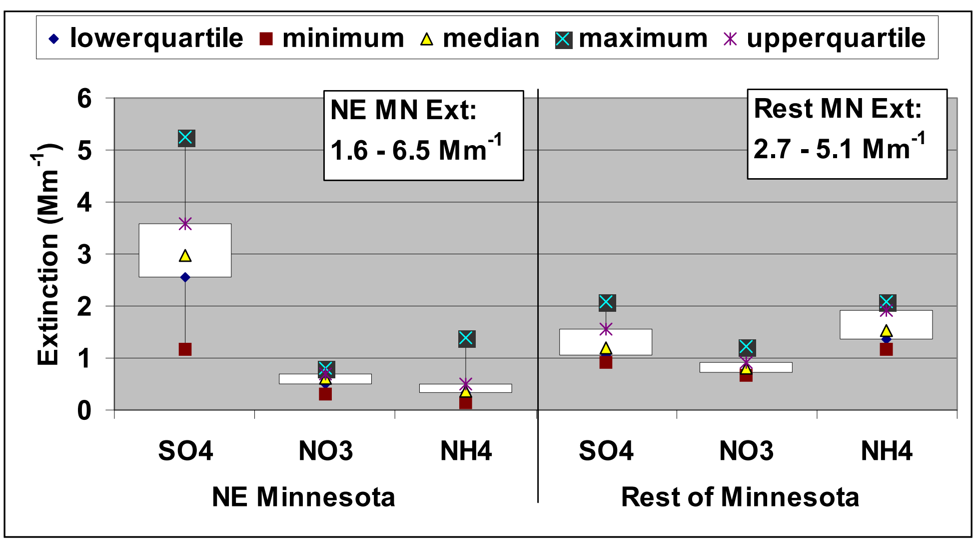


Figure 8.6: Percentage Contribution of Northeast and Rest of Minnesota to Maximum (BOWA_13) and Minimum (ISLE) Receptors in the Class I areas for W20% Days



Minnesota$_{(MRPO)}$ results for the 12km (with plume-in-grid) analysis indicate sulfate is the major component contributed by point sources in Northeast Minnesota, while the rest of the state is more evenly divided between sulfate from point sources and ammonium from agricultural sources. Figure 8.7 illustrates the species contributions across the Class I areas. The Figure shows significantly less visibility impact due to Northeast Minnesota contributions to nitrate. This may seem counterintuitive because emissions of NO_X in Northeast Minnesota are much higher than SO_2. Point source emissions of NO_X are about 37,500 tons per year, while SO_2 emissions are just over 8,000 tons per year.

Figure 8.7: Minnesota Contributions at Receptors Placed Throughout Boundary Waters, Voyageurs and the tip of Isle Royale in 2018 by Species and Geographic Region



An explanation for this discrepancy in contribution of NO_X and SO_2 to the 20 percent worst days is that particulate nitrate is an issue on fewer days and is formed in the colder months. Viewing animated spatial plots of the source apportionment results on days with high nitrate show that winds on several of the days winds appear to be coming from the west and northwest of Minnesota. Thus, the NO_X emissions are not moving north toward the Class I areas to form ammonium nitrate, but are moving to the East, Southeast and South.

Any actions taken based on these results should be done so with some caution. There are several remaining questions about ammonia emissions and nitrate. First, as mentioned previously, model performance for nitrate is worse than model performance for sulfate, and the model generally underpredicts the formation of nitrate, likely due to an underestimation of wintertime ammonia. Without ammonia monitors located in Northeast Minnesota, it is not possible to measure actual ammonia concentrations. Also, as noted in Chapter 9 (related to BART), emissions estimates for NO_X from non-EGU point sources in Northeastern Minnesota may be less accurate than those for other point sources.

Current future emissions estimates show significant SO_2 emission reductions in the area. If there is considerably more ammonia in the system than represented in the $\text{Minnesota}_{(MRPO)}$ case , more ammonia may be available to form ammonium nitrate and a greater model response may be seen from reductions in NO_X emissions.

The uncertainties surrounding the impact of ammonia in the formation of ammonium nitrate and the resulting effect on visibility provide enough incentive not to discount the ability of NO_X emission reductions to improve visibility. Therefore, potentially reasonable 2018 control measures for visibility should continue to include measures to reduce NO_X emissions.

The potentially reasonable measures explored in 2018 include:

1. Estimated emission levels applied to the Xcel Energy – Sherburne County plant (located in central Minnesota) based on a January 2007 announcement of a potential project. This involves retrofit SCRs, fabric filters and dry scrubbers on Units 1 and 2 and SCR on Unit 3;[50]
2. A 0.25 lb/MMBtu emission rate from Iowa, Missouri, North Dakota and Wisconsin. These rates were applied to EGUs in those states that did not already have additional controls in place; and
3. Additional emissions reductions associated with the Northeast Minnesota Plan, under which the six counties in northeast Minnesota would maintain a 30% reduction in NO_x and SO_2 from 2002 emissions levels. About 21 percent of that reduction is already associated with Northeast Minnesota utility emission projections in the IPM version 3.0 “will do” scenario. The remaining approximately 10 percent was applied to taconite industry sources. The emission reductions were based on permit limits, furnace modifications in 2006 and 2007, fuel switching, a new scrubber, newer rate information, and some reductions due to BART. The details of these future year emissions estimations are specified in the TSD.

Table 8.5 summarizes the 2018 point source emissions projections of SO_2 and NO_X associated with the potentially reasonable control measures and the emissions change from the 2018 $\text{Minnesota}_{(MRPO)}$ emissions projections modeled.

[50] In a December 2007 filing, Xcel Energy dropped the proposal for SCR from all three units due to cost concerns. Instead they propose low NO_X burners for NO_X controls. The new proposal projects less SO_2 emissions, but quite a bit more NO_X emissions than the proposal reflected in the potentially reasonable control measures modeling.

Table 8.5: 2018 Annual Potentially Reasonable Control Measures Emissions for Point Sources

Region	SrcGroup	Potentially Reasonable Control Measure Emission (ton/year)		Emission Reduction from 2018 (ton/year)		Percent Reduction from 2018	
		SO_2	NO_X	SO_2	NO_X	SO_2	NO_X
Iowa	EGU	66,700	58,500	-47,200	0	-41%	
	non-utility	49,000	32,500	0	0		
Minnesota	EGU	51,000	38,200	-2,980	-10,700	-6%	-22%
	non-utility	26,000	57,700	-1,900	-6,550	-7%	-10%
Missouri	EGU	127,000	72,700	-111,000	0	-47%	
	non-utility	125,000	31,300	0	0		
North Dakota	EGU	46,000	39,900	-12,300	-18,900	-21%	-32%
	non-utility	19,000	11,600	0	0		
Wisconsin	EGU	96,300	51,900	-48,200	0	-33%	
	non-utility	57,200	30,600	0	0		

The visibility analysis methodology, described at the beginning of this Chapter 8, was used to consider a reasonable progress goal were the potentially reasonable control measures in place. The resulting goals at BWCAW and VNP, due to the emissions reductions summarized above, are shown in Figures 8.8 and 8.9. The results show a potential reasonable progress goal at BWCAW of 18.3 deciviews and a potential reasonable progress goal at VNP of 18.7 deciviews.

A straight line connecting the baseline visibility average (2000-2004) and natural conditions (2064) form the uniform rate of progress or "glidepath." Placement relative to the line determines whether estimated future visibility (i.e. 2018) moves in a downward direction at such a rate that natural conditions are likely reached by 2064. A reasonable progress goal at VNP would be on the glidepath in 2018 if visibility impairment on the 20 percent worst visibility days were reduced from the baseline by a total of 1.7 deciviews. $[(19.5-12.1)\times((2018-2004)\div(2064-2004))]$. BWCAW would be on the glidepath in 2018 if visibility impairment on the 20 percent worst days were reduced from the baseline by 2 deciviews.

The reasonable progress assessment based on the potentially reasonable controls described above indicate that the goal for the 20 percent worst days would be a reduction from the baseline of 0.8 deciviews at VNP and 1.6 deciviews at BWCAW. Although the values show progress toward natural visibility conditions, obviously the 2018 goal would be positioned above the uniform rate of progress toward natural visibility conditions at both Class I Areas.

Figure 8.8: BWCAW 36-km Minnesota$_{(MRPO)}$ Potentially Reasonable Emissions Reduction Results

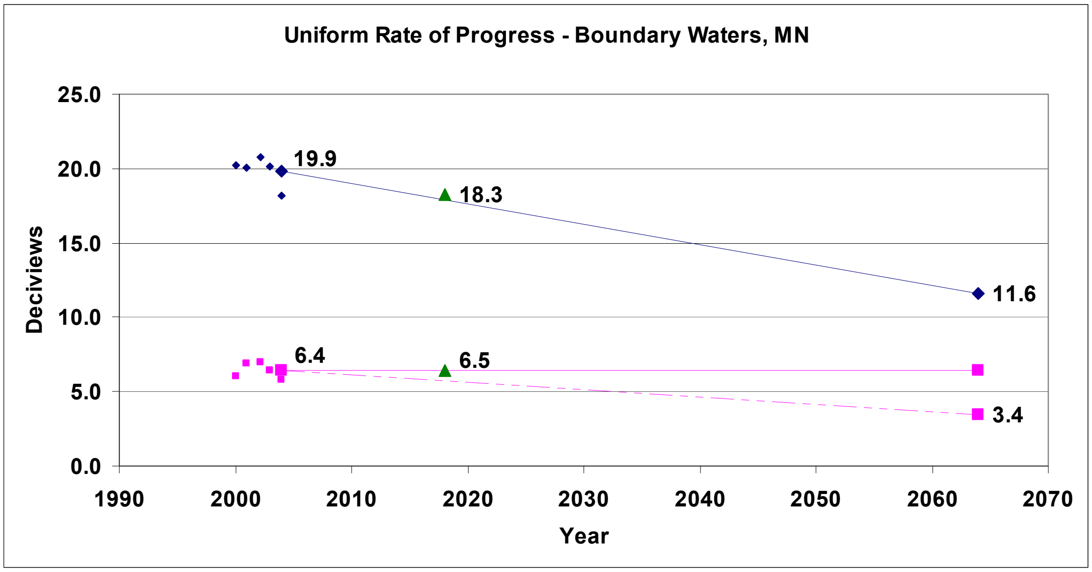
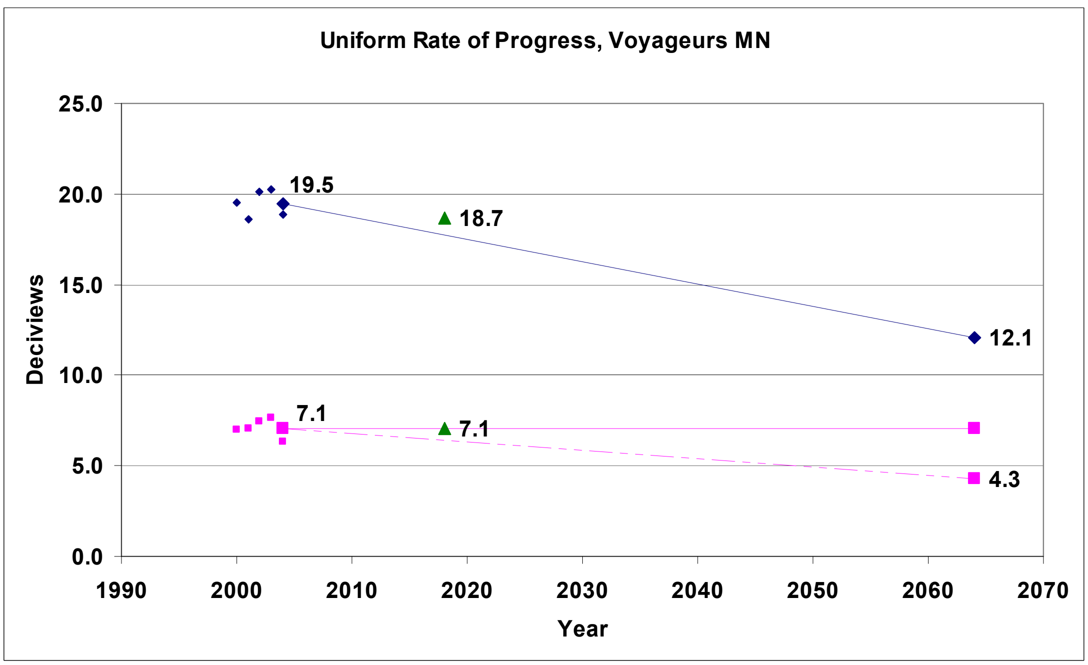


Figure 8.9: VNP 36-km Minnesota$_{(MRPO)}$ Potentially Reasonable Emissions Reduction Results



Reasonable Progress Strategy and Goals

Rather than set a reasonable progress goal based on potentialities, without determinations of reasonableness, the MPCA set the reasonable progress goal only considering the "on-the-books" controls (those controls expected due to programs other than the Regional Haze Rule) and the emissions strategy outlined in the Northeast Minnesota Plan. Based on these measures, the goal for the 20 percent worst days is a reduction from the baseline of 0.6 deciviews at VNP and 1.3 deciviews at BWCAW, as presented in Table 8.6 and illustrated in Figures 8.10 and 8.11. Further information on the reasonable progress goals, and why they are set at this level, is presented in Chapter 10.

Table 8.6: Reasonable Progress Goals for BWCAW and VNP

Class I Area	Days Represented	Reasonable Progress Goal for 2018 in deciviews	Difference Between RPG and URP in deciviews
BWCAW	20% Worst	18.6	0.7
	20% Best	6.4	0.0
VNP	20% Worst	18.9	1.1
	20% Best	7.0	0.0

Figure 8.10: BWCAW 36-km Minnesota$_{(MRPO)}$ Results

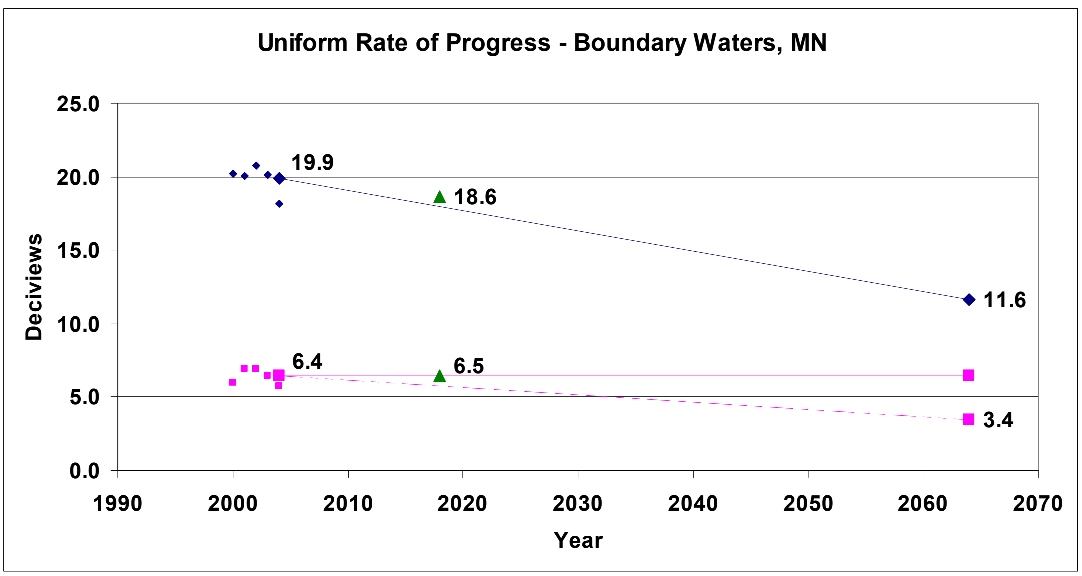
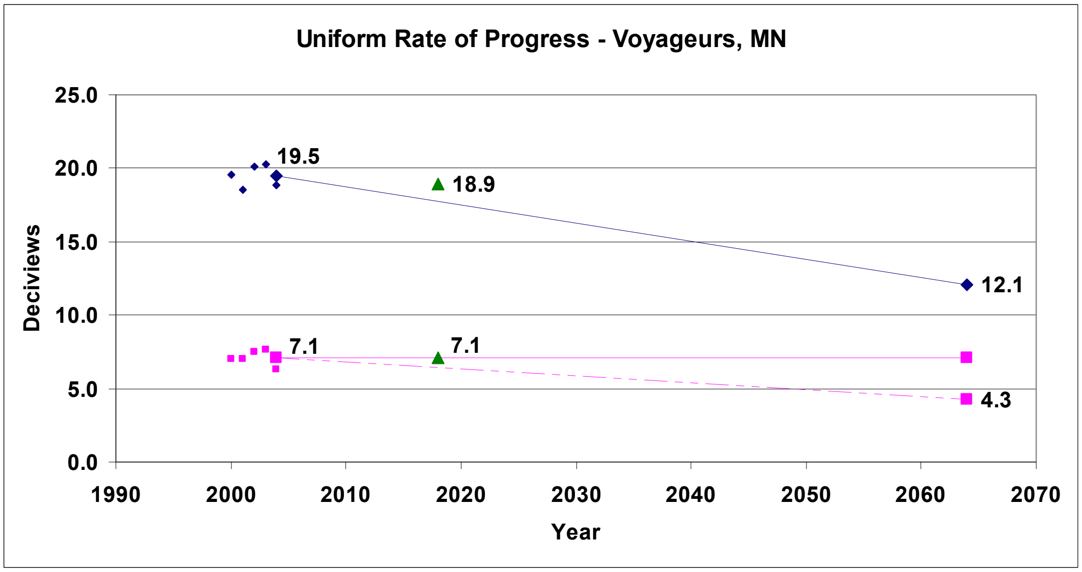


Figure 8.11: VNP 36-km Minnesota$_{(MRPO)}$ Results



Supplemental Analysis/ Weight of Evidence Determination

As mentioned above, there are differences among the future year projections modeled by CENRAP, MRPO and Minnesota$_{(MRPO)}$ available to derive reasonable progress goals for BWCAW and VNP. The resulting future year projections with on-the-books controls and some reasons for the differences are summarized here. Because the MRPO conducted modeling for both a 2002 and a 2005 base year, the MRPO 2002 base year modeling will be discussed first in relation to CENRAP and Minnesota$_{(MRPO)}$ modeling, which also both use a 2002 base year. Discussion of the use of the 2005 base year follows.

In order to do an equitable comparison, the visibility conditions and future year values for each organization were calculated using the same monitoring data establishing the baseline. The only difference lies in the modeled base year and future year concentrations, which are used to calculate RRFs applied to the baseline monitoring data.

Table 8.7 contains the Minnesota$_{(MRPO)}$ projections[51] for the 20 percent worst days at BWCAW and VNP along with the results of other modeling work conducted by CENRAP, and by MRPO for the 2002 base year. For the 20 percent worst days, the CENRAP results show future year projections that are the same at BWCAW, and 0.4 deciviews closer to the glidepath at VNP, than Minnesota$_{(MRPO)}$. The Minnesota$_{(MRPO)}$ projections are 0.3 deciviews closer to the glidepath at both BWCAW and VNP than MRPO.

[51] Minnesota$_{(MRPO)}$ values for the 12km grid assessed for several receptors throughout the Class I areas, indicated a range of 2018 projected values from 18.3 – 19.0 deciviews, with an average value of 18.7 deciviews in Boundary Waters for the 20 percent worst days. The average value is the same as the 36km result at the monitor location. The same is true for the 20 percent best days. It does not appear necessary to set separate goals for various locations across the Class I area based on the 12km results.

Table 8.7: Visibility Projections to 2018 using CENRAP, Minnesota$_{(MRPO)}$, and MRPO Modeling from a 2002 Base Year for the 20% Worst Days

Class I Area Name	Organiza-tion	Grid Resolution	Base Year	Baseline (dv)	2018 URP (dv)	2018 Projected (dv)	difference (dv)
Boundary Waters	CenRAP	36	2002	19.9	17.9	18.6	0.7
Boundary Waters	**Minnesota**	**36**	**2002**	**19.9**	**17.9**	**18.6**	**0.7**
Boundary Waters	MRPO	36	2002	19.9	17.9	18.9	1.0
Voyageurs	CenRAP	36	2002	19.5	17.8	18.6	0.8
Voyageurs	**Minnesota**	**36**	**2002**	**19.5**	**17.8**	**18.9**	**1.1**
Voyageurs	MRPO	36	2002	19.5	17.8	19.2	1.4

Reviewing the RRFs for the individual species can help gain a better understanding of why there are differences in the position relative to the URP. Table 8.8 contains the RRFs by visibility component, or species, for each organization. A factor above 1.000 means the modeled concentration increases from 2002 to 2018. A factor below 1.000 means the modeled concentration decreases from 2002 to 2018.

Table 8.8: Relative Response Factors to 2018 using CENRAP, Minnesota$_{(MRPO)}$, and MRPO Modeling from a 2002 Base Year for the 20% Worst Days

Class I Area Name	Organiza-tion	Grid	Base Year	Relative Response Factors: sulfate	nitrate	organic carbon	elemental carbon	crustal/ soil	coarse mass
Boundary Waters	CenRAP	36	2002	0.870	0.790	0.947	0.756	1.102	1.062
Boundary Waters	**Minnesota**	**36**	**2002**	**0.791**	**0.921**	**0.943**	**0.786**	**1.402**	**1.127**
Boundary Waters	MRPO	36	2002	0.877	0.929	0.949	0.788	1.265	1.112
Voyageurs	CenRAP	36	2002	0.932	0.817	0.954	0.796	1.101	1.091
Voyageurs	**Minnesota**	**36**	**2002**	**0.848**	**1.031**	**0.954**	**0.834**	**1.275**	**1.069**
Voyageurs	MRPO	36	2002	0.949	1.054	0.956	0.830	1.200	1.064

Evaluation of the RRFs for BWCAW and VNP focuses on sulfate and nitrate. Both of these components figure prominently in the extinction calculation (see Chapter 5). Crustal/soil and coarse mass are not prominent components in the extinction calculation, nor are they significant in the extinction calculated at BWCAW and VNP on the 20 percent worst days (see Appendix 5.2), so changes in these components will not affect the resulting future year projection. Elemental carbon has low measured values at the two Class I areas; even though the extinction calculation multiplies the observed concentration of elemental carbon by a factor of 10, it still does not feature prominently in the future year projections at BWCAW and VNP. The RRFs for organic carbon are similar between the various analyses, so no further discussion is warranted for that component.

Because the 2002 MRPO modeling is the basis for the Minnesota$_{(MRPO)}$ analysis, it is easier to compare these two analyses. According to the RRFs, the most noticeable differences between MRPO and Minnesota$_{(MRPO)}$ cases are in the response to sulfate reductions. As expected, the Minnesota$_{(MRPO)}$ modeling shows greater reductions due to the EGU emission projections associated with IPM version 3.0 “will do”. The MRPO modeling for the 2002 base year used IPM version 2.1.9(VISTAS).

The noticeable differences in RRFs for sulfate between CENRAP and Minnesota$_{(MRPO)}$ are also mainly due to the differences in future year EGU emission estimates. This conclusion is drawn from the similarity in the MRPO and CENRAP sulfate RRFs; both organizations used IPM version 2.1.9(VISTAS).

Even more noticeable than the differences in sulfate RRFs, are the differences in RRFs for nitrate between the CENRAP and the MRPO and $Minnesota_{(MRPO)}$ cases. CENRAP RRFs show significantly more reductions in nitrate. These differences in nitrate RRFs overcome the sulfate decreases in the $Minnesota_{(MRPO)}$ modeling attributable to the change from IPM2.1.9 to IPM3.0, so that overall, the CENRAP position in relation to the URP is the same as the $Minnesota_{(MRPO)}$ results at BWCAW and is closer to the URP than the $Minnesota_{(MRPO)}$ results at VNP. The reasons for these differences are more complicated to discern because there are more underlying differences in the emissions inventories. The MPCA suspects that the greater reductions in nitrate in the CENRAP modeling are associated with the following:

- While the $Minnesota_{(MRPO)}$ case keeps Canada emissions constant between the base year and the future year, the CENRAP case uses a 2000 and a projected 2018 Canadian inventory. Projected emissions in the CENRAP case contain lower Canadian NO_X emissions in 2018 than in 2002. Thus, these emissions reductions could be reflected in the CENRAP RRF; and

- The CENRAP case has significantly more ammonia than the $Minnesota_{(MRPO)}$ case. Model performance evaluation of the CENRAP modeling indicates overprediction of ammonium nitrate formation at BWCAW and VNP compared to observed values collected at monitoring stations. This is likely caused by additional NO_X and a significant amount of available ammonia with which to react. These conditions allow the model to respond well to future projected reductions in NO_X emissions, possibly even over-stating them.

  On the other hand, the $Minnesota_{(MRPO)}$ case underpredicts ammonium nitrate formation on the same days. The $Minnesota_{(MRPO)}$ case does not appear to have much available ammonia in the winter to form the same level of ammonium nitrate from NO_X emissions as observed. In the future emissions estimates, NO_X in the $Minnesota_{(MRPO)}$ case are reduced while ammonia significantly increases; the increased ammonia allows the model to form ammonium nitrate. Even though NO_X emissions decrease, the corresponding increase in ammonia emissions and ammonium nitrate formation may prevent model response to the reduction in NO_X emissions. Thus, the CENRAP case would reflect greater nitrate reductions in the RRF than the $Minnesota_{(MRPO)}$ case. In fact, the $Minnesota_{(MRPO)}$ RRFs show a slight increase in nitrate at VNP from 2002 to 2018.

Based on the above premise regarding model response in nitrate RRF development above, the MPCA would anticipate the nitrate RRF would likely be somewhere between the CENRAP case (nitrate RRF of 0.790 at BWCAW and 0.817 at VNP) and the $Minnesota_{(MRPO)}$ case (nitrate RRF of 0.921 at BWCAW and 1.031 at VNP). Should that prove true, visibility conditions would be closer to the URP in 2018 than projected in this SIP.

As mentioned above, the MRPO switched from a 2002 base year to a 2005 base year for developing relative response factors. These factors are applied to the same 2000-2004 baseline. Applying substantially the same control measures[52] to the 2005 base year as the 2002 base year resulted in future year projections at, or below, the URP at BWCAW and VNP. The resulting future year projections are 0.7 deciviews lower at BWCAW and 1.2 deciviews lower at VNP than the $Minnesota_{(MRPO)}$ results.

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[52] There are also emissions inventory differences. For example, the MRPO 2005 case was conducted using the 2005 state emissions inventory for Illinois, Indiana, Iowa, Michigan, Minnesota (point sources), Ohio and Wisconsin, and more updated 2002 emissions inventory with growth factors to 2005 applied for other states (and Minnesota sources other than point sources). The MRPO 2005 case does not include the revised growth estimates for taconite facilities in Northeast Minnesota or the Northeast Minnesota Plan in the future year emissions estimates.

Inspection of the source apportionment results from the MRPO 2005 and the $Minnesota_{(MRPO)}$ 2002 cases suggests that much of the difference is due to the use of different meteorology, and a different set of 20 percent worst days. The modeled RRFs for 2005 are established using the 20 percent worst days determined from 2005 monitoring data. Apportioning the 2005 model results to geographic regions of visibility impact on the 20 percent worst days and comparing that to similar apportionment results for the $Minnesota_{(MRPO)}$ 2002 case shows less contribution from Minnesota sources, much less contribution from the Western United States and Canada, and more contribution from states to the East and Southeast of BWCAW and VNP. The source apportionment results are available in the TSD.

In order to verify the impact of the different meteorological year on the resulting RRFs, Minnesota modeled the 2002 emissions inventory (minus 2002 biogenic emissions) from the $Minnesota_{(MRPO)}$ case with the 2005 meteorology and 2005 biogenic emissions used in the MRPO 2005 case. The 2005 biogenic emissions replace the 2002 biogenic emissions because these emissions are highly dependent on meteorology. Because biogenic emissions remain the same from the base year to the future year, use of 2005 biogenics does not influence the resulting RRFs.

Table 8.9 shows the future year projections resulting from this exercise. Table 8.10 shows the RRFs. The results of the Minnesota 2002 emissions\2005 meteorology future year projections are shown in relation to the $Minnesota_{(MRPO)}$ 2002[53] case and the MRPO 2005 case. The use of 2005 meteorology coupled with 2002 anthropogenic emissions results in future year projections 0.4 deciviews closer to the URP at BWCAW and 0.8 deciviews closer to the URP at VNP than the $Minnesota_{(MRPO)}$ 2002 case. The results demonstrate that the RRF, and hence, future year projections, are sensitive to meteorology and where the emission reductions occur geographically. In this case, it appears that the RRFs developed using 2005 meteorology are more sensitive to emission reductions that occur in states located to the East and Southeast of BWCAW and VNP.

Table 8.9: Visibility Projections to 2018 using 2002 and 2005 Meteorology for the W20% Days

Class I Area Name	Organiza-tion	Grid Resolution	Base Year	Baseline (dv)	2018 URP (dv)	2018 Projected (dv)	difference (dv)
Boundary Waters	**Minnesota**	**36**	**2002***	**19.9**	**17.9**	**18.7**	**0.8**
Boundary Waters	**Minnesota**	**36**	**2002/05 met**	**19.9**	**17.9**	**18.3**	**0.4**
Boundary Waters	MRPO	36	2005	19.9	17.9	17.9	0.0
Voyageurs	**Minnesota**	**36**	**2002***	**19.5**	**17.8**	**19.0**	**1.2**
Voyageurs	**Minnesota**	**36**	**2002/05 met**	**19.5**	**17.8**	**18.2**	**0.4**
Voyageurs	MRPO	36	2005	19.5	17.8	17.7	-0.1

* The base year (2002) modeling used in the 2002-2005 comparison does not contain the NE Minnesota Plan

[53] The 2002 emissions/2005 meteorology modeling exercise was conducted using a future year that did not include the Northeast Minnesota Plan. Thus, the $Minnesota_{(MRPO)}$ case used for comparison in Table 8.10 has a future year projection 0.1 deciviews greater both BWCAW and VNP than Minnesota's reasonable progress goal.

Table 8.10: RRFs for 2018 using 2002 and 2005 Meteorology for the W20%

Class I Area Name	Organiza-tion	Grid	Base Year	Relative Response Factors					
				sulfate	nitrate	organic carbon	elemental carbon	crustal/ soil	coarse mass
Boundary Waters	**Minnesota**	**36**	**2002***	**0.798**	**0.936**	**0.945**	**0.786**	**1.402**	**1.127**
Boundary Waters	**Minnesota**	**36**	**2002/05 met**	**0.755**	**0.886**	**0.925**	**0.750**	**1.375**	**1.108**
Boundary Waters	MRPO	36	2005	0.746	0.849	0.990	0.800	1.269	0.596
Voyageurs	**Minnesota**	**36**	**2002***	**0.855**	**1.035**	**0.956**	**0.834**	**1.275**	**1.069**
Voyageurs	**Minnesota**	**36**	**2002/05 met**	**0.768**	**0.898**	**0.937**	**0.780**	**1.342**	**1.065**
Voyageurs	MRPO	36	2005	0.761	0.822	0.976	0.772	1.239	0.637

* The base year (2002) modeling used in the 2002-2005 comparison does not contain the NE Minnesota Plan

The supplemental analysis shows that the three modeling analyses produce RRFs that lead to varying approximations of future visibility conditions presuming the same "on-the-books" controls. In addition to the "on-the-books" controls, the Minnesota$_{(MRPO)}$ case also includes the Northeast Minnesota Plan; yet the reasonable progress goals established in this SIP are conservative in relation to those that would be established using the other modeling analyses. Nevertheless, all the estimated future visibility conditions are moving in the desired downward direction toward natural conditions.

Continued emission inventory improvement projects are active, and a new base year emissions and meteorology, likely a 2007/2008 base year, are expected to be available for the five-year SIP assessment. The continuing analyses will provide additional evidence supporting future year projections, and establishment of reasonable progress goals toward natural visibility conditions.

Data Access

All data files used to support this SIP and the accompanying TSD are archived at the MPCA offices and provision has been made to maintain them. The MRPO and CENRAP maintain their own files for their work. The Minnesota$_{(MRPO)}$ files are generated and read on a Linux operating platform. Model outputs are processed with a series of Fortran programs invoked by C-shell scripts. To obtain files used in the analyses contact Margaret McCourtney at 651-757-2558 or margaret.mccourtney@state.mn.us.

Chapter 9. Best Available Retrofit Technology

The EPA's 1999 Regional Haze Rule singles out certain older emission sources that have not been regulated under other provisions of the Clean Air Act for additional controls. The state of Minnesota is requiring these older sources that contribute to visibility impairment in Class I areas to install Best Available Retrofit Technology (BART). On July 6, 2005, EPA published a revised final rule, including 40 CFR 51, Appendix Y, *Guidelines for BART Determinations Under the Regional Haze Rule,* which provides direction for determining which older sources may need to install BART and for determining BART.

BART-Eligible Sources in Minnesota

The facilities with BART-eligible units in Minnesota are shown in Table 9.1. A detailed description of each BART-eligible emission unit is included in Appendix 9.1.

The BART-eligible sources were identified using the methodology in the *Guidelines for BART Determinations under the Regional Haze Rules* or *Guidelines*, referenced above.

To identify the BART-eligible emission units in Table 9.1, MPCA used the following criteria:

- One, or more, emission(s) units at the facility fit within one of the twenty-six (26) categories listed in the *Guidelines*;
- The emission unit(s) were in existence on August 7, 1977 and began operation at some point on or after August 7, 1962; and
- The sum of the potential emissions from all emission unit(s) identified in the previous two bullets was greater than 250 tons per year of the visibility-impairing pollutants: sulfur dioxide (SO_2), nitrogen oxide (NO_x), and PM_{10}.

Table 9.1: Minnesota Facilities with BART-eligible Units

BART Source Category Name	SIC Code	Facility ID	Facility Name	BART Emission Units (Emission Unit No.)
Fossil Fuel-fired Steam Electric Plants > 250 MMBtu/hour -- Electric Generating Units (EGU)	4931	2709900001	Austin Utilities NE Power Station	*Boiler No. 1 (EU001)
	4931	2713700027	Hibbing Public Utilities	North boiler (EU003)
	4911	2703100001	MN Power, Taconite Harbor	*Boiler no. 3 (EU003)
	4911	2706100004	MN Power, Boswell Energy Center	*Boiler no. 3 (EU003)
	4931	2701500010	New Ulm Public Utilities	No. 4 boiler (EU003)
	4911	2711100002	Otter Tail Power Hoot Lake	*Unit 3 boiler (EU003)
	4911	2710900011	Rochester Public Utilities, Silver Lake	Unit #3 boiler, *Unit #4 boiler (EU003, EU004)
	4911	2713700028	Virginia Public Utilities	Boiler no. 9 (EU003)
	4911	2714100004	Xcel Energy, Sherco	*Boilers 1 and 2 (EU001,EU002)
	4911	2716300005	Xcel Energy, Allen S King	*Boiler 1 (EU001)
	4911	2705300015	Xcel Energy, Riverside	*Boiler 8 (EU003)
Petroleum Refineries	2911	2703700011	Flint Hills Resources LP – Pine Bend	15 emission units
	2911	2716300003	Marathon Ashland Petroleum LLC	24 emission units
Taconite Ore Processing Plants	1011	2713700063	US Steel, Keewatin Taconite	32 emission units
	1011	2713700061	Hibbing Taconite Co	29 emission units
	1011	2713700005	US Steel, Minntac	375 emission units
	1011	2713700113	United Taconite LLC (formerly EVTAC)	54 emission units
	1011	2713700062	ArcelorMittal (formerly Ispat Inland Mining)	32 emission units

BART Source Category Name	SIC Code	Facility ID	Facility Name	BART Emission Units (Emission Unit No.)
	1011	2707500003	Northshore Mining Company, Silver Bay	43 emission units (*EU002 was a CAIR EGU)
Fossil fuel fired boilers of more than 250 MMBTU/hr	2063	2711900002	American Crystal Sugar, E. Gr. Forks	Boilers 1 and 2 (EU001, EU002)
	2063	2712900014	Southern MN Beet Sugar	Boiler no. 1 (EU001)
Kraft Pulp Mills	2621	2707100002	Boise White Paper LLC, Intl Falls	#2 boiler, recovery furnace, smelt dissolving tank (EU340, EU320, EU322)
	2611	2701700002	Sappi Cloquet, LLC	#7, #8 power boilers (EU002, EU037)
Iron and Steel Mill Plants	3312	2712300055	Gerdau Ameristeel	Reheat furnace (EU004)
Secondary Metal Production Facilities	3341	2703700016	Gopher Resources	3 emission units in reverberatory furnace area (EU003, EU007, EU008)

* These Electric Generating Units were initially covered under the Clean Air Interstate Rule (CAIR).

The *Guidelines* recommend addressing the visibility-impairing pollutants SO_2, NO_X, and Particulate Matter. The MPCA addressed these three pollutants and used particulate matter less than ten (10) microns in diameter (PM_{10}) as an indicator for particulate matter to identify BART-eligible units.

Consistent with the *Guidelines*, MPCA did not evaluate emissions of Volatile Organic Compounds (VOCs) and ammonia in BART determinations for these reasons:

Ammonia: In the *Guidelines*, EPA suggests that states consider ammonia as a precursor to $PM_{2.5}$ formation on a case-by-case basis. They make the point that "states are required to make BART determinations only for stationary sources that fall within certain industrial categories." A perusal of the specific industrial categories in Minnesota indicates that these sources do not emit ammonia in a "significant" (potential to emit 250 tons per year or more) amount. Thus, the inclusion of ammonia – while a potential contributor to visibility impairment – would not impact the MPCA's BART-eligibility determination. Ammonia from sources that may contribute to visibility impairment is included in the regional scale modeling used in this SIP.

VOCs: In the *Guidelines*, EPA suggests that states consider VOCs as a precursor to $PM_{2.5}$ formation on a case-by-case basis. Only specific VOC compounds form secondary organic aerosols that affect visibility, and these compounds are a fraction of the total VOCs reported in the emissions inventory. For the BART analysis, MPCA does not have the breakdown of VOC emissions necessary to model those that only impair visibility. Although not included in BART, VOCs – both anthropogenic and biogenic – are included in the regional scale modeling used in this SIP

The MPCA identified BART-eligible sources in the state by sending a Request for Information by certified mail to all facilities in the state that are major sources for New Source Review. The Request for Information asked the facility to identify its industrial category, any units constructed between 1962 and 1977, and the potential emissions from these units. If the facility identified BART-eligible units, additional information about those units was requested so that the MPCA could model the visibility impacts of those units. The MPCA also reviewed its databases to ensure that no BART-eligible units may have been overlooked in the survey process. Additional information about the identification process is contained in Appendix 9.1.

Determination of Sources Subject to BART

Under the *Guidelines*, the state has the following options regarding its BART-eligible sources: a) make BART determinations for all sources; or b) consider exempting some sources from BART because they do not cause or contribute to visibility impairment in a Class I area. The MPCA chose option b. The *Guidelines* then suggest the following three modeling options for determining which sources may be exempt:

- Individual source attribution approach (dispersion modeling).
- Use of model plants to exempt sources with common characteristics.
- Cumulative modeling to show that no sources in a state are subject to BART.

The state of Minnesota chose to use the individual source attribution approach to determine which sources are subject to BART.

The MPCA performed source-specific analyses using the CALPUFF model to determine which sources cause or contribute to visibility impairment; the CALPUFF modeling protocol used for determining which facilities are subject to BART is included in Appendix 9.2.

In accordance with the recommendation of the *Guidelines*, a contribution threshold of 0.5 deciviews was used in determining those sources that are subject to BART. The MPCA chose to use the 98^{th} percentile 0.5 deciview threshold because EPA states in its *Guidelines*, "As a general matter, any threshold that you use for determining whether a source 'contributes' to visibility impairment should not be higher than 0.5 deciviews."[54] The MPCA is not aware of any special circumstances in Minnesota that would merit the use of a higher threshold. The *Guidelines* provide states the discretion to set a threshold below 0.5 deciviews if "the location of a large number of BART-eligible sources within the state and in proximity to a Class I area justifies this approach."

The MPCA took into account four factors in analyzing the use of the 0.5 deciview threshold for subject-to-BART:

- How close the BART-eligible source contributions are to the 0.5 threshold;
- Total facility control measures/emission reductions gained by federal regulations and during the establishment of reasonable progress goals in the RH SIP;
- Visibility improvement gains from BART; and
- The tool (CALPUFF) used to determine subject-to-BART status and its applicability to regional haze analyses.

Although the MPCA could set the contribution threshold lower than 0.5 deciviews and is cognizant of a number of existing sources in close proximity to Class I areas, the modeling showed no sources causing impacts at levels just slightly below 0.5 deciviews. The 98^{th} percentile deciview values for those subject-to-BART range from 0.6 – 4.4 deciviews, while the 98^{th} percentile deciview values for those not subject-to-BART range from 0.0 – 0.4 deciviews.

A total of 15 facilities with BART-eligible sources were determined not subject-to-BART based on the 0.5 deciview threshold. Of those 15 facilities, three are subject to the Northeast Minnesota Plan and three are EGUs that were initially subject to CAIR. Minnesota was initially included in CAIR, leading many utilities to install controls in anticipation of CAIR compliance. EPA has recently published a proposed stay of CAIR in Minnesota until there is a repromulgated CAIR rule. Should Minnesota not be included

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[54] *Regional Haze Regulations and Guidelines for Best Available Retrofit Technology (BART) Determinations, Final Rule,* (2005). p. 39161

in a repromulgated rule, two of the three EGUs that showed modeling results closest to the BART threshold (Austin Public Utilities and Otter Tail Power Hoot Lake) will be re-evaluated for reasonable progress controls at the time of the Five Year SIP Assessment.

Based on these facts, the application of BART would likely have little impact on the emission reductions expected from these facilities. Of the remaining nine facilities not subject to the Northeast Minnesota Plan or initially subject to CAIR, all have 98th percentile deciview values of 0.2 deciviews or less. Therefore, MPCA did not readjust the contribution threshold chosen for exempting sources from BART.

The MPCA published the proposed BART implementation strategy in the *State Register* on September 6, 2005; comments were requested and received, and the MPCA responded to the comments. Appendix 9.2 details where to find information on the strategy and the MPCA's response to comments.

The facilities found by the MPCA to be subject to BART are shown in Table 9.2. Again, Appendix 9.2 contains information on how to find the detailed results of the modeling analyses for each BART-eligible source. Facilities found to be subject to BART must complete a BART analysis, unless the MPCA exempted them from that requirement.

Table 9.2: Facilities with Units Subject to BART in Minnesota

BART Source Category Name	Facility ID	Facility Name	Emission Units Subject to BART (Primary Contributor)	Max. Modeled # days > 0.50 dv from 2002-2004[a]
Taconite ore processing facilities	2713700063	US Steel, Keewatin Taconite	32 emission units (Line 1)	247
	2713700061	Hibbing Taconite Co	29 emission units (Lines 1,2,3)	247
	2713700005	US Steel, Minntac	375 emission units (Lines 3,4,5,6,7)	530
	2713700113	United Taconite	54 emission units (Lines 1,2)	442
	2713700062	ArcelorMittal	32 emission units (Line 1)	228
	2707500003	Northshore Mining, Silver Bay	42 taconite processing emission units (Lines 11,12)	169
Fossil Fuel-fired Steam Electric Plants > 250 MMBtu/hour – Electric Generating Units (EGU)	2703100001	MN Power, Taconite Harbor	Boiler No. 3 (EU003)	226
	2706100004	MN Power, Boswell Energy Center	Boiler No. 3 (EU003)	205
	2707500003	Northshore Mining, Silver Bay	Boiler No. 2 only (EU002)	316
	2710900011	Rochester Public Utilities, Silver Lake	Unit #3 boiler, Unit #4 boiler (EU003, EU004)	17
	2714100004	Xcel Energy, Sherco	Boilers 1 and 2 (EU001, EU002)	230

[a]Complete modeling results are available at http://www.pca.state.mn.us/publications/aq-sip2-07.pdf. Results are pre-control upgrades.

Determination of BART Requirements for Subject-to-BART Sources

BART is the emission limit for each pollutant based on the degree of reduction achievable through the application of the best system of continuous emission reduction, taking into consideration: the costs of compliance, the energy and the non-air quality environmental impacts of compliance, any pollution control equipment in use at the source, the remaining useful life of the source, and the degree of improvement in visibility which may reasonably be anticipated to result. However, a state is not required to make a determination of BART for SO_2, NO_X, or PM_{10} if a BART-eligible source has the potential to emit (PTE) less than 40 tons per year of SO_2 or NO_X or less than 15 tons per year for PM_{10}.

EPA's BART *Guidelines* set forth a process for making BART determinations that may be used by states; this process is mandatory for 750 MW power plant sources, but advisory for other sources. The MPCA's BART determinations are influenced largely by two factors: the technology available and the costs of compliance. The technology available particularly influenced the determination of BART for the taconite facilities. In some other cases, technically feasible and cost effective controls were not determined to be BART due to concern over other environmental impacts, namely water discharge. Existing air pollution control equipment at the source is taken into account in the cost effectiveness of controls, and where it impacts the determination of feasible additional controls. In no instance did the MPCA or an affected facility identify units where the emitting unit's remaining useful life mitigated the selected control option. All units are presumed to continue operating for at least 20 years for the cost estimating procedures.

Finally, the MPCA largely did not rely on evaluations of resulting visibility improvement in choosing controls, except in a case where a facility was only marginally subject-to-BART, and therefore BART controls were not required on one of two BART units. In cases where full BART determinations were requested, the facilities estimated visibility improvement from various BART options, and these are included in the memos documenting the MPCA's BART determinations. However, the MPCA's position is that cost-effective controls should be installed, even if they result in limited improvement in visibility, and technically infeasible or not cost-effective controls are not required under BART, even if they result in significant visibility improvement. Controls approximating MPCA's BART determinations for EGUs were included in the visibility modeling used to set the RPGs, thereby demonstrating "the degree of visibility improvement which may reasonably be anticipated from the use of BART."

EGU BART Determinations

The MPCA initially did not perform a BART determination for subject-to-BART EGUs to evaluate NO_X and SO_2 because of Minnesota's inclusion in the Clean Air Interstate Rule (CAIR). EPA found that, as a whole, the CAIR cap-and-trade program improves visibility more than implementing BART in states affected by CAIR. A state that opts to participate in the CAIR program need not require affected BART-eligible EGUs to install, operate, and maintain BART. BART-eligible EGUs in both CAIR states and non-CAIR states must submit a BART determination if the state finds they are subject to BART. If a state accepts EPA's overall finding that CAIR "substitutes" for BART, then the BART determination need only be done for PM emissions, as NO_X and SO_2 emissions are addressed by CAIR.

In addition, as the MPCA began the process of looking at BART controls, it appeared that all but one EGU otherwise subject-to-BART would be adding controls with implementation expected by 2010. This is shown in Table 9.3.

However, subsequent legal uncertainty concerning CAIR, as well as several comments received on the draft SIP, led to reconsideration of the decision to allow CAIR to substitute for BART. Although CAIR went into effect, as written, on January 1, 2009, EPA issued a proposed rule on May 12, 2009 to stay the effectiveness of CAIR in Minnesota.[55] The MPCA therefore has made BART determinations for the six EGUs found to be subject to BART. In most of these cases, planned controls for SO_2 and NO_X have been determined to represent BART levels of control.

The MPCA modeled the PM visibility impacts from each subject-to-BART EGU and found that impacts were less than 0.20 deciview for all units, also shown in Table 9.3. Because of the small impact from the PM emissions, the MPCA determined that any additional control would not be cost effective, particularly when weighed against the small amount of visibility improvement and other environmental impacts. In addition, all of the subject-to-BART EGUs already have PM controls installed and some are planning PM control upgrades.[56] Therefore, each facility's existing controls and emission limits for PM were considered to be BART.

Table 9.3: Planned Control Upgrades by Subject-to-BART EGUs and Projected PM Contribution to Visibility Impairment

Facility ID	Facility Name	Emission Units Subject to BART	Estimated % Reduction Over Average '01-'03 lb/ MMBTU Emission Rate	Estimated Year Control Upgrade Project Completed	Maximum Modeled Contribution to Visibility Impairment from PM[a] (Δ dv)
2703100001	MN Power, Taconite Harbor	Boiler no. 3 (EU003)	NO_X- 66% SO_2- 63%	2009	0.078
2706100004	MN Power, Boswell	Boiler no. 3 (EU003)	NO_X- 81% SO_2- 90% PM_{10}- 65%	2009	0.048
2710900011	Rochester Public Utilities, Silver Lake[b]	Unit #4 boiler (EU004)	NO_X- 63% SO_2- 85%	2009 – NO_X 2010 – SO_2	0.005
2714100004	Xcel Energy, Sherco	Boilers 1 and 2 (EU001, EU002)	NO_X-43-45%	2006-2008	0.047
2707500003	Northshore Mining, Silver Bay	Boiler 2 (EU002)	No upgrades announced	No upgrades announced	0.16

[a] Results shown are from CAMx modeling performed by MPCA staff using 2002 emissions input. More information can be found in the TSD.

[b] The MPCA has determined that BART for Unit 3 is no additional control because Units 3 and 4 combined were found to be only "marginally" subject-to-BART and significant control upgrades are planned for Unit 4, the larger BART unit. Unit 4 impacted visibility more than Unit 3 as its 2002 SO_2 emissions were about four times those of Unit 3. In addition, the Title V permit issued in September 2007 requires additional emission reduction strategies (to be determined) for SO_2 attainment.

[55] 74 FR 22147

[56] Minnesota Power is installing BACT-like PM controls on Boswell 3 as part of its voluntary emission reduction project.

Table 9.4 documents the NO_X and SO_2 BART determinations made by the MPCA for the subject-to BART EGUs.

Table 9.4: NO_X and SO_2 BART Determinations for EGUs

Facility Name	Emission Unit	NO_X Bart Technology	NO_X BART Limit (lbs/MMBtu)	SO_2 BART Technology	SO_2 BART Limit (lbs/MMBtu)
MN Power, Taconite Harbor	Boiler no. 3 (EU003)	ROFA	0.20	FSI and FF	0.40
MN Power, Boswell	Boiler no. 3 (EU003)	LNB + OFA, SCR	0.07	Wet scrubber	0.09
Rochester Public Utilities, Silver Lake	Unit #3 boiler (EU003)	No additional	No Limit	No additional	2.30
	Unit #4 boiler (EU004)	ROFA/Rotamix	0.25	Spray dryer absorber	0.60
Xcel Energy, Sherco	Boiler 1 (EU001)	LNB +SOFA+ Combustion Optimization	0.15	Retrofit FGD with sparger tubes	0.12
	Boiler 2 (EU002)	Combustion optimization			
Northshore Mining, Silver Bay	Boiler 1 (EU001)	LNB + OFA	0.41	Biomass co-fire	0.41
	Boiler 2 (EU002)	LNB + OFA	0.40	Biomass co-fire	0.48

Appendix 9.4 contains the MPCA's full BART analysis and determinations, including appropriate emission limits, for NO_X, SO_2, and PM_{10} at each subject-to-BART EGU.

As shown in Appendix 9.7, the MPCA promulgated a rule that makes the requirements of BART "Applicable Requirements" for facilities. The MPCA will therefore add BART requirements to affected facility's Title V permits as a basis for permit limits. Due to the length of time that is necessary to re-open a permit and amend requirements, the MPCA is not likely to have these requirements fully incorporated into Title V permits until the Five Year SIP Assessment. Since Minnesota rules mandate that permits include all applicable requirements, the BART requirements must be included.

Visibility Improvement

The MPCA modeled the visibility improvement expected from the installation of the BART controls shown in Table 9.4. The modeling compared actual emissions as modeled for the 2002 base year modeling to the emissions expected with the installation of BART, using two years of meteorology (2002 and 2005). The overall results are documented in each BART determination memo in Appendix 9.4, with more explanation of the methodology and more detailed results in Appendix 9.5.

Taconite BART Determinations

Table 9.5, below, describes the characteristics of Minnesota's taconite pellet furnaces, which are the other main source category subject-to-BART. BART requirements for the taconite sources are shown in Tables 9.6 and 9.7 for each visibility impairing pollutant.

The BART analysis conducted by the facilities for each subject-to-BART source is listed in Appendix 9.2. BART for each subject-to-BART source was determined by the state taking into account the required factors. However, determining BART for the pellet furnaces at Minnesota's taconite plants is more difficult than for EGUs or other, more common, types of equipment.

Eight taconite plants exist nationally: six in Minnesota and two in Michigan. The first new taconite plant to be built in over 30 years is not scheduled to begin operation until 2010. The lack of new taconite plants and retrofit projects at existing plants as well as the uniqueness of the industry and the individual facilities (see Table 9.5) means that very few add-on control strategies are known to be feasible for taconite pellet furnaces. Even fewer control strategies are known to be cost-effective or otherwise reasonable.

Table 9.5: Characteristics of Minnesota Taconite Pellet Furnaces[57]

Plant (line)	Pelletizer type	Pellet type	Pellets fired, Long ton/hr	Fuel	Existing Control
Keetac	Grate Kiln	Standard	600-660	PRB[58] coal-NG	Wet scrubber[a]
Hibbing Taconite					
1	Straight Grate	Standard	250-380	NG	Wet scrubber
2	Straight Grate	Standard	250-380	NG	Wet scrubber
3	Straight Grate	Standard	250-380	NG	Wet scrubber
Minntac [b]					
3	Grate Kiln	Standard	200-250	NG	Wet scrubber[a]
4	Grate Kiln	Flux/standard	400-450	60%wood-40% NG	Wet scrubber
5	Grate Kiln	Flux/standard	400-450	60%wood-40% NG	Wet scrubber
6	Grate Kiln	Flux	400-450	PRB coal-NG	Wet scrubber
7	Grate Kiln	Flux	400-450	PRB coal-NG	Wet scrubber
United Taconite [c]					
1	Grate Kiln	Standard	170-270	NG	Wet scrubber
2	Grate Kiln	Standard	480-550	Pet coke-coal	Wet scrubber
ArcelorMittal [d]	Straight Grate	Flux	310-440	NG	Wet scrubber
Northshore[e]					
11	Straight Grate	Standard	235-255	NG	Wet-Wall ESP
12	Straight Grate	Standard	235-255	NG	Wet-Wall ESP

[a] Scrubber adds lime to enhance SO_2 removal
[b] Minntac can fire wood + NG in L3 through L7 but typically uses the fuels as shown above.
Minntac can make standard or flux pellets in L3 through L7 but typically schedules production as shown above.
[c] United Taconite's Line 2 is permitted to burn coal and petroleum coke with no coal type specified.
[d] ArcelorMittal can make standard pellets but typically does not; data comes from stack test results during flux pellet production.
[e] Northshore can make flux pellets in its furnaces without adding auxiliary burners in the preheat zone; pellet type is not seen in the stack test reports.

The MPCA has determined that BART for NO_X for all taconite pellet furnaces is an operating standard of good combustion practices in combination with process changes proposed as BART by the facilities, such as low-NO_X burners in pre-heat zones, ported kilns, and modified furnace design for improved fuel efficiency.

BART for most direct PM emissions was determined to be equivalent to the taconite MACT, which requires control of PM emissions to control hazardous air pollutants. (Some PM emission sources are not covered by the taconite MACT.) Due to the MACT, the taconite facilities already have particulate control, with five facilities operating wet scrubbers and one wet-wall electrostatic precipitators (ESPs). The taconite MACT establishes a PM_{10} limit of 0.01 grains per dry standard cubic foot for the pellet furnaces at each of the six taconite plants.

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[57] Table 9.3.2 in Appendix 9.3 contains additional information.
[58] PRB coal is Powder River Basin coal, which is generally low sulfur.

BART for SO_2 for these units was generally determined to be the existing particulate scrubber optimized for SO_2 removal, as in most cases, add-on scrubbers were not cost-effective. The one exception is United Taconite's Line 2. This line burns a combination of high sulfur fuels: petroleum coke and coal in varying blends with natural gas. MPCA has determined that the SO_2 BART limit for this line is 1.7 lbs/MMBtu, and believes that this limit can be met either through fuel blending, installation of an additional polishing scrubber, or a combination.

Due to the lack of emissions data representing the range of operating conditions that influence emissions and the inability to predict emissions using operating parameters, the MPCA is unable at this time to set an emission limit that corresponds to BART for SO_2 and NO_X at most facilities, and it would be difficult to determine continuous compliance with a limit for most taconite pellet furnaces. In particular, the seeming variance of NO_X emissions at all furnaces (similar to NO_X variability at cement kilns) and SO_2 emissions at facilities that burn fuels other than natural gas prevents the MPCA from setting a meaningful BART emission limit at this time for those situations.

Therefore, the only specific BART limits that the MPCA has been able to include at this point are SO_2 emission limits for those taconite lines that burn low-sulfur fuels, such as natural gas or biomass, as their primary fuel, and the SO_2 limit at United Taconite Line 2. The SO_2 limits will apply only when the lines are burning those primary fuels, not during the use of back up fuels, such as fuel oil. These backup fuels are subject to a general state limit and are not significant fuel sources for the facilities.

The MPCA believes that the scrubbers for lines burning low-sulfur fuels are already optimized for SO_2 removal. In general, the SO_2 limits are set using existing data and a 95% predictive interval. For lines that burn solid fuels, more data is needed to determine if the PM scrubbers can be further optimized to improve SO_2 removal.

SO_2 BART emission limits, for these lines where sufficient information exists to establish a limit, are summarized in Table 9.6 and will be included in the Title V operating permit for each source during the next re-opening of the permit, after EPA SIP approval.

The MPCA has issued Administrative Orders to each of the subject-to-BART taconite sources requiring the source to install Continuous Emissions Monitoring Systems (CEMs) or to demonstrate a comparable method of emission estimation, and to provide the MPCA with data from these new emission estimation methods. The MPCA anticipates that a year of data will be necessary in order to determine the remaining BART emission limits for the taconite facilities.[59]

The comparable alternative method requires a minimum of 150 one-hour data points collected under varying furnace conditions. Should emissions be of low variability, the facility is to develop an emission factor based on the process parameters. Frequent (annual or bi-annual) stack testing will be required, along with submission of quarterly parameters showing continued operation of the furnace under the conditions tested. Should emissions be highly variable, facilities must develop a predictive equation to correlate emissions with other process parameters. The requirement for more accurate data collection through CEMs or a comparable alternative applies to NO_X emissions at all the facilities and to SO_2 emissions at facilities burning high sulfur fuels. The MPCA will use the emissions and operating data gathered to establish BART limits and will include those limits in each facility's Title V operating permit.

[59] Due to economic conditions, many of the taconite lines have not been operating over the past several months. This will impact when the MPCA is able to obtain of year of operation data. At this time, we believe many of the lines will be starting up during Fall 2009; thus, a full year of data should be obtained by the end of 2010 or early 2011.

Administrative Orders by Consent were developed and signed between September 2007 and April 2009. US Steel signed Administrative Orders requiring CEMs for its two facilities, Minntac and Keetac. United Taconite has also signed an Order to install NO_X CEMs and provide NO_X data to the MPCA.[60] Hibbing Taconite, Northshore Mining, and Arcelor Mittal have agreed to and signed Administrative Orders requiring the use of a comparable emission estimation method for their facilities. These Orders are included in Appendix 9.7.

In weighing the five factors, MPCA has determined that BART does not result in the installation of any new controls or other additional work practice standards or limits for the non-pellet furnace emission units primarily because the units are low emitters and thus have negligible impact on visibility.

The MPCA is unable at this time to quantify the degree of emission reductions resulting from BART, but will do so in the Five Year SIP Assessment and revision.

BART Alternative

In discussing BART with various facilities, it has come to the MPCA's attention that some facilities with subject-to-BART sources may be considering projects that could result in greater overall emissions reductions than would be obtained through installation of BART.

In October 2006, EPA finalized a rule called *Revisions to Provisions Governing Alternative to Source-Specific Best Available Retrofit Technology (BART) Determinations*.[61] The preamble to this rule says,

> "The Regional Haze Rule provides States with the authority to implement…alternative measures in lieu of meeting the requirements for source-by-source BART. Under this provision of the Regional Haze Rule, States have the flexibility to design programs to reduce emissions from stationary sources in a more cost-effective manner so long as they can demonstrate that the alternative approach will achieve greater reasonable progress towards improving visibility than would have been achieved by implementation of the BART requirements…[T]he emissions reductions that could be achieved through implementation of the BART provisions at section 51.308(e)(1) serve as the benchmark against which States can compare an alternative..."[62]

The MPCA believes that certain voluntary projects at individual facilities could satisfy this BART alternative requirement, with the MPCA's BART determination serving as the benchmark that must be met or exceeded. Should emission reductions of SO_2 or NO_X result from the proposed projects, the MPCA would evaluate these projects in comparison to the BART determinations to see if they result in greater control of visibility impairing pollutants than would be expected under BART.

Due to questions raised during discussion of MPCA's BART determinations and the opportunity to propose an alternative, this section elaborates what the MPCA would consider as acceptable BART alternatives, subject to EPA approval of Minnesota's Regional Haze SIP and BART determinations.

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[60] Through a stipulation agreement, United Taconite has agreed to install NO_X and SO_2 CEMS on both Line 1 and Line 2. CEMS at Line 2 were installed in January 2009 and must be certified by October 1, 2009; Line 1 has been shut down since November 2008, so the CEMS must be installed and certified by 60 days after the line is restarted.

[61] 71 FR 60612

[62] 71 FR 60614.

A facility may choose to propose a BART alternative project. The BART alternative must result in equivalent or greater emissions reductions and visibility benefits from the facility when compared to the MPCA's BART determination.

Should a facility choose to propose a BART alternative, the proposal must include:

- A demonstration of equivalent or greater combined annual emission reductions of NO_X and SO_2 (in tpy) than that established in this BART determination;
- Appropriate visibility modeling demonstrating equivalent or greater visibility protection than the MPCA's BART determination; and
- A proposal for enforceable emission limitations, with appropriate and justified averaging periods and methods for evaluating compliance.

Since the facility would be proposing an alternative to MPCA's BART determination, visibility modeling should follow the MPCA's *Guidance for Facilities Conducting a BART Analysis*[63] and *Best Available Retrofit Technology (BART) Modeling Protocol to Determine Sources Subject-to-BART in the State of Minnesota,*[64] using the most recent versions of any model or EPA guidance referenced in those documents. The modeling should compare the baseline, pre-control scenario to post-control scenarios representing the MPCA's BART determination and the BART alternative being proposed by the facility.

Facilities may propose a BART alternative that covers multiple BART units or both BART and non-BART units at the facility in the same source category. A proposal covering BART and non-BART units must demonstrate greater emission reductions and more visibility improvement from the facility than MPCA's BART determination.

The MPCA would evaluate the BART alternative proposal, consult with the Federal Land Managers and Tribes, and determine if it is an acceptable BART alternative. If the project is deemed to result in equivalent or greater pollution control than BART, the MPCA may determine that the proposed project is equivalent to BART. The resulting emission limits would then substitute for the BART emission limits. Ultimately, EPA approval of an enforceable document (such as a Title V permit) containing BART emission limits will be necessary.

BART Implementation

Minnesota is requiring that each subject-to-BART source, whether EGU or taconite facility, to install and operate BART as expeditiously as practicable but in no event later than five years after approval of the SIP or plan revision by EPA. Although at this time the exact BART emission limits for all the taconite furnaces have yet to be determined, BART implementation and compliance will still occur within the required five-year time frame.

The MPCA has an established procedure, approved by EPA Region 5, for including SIP conditions in Title V permits. The permits then become joint Title I/Title V documents, and any conditions imposed on the individual facilities to meet SIP requirements are cited as "Title I Condition: SIP for <pollutant>." Title I conditions in Minnesota permits never expire.

Whether the final BART is good combustion practices measured by CEMs or more accurate emission measurements, or if another project that provides greater emission reductions is chosen to substitute for BART, any resulting emissions limits will be placed in the facility's Title V permit. The MPCA is likely to include BART limits in Title V permits with the citation "Title I Condition: SIP for Regional Haze."

[63] http://www.pca.state.mn.us/publications/aq-sip2-09.pdf
[64] http://www.pca.state.mn.us/publications/aq-sip2-05.pdf

The Title V operating permits also will include a requirement that each source maintain any necessary control equipment and establish procedures to ensure such equipment is properly operated and maintained. Minnesota intends to include these Title V operating permits in the Five Year SIP Assessment and revision.

Table 9.6: SO_2 BART Determinations for Units Where a Full BART Analysis Was Conducted

Facility Name ID Title V Permit #	Emission Unit #	Emission Unit Description	SO_2 Baseline Emissions Used in Cost Analysis (tpy)	Capacity[65]	Baseline Controls	SO_2 Max. 24-Hr Actual Emissions Reported (lb/day)	BART	BART Emission Limit (30-day rolling average)	Schedule of Compliance
Keetac 2713700063 # 13700063-003	EU030	Pellet Furnace	950.5	93%	Recirculating lime scrubber for PM/SO_2 control	9600	Existing (2005) recirculating lime scrubber	TBD after gathering emissions/ scrubber parameter data	Administrative Order requires installation of SO2 CEMs by Nov. 30, 2008
Hibbing Taconite 2713700061 #13700061-002	EU020	Pellet Furnace Line 1	202.2	93%	Wet scrubber for PM control	720	Existing PM wet scrubber	0.207 lb SO_2/long ton pellet fired	Limit to be incorporated into Title V operating permit after EPA approval of Regional Haze SIP as permit is reopened or amended
	EU021	Pellet Furnace Line 2	179.5	93%	Wet scrubber for PM control	912	Existing PM wet scrubber	0.207 lb SO_2/long ton pellet fired	Limit to be incorporated into Title V operating permit after EPA approval of Regional Haze SIP as permit is reopened or amended
	EU022	Pellet Furnace Line 3	188.1	93%	Wet scrubber for PM control	1,032	Existing PM wet scrubber	0.207 lb SO_2/long ton pellet fired	Limit to be incorporated into Title V operating permit after EPA approval of Regional Haze SIP as permit is reopened or amended
Minntac 2713700005 #13700005-002	EU223	Line 3	329.3	93%	Recirculating scrubber	2366	Existing recirculating scrubber (installed 2006)	116 lbs SO_2/hour	Limit to be incorporated into Title V operating permit after EPA approval of Regional Haze SIP as permit is reopened or amended
	EU259	Line 4	447.5	93%	Wet scrubber for PM control	3511	Existing wet scrubber	180 lbs SO_2/hour	Limit to be incorporated into Title V operating permit after EPA approval of Regional Haze SIP as permit is reopened or amended
	EU280	Line 5	447.5	93%	Wet scrubber for PM control	3511	Existing wet scrubber	180 lbs SO_2/hour	Limit to be incorporated into Title V operating permit after EPA approval of Regional Haze SIP as permit is reopened or amended
	EU313	Line 6	544.8	93%	Wet scrubber for PM control	4435	Existing wet scrubber	TBD after gathering emissions/ scrubber parameter data	Administrative Order requires installation of SO_2 CEMs by Nov. 30, 2008

[65] Capacity figures comes from expected capacity utilization described in the facilities' BART analyses.

Facility Name ID Title V Permit #	Emission Unit #	Emission Unit Description	SO_2 Baseline Emissions Used in Cost Analysis (tpy)	Capacity[65]	Baseline Controls	SO_2 Max. 24-Hr Actual Emissions Reported (lb/day)	BART	BART Emission Limit (30-day rolling average)	Schedule of Compliance
	EU332	Line 7	544.8	93%	Wet scrubber for PM control	4435	Existing wet scrubber	TBD after gathering emissions/ scrubber parameter data	Administrative Order requires installation of SO_2 CEMs by Nov. 30, 2008
United Taconite 2713700113 #13700113-004	EU040	Line 1	13.9	93%	Wet scrubber for PM control	100.8	Existing wet scrubber	0.121 lb SO_2/long ton pellet fired	Certification of SO_2 CEMs 60 days after Line 2 CEMs certification. Limit to be incorporated into Title V operating permit at time NO_X limit is established.
	EU042	Line 2	2749.7	93%	Wet scrubber for PM control	15,173	Fuel blending	1.7 lbs/MMBtu	Certification of SO_2 CEMs by June 1, 2010. Limit to be incorporated into Title V operating permit after EPA approval of Regional Haze SIP as permit is reopened or amended
ArcelorMittal 2713700062 #13700062-002	EU026	Pellet furnace SV014	44.8	93%	Wet scrubber for PM control	3000	Existing wet scrubber	0.165 lb SO_2/long ton pellet fired Facility has one furnace with four stacks; the emission limit is based on the sum of emissions from all four stacks.	Limit to be incorporated into Title V operating permit after EPA approval of Regional Haze SIP as permit is reopened or amended
	EU026	Pellet furnace SV015	44.8	93%	Wet scrubber for PM control	3000	Existing wet scrubber		
	EU026	Pellet furnace SV016	44.8	93%	Wet scrubber for PM control	3000	Existing wet scrubber		
	EU026	Pellet furnace SV017	44.8	93%	Wet scrubber for PM control	3000	Existing wet scrubber		
Northshore Mining 2707500003 #07500003-004	EU003	Process Boiler #1	73.4	100% (0% in past practice)	Permit allows only NG/ distillate fuel burned	403.8	No additional control	None needed	None needed.
	EU004	Process Boiler #2	73.4	100% (0% in past practice)	Permit allows only NG/ distillate fuel burned	403.8	No additional control	None needed	None needed.

Facility Name ID Title V Permit #	Emission Unit #	Emission Unit Description	SO_2 Baseline Emissions Used in Cost Analysis (tpy)	Capacity[65]	Baseline Controls	SO_2 Max. 24-Hr Actual Emissions Reported (lb/day)	BART	BART Emission Limit (30-day rolling average)	Schedule of Compliance
Northshore Mining 2707500003 # 07500003-004	EU100	Furnace 11 Hood Exhaust	28.6	93%	Wet-Wall ESP for PM control	852	Existing wet-wall ESP	0.0651 lb SO_2/long ton pellet fired for EU100/EU104 combined	Limit to be incorporated into Title V operating permit after EPA approval of Regional Haze SIP as permit is reopened or amended
	EU104	Furnace 11 Waste Gas	9.6	93%	Wet-Wall ESP for PM control	283.2	Existing wet-wall ESP	0.0651 lb SO_2/long ton pellet fired for EU100/EU104 combined	Limit to be incorporated into Title V operating permit after EPA approval of Regional Haze SIP or as soon as permit is reopened or amended
	EU110	Furnace 12 Hood Exhaust	26.3	93%	Wet-Wall ESP for PM control	852	Existing wet-wall ESP	0.0651 lb SO_2/long ton pellet fired for EU110/ EU114 combined	Limit to be incorporated into Title V operating permit after EPA approval of Regional Haze SIP or as soon as permit is reopened or amended
	EU114	Furnace 12 Waste Gas	8.8	93%	Wet-Wall ESP for PM control	283.2	Existing wet-wall ESP	0.0651 lb SO_2/long ton pellet fired for EU110/ EU114 combined	Limit to be incorporated into Title V operating permit after EPA approval of Regional Haze SIP or as soon as permit is reopened or amended

Table 9.7: NO_X BART Determinations for Units Where a Full BART Analysis Was Conducted

Facility Name ID Title V Permit #	Emission Unit Number	Emission Unit Description	NOx Baseline Emissions Used in Cost Analysis (tpy)	Capacity[66]	Baseline Controls	NOx Max. 24-hr Actual Emissions Reported (lb/day)	BART	BART Emission Limit (30-day rolling average)	Schedule of Compliance
Keetac 2713700063 #13700063-003	EU030	Pellet Furnace	4154	93%	None	33,520	Good combustion practices, fuel blending	TBD after gathering sufficient emissions data	Administrative Order requires installation of NOx CEMs by Nov. 30, 2008
Hibbing Taconite 2713700061 #13700061- 002	EU020	Pellet Furnace Line 1	2497.7	93%	None	13,392	Good combustion practices, furnace energy efficiency project made in 2006	TBD after gathering sufficient emissions data	Delineated in Administrative Order; installation of stack gas flow monitors required 60 days after line restart (estimated as January 2010)
	EU021	Pellet Furnace Line 2	2143.5	93%	None	11,112	Good combustion practices, furnace energy efficiency project made in 2006	TBD after gathering sufficient emissions data	Delineated in Administrative Order; installation of stack gas flow monitors required by March 1, 2010.
	EU022	Pellet Furnace Line 3	2247.1	93%	None	12,624	Good combustion practices, furnace energy efficiency project made in 2007	TBD after gathering sufficient emissions data	Delineated in Administrative Order; installation of stack gas flow monitors required 60 days after line restart (estimated as January 2010)
Minntac 2713700005 # 13700005-002	EU223	Line 3	1345	93%	None	21,046	Good combustion practices, fuel blending	TBD after gathering sufficient emissions data	Administrative Order requires installation of NOx CEMs by Nov. 30, 2008
	EU259	Line 4	1812	93%	None	32,472	Good combustion practices, fuel blending, low NO_X burners in pre-heat zone	TBD after gathering sufficient emissions data	Administrative Order requires installation of NOx CEMs by Nov. 30, 2008
	EU280	Line 5	1820	93%	None	32,472	Good combustion practices, fuel blending, low NO_X burners in pre-heat zone	TBD after gathering sufficient emissions data	Administrative Order requires installation of NOx CEMs by Nov. 30, 2008

[66] Capacity figures comes from expected capacity utilization described in the facilities' BART analyses.

Facility Name ID Title V Permit #	Emission Unit Number	Emission Unit Description	NOx Baseline Emissions Used in Cost Analysis (tpy)	Capacity[66]	Baseline Controls	NOx Max. 24-hr Actual Emissions Reported (lb/day)	BART	BART Emission Limit (30-day rolling average)	Schedule of Compliance
	EU313	Line 6	1776	93%	None	28,855	Good combustion practices, fuel blending, low NO_X burners in pre-heat zone	TBD after gathering sufficient emissions data	Administrative Order requires installation of NOx CEMs by Nov. 30, 2008
	EU332	Line 7	1928	93%	None	28,855	Good combustion practices, fuel blending, low NO_X burners in pre-heat zone	TBD after gathering sufficient emissions data	Administrative Order requires installation of NOx CEMs by Nov. 30, 2008
United Taconite 2713700113 #13700113-004	EU040	Line 1	2151	93%	None	15,631	Good combustion practices, past heat recuperation project	TBD after gathering sufficient emissions data	CEMs installation and certification required 60 days after CEMs certification on Line 2.
	EU042	Line 2	1633	93%	None	9,005	Good combustion practices, fuel blending; further evaluation of Ported Kilns needed.	TBD after gathering sufficient emissions data	CEMs certification by June 1, 2010.
ArcelorMittal 2713700062 #13700062-002	EU026	Pellet furnace SV014	369.6	93%	None	3730	Good combustion practices and furnace energy efficiency project completed in fall '07, low NO_X burner in furnace pre-heat zone.	TBD after gathering sufficient emissions data.	Administrative Order requires submittal of an alternative emission measurement method (comparable to CEMs) by March 1, 2009.
	EU026	Pellet furnace SV015	669	93%		4800			
	EU026	Pellet furnace SV016	1031	93%		7399			
	EU026	Pellet furnace SV017	1419	93%		10,183			
Northshore Mining	EU003	Process Boiler #1 (back-up)	50.9	100% (0% in past practice)	None	278.4	No additional control	None needed	None needed.

Facility Name ID Title V Permit #	Emission Unit Number	Emission Unit Description	NOx Baseline Emissions Used in Cost Analysis (tpy)	Capacity[66]	Baseline Controls	NOx Max. 24-hr Actual Emissions Reported (lb/day)	BART	BART Emission Limit (30-day rolling average)	Schedule of Compliance
2707500003 # 07500003-004	EU004	Process Boiler #2 (back-up)	50.9	100% (0% in past practice)	None	278.4	No additional control	None needed	None needed.
	EU100	Furnace 11 Hood Exhaust	112.4	93%	None	1231.2	Good combustion practices	TBD after gathering sufficient emissions data	Administrative Order requires submittal of an alternative emission measurement method (comparable to CEMs) by June 30, 2008
	EU104	Furnace 11 Waste Gas	273.7	93%	None	2995.2	Good combustion practices	TBD after gathering sufficient emissions data	Administrative Order requires submittal of an alternative emission measurement method (comparable to CEMs) by June 30, 2008
	EU110	Furnace 12 Hood Exhaust	109.9	93%	None	1231.2	Good combustion practices	TBD after gathering sufficient emissions data	Administrative Order requires submittal of an alternative emission measurement method (comparable to CEMs) by June 30, 2008
	EU114	Furnace 12 Waste Gas	267.7	93%	None	2995.2	Good combustion practices	TBD after gathering sufficient emissions data	Administrative Order requires submittal of an alternative emission measurement method (comparable to CEMs) by June 30, 2008

Chapter 10. Reasonable Progress Goals and Long-Term Strategy

The requirements of 40 CFR 51.308(d)(1) call for Minnesota to establish a Reasonable Progress Goal (RPG) for each Class I area within the state. The RPG, expressed in deciviews, ensures the state is making progress towards achieving natural visibility. Over the SIP period, the goals must provide for improvement in visibility over the most impaired days, and ensure no degradation in visibility over the least impaired days. The state must also provide an assessment of when the Class I areas would attain natural visibility conditions if improvement continues at the rate represented by the RPG.

In addition, 40 CFR 51.308(d)(3) requires states to submit a long-term strategy (LTS) addressing regional haze for each mandatory Class I area which may be affected by emissions from within the state. The LTS must include enforceable emissions limitations, compliance schedules and other measures necessary to achieve the RPG established by the state in which the Class I area is located for both best and worst visibility days.

This chapter contains Minnesota's long-term strategy for implementing all known reasonable control measures in order to ensure the RPG is met at all Class I areas to which Minnesota's emissions are a significant contributor to visibility impairment. It also includes the reasonable progress goals established by Minnesota for BWCAW and VNP.

Consultation

Minnesota must consult with other states and tribes to set the RPG and develop coordinated emission strategies for meeting the established RPG. This requirement applies both where emissions from Minnesota are reasonably anticipated to contribute to visibility impairment in Class I areas outside the state and where emissions from other states and tribes are reasonably anticipated to contribute to visibility impairment in Minnesota's Class I areas.

Minnesota consulted with other states and tribes in several ways, including participation in CENRAP and the Northern Class I consultation processes, in order to develop the technical information necessary for determining where each state's emissions are reasonably anticipated to contribute to visibility impairment, as well as information about the URP, implementation of coordinated emission strategies, and the RPG. These consultation processes are documented in Chapter 3. The state's coordination with FLMs is described in Chapter 4.

Basis for emission reduction obligations

Minnesota is required to demonstrate that its implementation plan includes all measures necessary to obtain its fair share of emission reductions needed to meet reasonable progress goals at all Class I areas where visibility is impacted by emissions from Minnesota sources (40 CFR 51.308(d)(3)(ii)). Determining that fair share of emission reduction requires knowledge of which Class I areas are most impacted by emissions from Minnesota, and which states' emissions most impact visibility in Minnesota's Class I areas. This section documents the technical basis for Minnesota's apportionment of emission reductions, both to meet the RPG in Minnesota's Class I areas and to meet the RPG in any Class I area impacted by Minnesota emissions.

Minnesota relied in part on technical analyses developed by MRPO and CENRAP to demonstrate that the state's emission reductions, when coordinated with those of other states, are sufficient to achieve all reasonable progress goals. In cooperation with the Northern Class I consultation group and using the aforementioned technical analyses, as well as analyses and modeling done in-house, the MPCA went through the following steps to determine Minnesota's contribution to visibility impairment at various

Class I areas, which forms the basis for Minnesota's emission reduction obligations. (Documentation of the various steps is in the listed appendices.)

Baseline inventory

Minnesota assessed the RPG and developed its long-term strategy using emission inventories developed by MRPO, with some Minnesota specific changes.[67] See Chapter 8 for further information.

Minnesota's Impact on Class I areas

Minnesota is reasonably anticipated to significantly contribute to visibility impairment at three of the four Northern Class I areas: BWCAW, VNP, and Isle Royale. Initial modeling and data analysis studies done by MRPO showed that Minnesota was expected to contribute 30 – 35% of the visibility impairment affecting its own Class I areas in 2018, and about 14% of the visibility impairment affecting Isle Royale. Using the MPCA's determination that a significant contribution to visibility impairment is a contribution over five percent on the worst days, Minnesota is not expected to significantly contribute to visibility impairment at any other Class I areas. Although Minnesota contributes five percent to overall visibility impairment at the fourth Northern Class I area, Seney Wilderness, Minnesota's contribution on the worst visibility days is below the five percent threshold and therefore is not further discussed.

Minnesota's own modeling analysis, described in Chapter 8, supports the conclusions drawn in the initial modeling and data analysis done by MRPO. Based on the MPCA's modeling, Minnesota has the following contributions to light extinction in 2018 at BWCAW, VNP, and Isle Royale:

Table 10.1: Class I areas Impacted by Minnesota

Class I area	Minnesota Contribution to Light Extinction[68] in 2018
BWCAW	28%
VNP	31%
Isle Royale	13%

CENRAP constructed Areas of Influence (AOIs) for each of its Class I areas, showing the important upwind source areas for emissions of precursors to visibility impairing pollutants. The AOIs show that Minnesota is in the Level 1 AOI (the AOI with the most impact) for the two Minnesota Class I areas, with small areas of the state in the Level 1 AOI for nitrate for the Class I areas in Missouri and Arkansas and in the sulfate and nitrate AOIs for the Class I areas in North and South Dakota.[69] However, CENRAP's PSAT analysis indicates Minnesota is not a significant contributor to these Class I areas, based on MPCA's chosen five percent threshold. (See Appendix 10.1)

Oklahoma identified Minnesota as a state that contributes to visibility impairment in the Wichita Mountains Class I area, using CENRAP's PSAT analysis and a threshold of one inverse megameter contribution in 2018. However, Oklahoma did not identify any particular control measures that Minnesota was expected to undertake, due to the fact that Minnesota's contribution was equivalent to the threshold level.

The contribution assessment performed by Northeast States for Coordinated Air Use Management (NESCAUM) for the Mid-Atlantic/Northeast Visibility Union (MANE-VU) shows Minnesota contributing less than one percent of the sulfate impact at the Mid-Atlantic and Northeast Class I areas.[70]

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[67] MRPO, 2006.
[68] This shows only light extinction resulting from nitrate, sulfate, and ammonium.
[69] Stella, G.M et al., 2006.
[70] NESCAUM, 2006.

CENRAP's PSAT analysis shows that Minnesota contributes less than 3.5% of modeled light extinction to the MANE-VU Class I areas on the 20% worst days in 2018. Minnesota was not identified by MANE-VU as a state impacting its Class I areas.[71]

Back trajectory analysis by the Visibility Improvement State and Tribal Association of the Southeast (VISTAS) shows that some air masses impacting various Class I areas in Virginia, North Carolina, and Florida may have had some residence time over Minnesota, but it does not appear substantial enough to make Minnesota a significant contributor to those Class I areas.[72] CENRAP's PSAT analysis shows that Minnesota contributes less than two percent of modeled light extinction to the VISTAS Class I areas on the 20% worst days in 2018. (See Appendix 10.1).

No states other than Michigan and Oklahoma have, at this time, formally asked Minnesota to consult with them as a significant contributor to visibility impairment at their Class I areas. Neither state has asked Minnesota to undertake specific emission reductions.

Because Minnesota is the major contributor to its own Class I areas, the MPCA believes that the measures undertaken to reach the RPG set for BWCAW and VNP will be sufficient to account for its share of emission reductions needed to meet the RPG at any other Class I areas that Minnesota may impact, particularly Isle Royale.

States Impacting Minnesota's Class I areas

Minnesota identified the states expected to contribute significantly to visibility degradation, defined as more than five percent of visibility impairment on the worst days, in both VNP and BWCAW using the MRPO's initial 2018 PSAT analysis, without later modifications (i.e., inclusion of IPM version 3.0 for EGUs.). Based on this information, the states identified as contributing to visibility impairment in Minnesota's Class I areas are: Minnesota, Wisconsin, Illinois, Iowa, Missouri, and North Dakota. Appendix 3.2, containing Minnesota's consultation letter, gives further information and shows that other analyses by MRPO and CENRAP support the determination of the contributing states.

Subsequent analyses by Minnesota, using in-house modeling, show that the impacts of the contributing states on BWCAW, VNP, and Isle Royale are as follows:

Table 10.2: Percentage Contributions by State to Light Extinction[73]

	BWCAW	VNP	Isle Royale[74]
Minnesota	28%	31%	13%
Wisconsin	10%	6%	16%
Illinois	6%	3%	8%
Iowa	8%	7%	8%
Missouri	6%	4%	5%
North Dakota	6%	13%	4%

Further information can be found in Appendices 3.1, 3.2 and 10.1, Chapter 8, and the Technical Support Document.

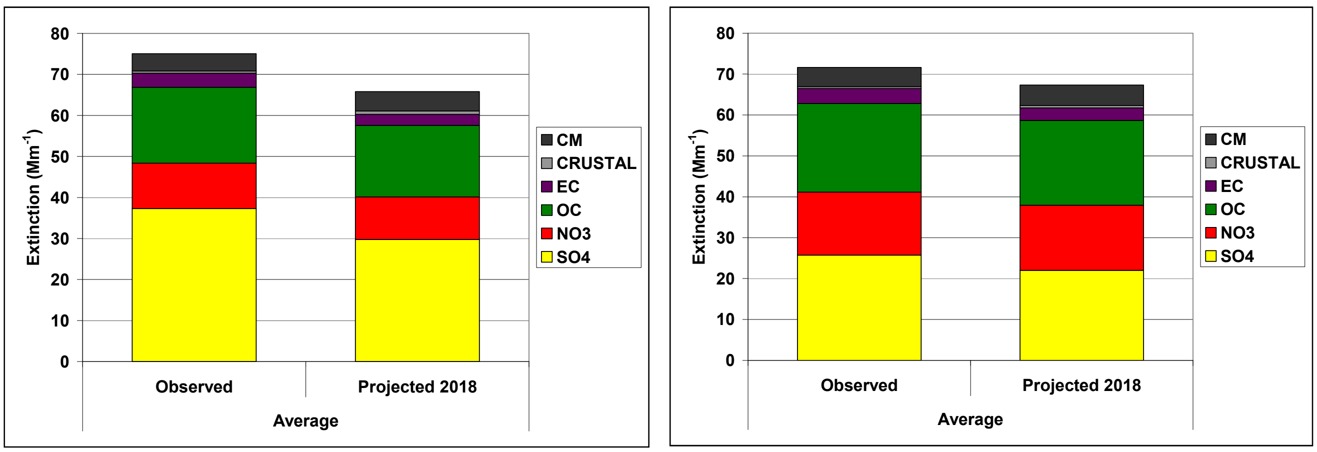
[71] MANE-VU, *Inter-RPO Consultation Briefing Book*. (webpage)
[72] VISTAS. *Summary Materials: Summary Presentations for each Class I area*. (webpage)
[73] Again, this shown only light extinction resulting from sulfate, nitrate, and ammonium.
[74] This indicates contributions shown at the western tip of the island of Isle Royale, which is closest to Minnesota, not the IMPROVE monitor location, which is on the mainland.

Pollutants and Sources Impacting Minnesota's Class I areas

The pollutants predicted to contribute most to visibility impairment in each Class I area on the 20% worst days, both in the baseline period and in 2018, are sulfate, nitrate, and primary organic carbon. (See Figure 10.3.) MPCA chose to focus on sulfate and nitrate, as primary organic carbon appears to be at levels close to those estimated as natural condition levels and is a smaller contributor to light extinction. Also, the main sources of organic carbon seen in the Northern Class I areas are primarily biogenic in origin. Organic carbon is treated further in the section on fires and smoke emissions. More information on visibility impairing pollutants can be found in Appendices 3.1, 10.1, Chapter 8 and the TSD.

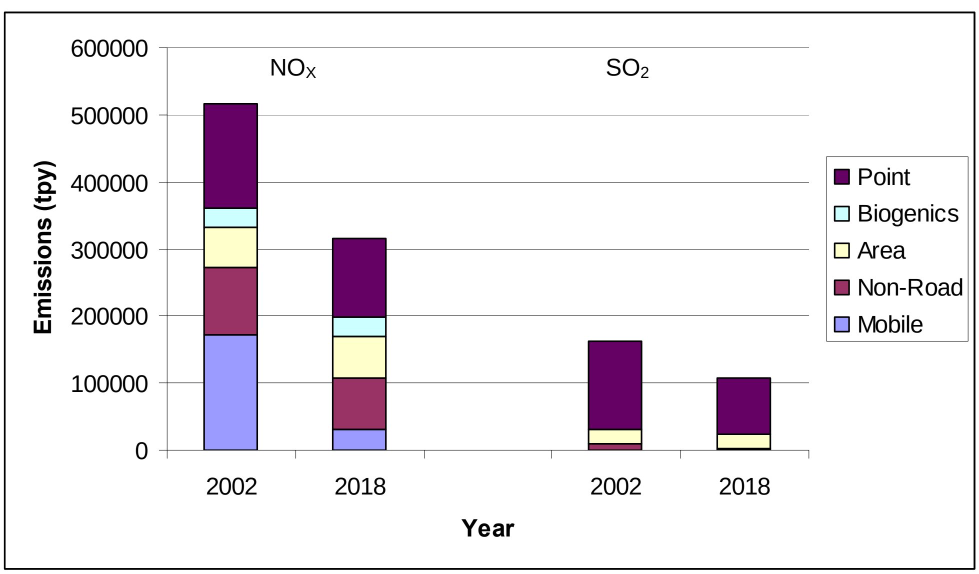
Figure 10.3: 2002 Observations and 2018 Projections in Extinction by Species W20% Days

BWCAW **VNP**



MPCA also identified the major sources of the pollutants likely to contribute to visibility degradation in each Class I area in 2018. Figure 10.4 documents the major sources of NO_X and SO_2 emissions (in tons per year) in 2002 and 2018. Point sources are clearly a key source of emissions.

Figure 10.4: NO_X and SO_2 Emissions in Minnesota by Source Category



Figures 10.5 and 10.6 show the main source categories contributing to light extinction from sulfate, nitrate, and ammonium in BWCAW and VNP. The major contributing sources in 2018 are projected to be EGUs. EGUs remain a large percentage contributor in 2018, as they were in 2002, partially due to major projected reductions in nonroad and onroad emissions. More information can be found in Appendices 3.1 and 10.1, along with Chapter 8 and the TSD.

Figure 10.5: BWCAW 2018 Extinction by Sector for each Specie, W20% Days

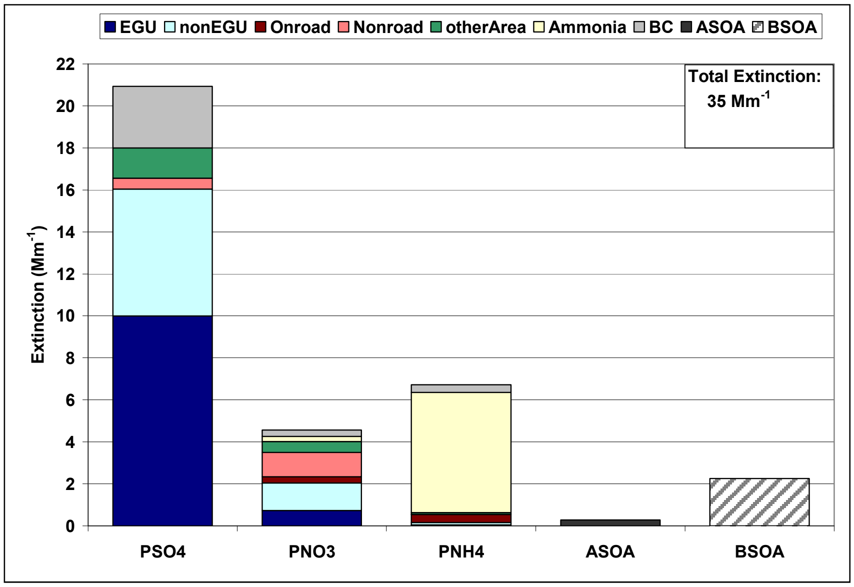
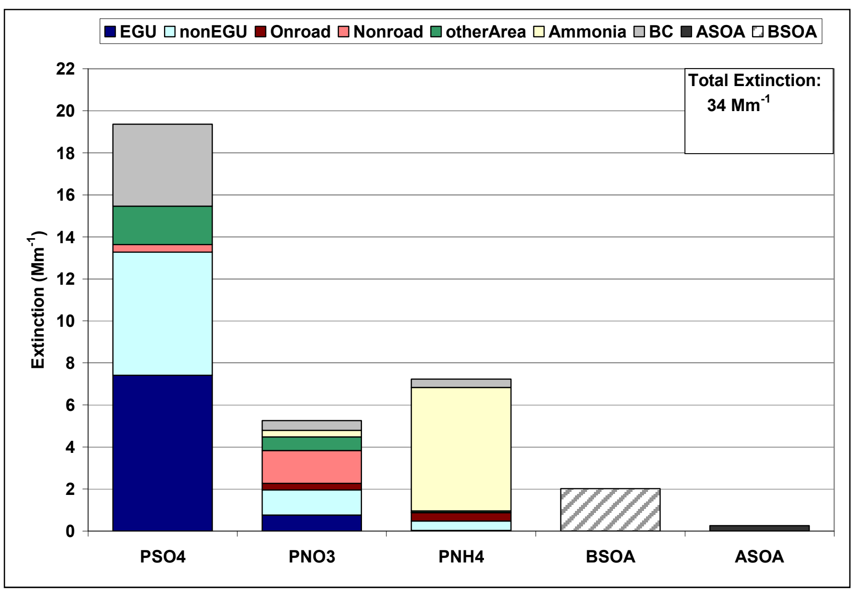


Figure 10.6: VNP 2018 Extinction by Sector for each Specie, W20% Days



These figures, along with Chapter 8 and the modeling TSD, document the anthropogenic sources of visibility impairment considered by the state in developing its long-term strategy, as required by 40 CFR 51.308(d)(3)(iv). More detailed discussion of the pollutants and source categories considered can be found in Chapter 8.

Guidance in Determining RPG

EPA released final guidance on June 1, 2007 to use in setting RPGs.[75] The EPA guidance states:

> "RPGs are interim goals that represent incremental visibility improvement over time toward the goal of natural background conditions and are developed in consultation with other affected states and Federal Land Managers (FLMs). In determining what would constitute reasonable progress, section 169A(g) of the CAA requires states to consider the following four factors:
>
> - The costs of compliance;
> - The time necessary for compliance;
> - The energy and non-air quality environmental impacts of compliance; and
> - The remaining useful life of existing sources that contribute to visibility impairment.
>
> States must demonstrate in their SIPs how these factors are taken into consideration in selecting the RPG for each Class I area in the state…As noted above, the RHR establishes an additional analytical requirement for states in the process of establishing the RPG. This analytical requirement requires states to determine the rate of improvement in visibility needed to reach natural conditions by 2064, and to set each RPG taking this 'glidepath' into account…EPA adopted this approach, in part, to ensure that states use a common analytical framework that accounts for the regional difference affecting visibility and, in part, to ensure an informed and equitable decision making process. The glidepath is not a presumptive target, and states may establish a RPG that provides for greater, lesser, or equivalent visibility improvement as that described by the glidepath."

The glidepath named in the EPA guidance, also called the "Uniform Rate of Progress" (URP) is essentially a line between current or baseline conditions on the worst days and natural background in 2064. (See Chapter 5) The URP requires 0.12 deciviews of improvement annually at VNP and 0.14 deciviews annually at BWCAW to meet natural conditions by 2064. The tables in Chapter 5 give additional information about the observed visibility conditions.

Approach to Determining RPG[76]

The following approach was used to determine the RPG for the four Northern Class I areas. It was developed by MRPO based on EPA's draft guidance for setting reasonable progress goals, and agreed to by the states involved in the Northern Class I consultation process. By the time of the publication of EPA's final reasonable progress guidance, the states in the Northern Class I consultation process were already acting based on the draft guidance, and Minnesota did not feel that the changes to the guidance were substantive enough to warrant changes to the RPG approach.

The states involved in the Northern Class I consultation process worked together to identify and prioritize sources, assess the impact of existing control programs on priority sources, and to direct a contract to investigate and evaluate control options for those priority sources. MPCA then followed this basic approach in setting the RPGs for Minnesota. The basic steps for determining the RPG were as follows:

<u>Identify and Prioritize Sources</u>: The first step was to determine existing visibility conditions, examine which sources and geographic regions are contributing to worst and best visibility days, and, with the help of air quality models and monitoring receptor analyses, identify the major anthropogenic sources/sectors contributing to worst visibility days (priority sources) and their relative impacts on visibility impairment.

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[75] U.S. EPA, OAQPS, 2007b.
[76] MRPO, 2005c.

Overall, the states comprising the Northern Class I areas consultation group agreed that the priority emissions and sources were:

- SO_2 from point sources (EGUs and non-EGUs)
- NO_X from point sources (EGUs and non-EGUs) and mobile sources
- NH_3 from agricultural operations

MPCA determined that the major pollutant and source impacting Minnesota's Class I areas appears to be SO_2 from EGU, which forms ammonium sulfate. Modeling shows that sulfate is one of the main components of haze at VNP, BWCAW, and Isle Royale on the 20% worst days. (See Appendix 3.1 and Chapter 8). EGU SO_2 emissions from Minnesota, Wisconsin, Iowa, North Dakota, Missouri and Illinois appear to be the key contributors. Ammonium nitrate is also an important anthropogenic contributor to visibility impairment.

MPCA also identified the Northeastern corner of the state, the six counties closest to the Class I areas, as an important source area of SO_2 and NO_X emissions. MPCA reviewed control strategy analyses done by CENRAP, which identified natural gas compressor stations and industrial, commercial and institutional (ICI) boilers as priority sources that should be evaluated for potential control, and also identified potentially low cost control measures for multiple sources.

Identify Control Options for Priority Sources: The second step was to develop control options for reducing the emissions from the priority sources, including existing and expected control programs (e.g., CAIR, BART, and nonattainment area controls) and other possible control programs. Minnesota worked in conjunction with MRPO to fund a contract to examine various control strategies. (See Appendix 10.5.)

On the books control measures examined were:

- Clean Air Interstate Rule
- BART
- MACT
  - Reciprocal Internal Combustion Engines
  - Industrial Boilers and Process Heaters
- On-Road Mobile Source Programs
  - 2007 Highway Diesel Rule
  - Tier II/Low Sulfur Gasoline
- Non-road mobile source programs
  - Non-road Diesel Rule
  - Control of Emissions from Unregulated Non-road Engines
- Locomotive/Marine

The other control options or scenarios examined, developed by MRPO, were the following:

- EGU control scenarios setting regional emission limits based on
  - EGU1: SO_2 limits of 0.15 lbs/MMBtu
NO_X limits of 0.10 lbs/MMBtu
  - EGU2: SO_2 limits of 0.10 lbs/MMBtu
NO_X limits of 0.07 lbs/MMBtu
- ICI Boilers
  - ICI1: SO_2 reduction of 40% from 2018 baseline
NO_X reduction of 60% from 2018 baseline
  - MRPO Workgroup Proposal resulting in approximately a 77% reduction in SO_2 and 70% in NO_X.

In Minnesota, the majority of the EGUs whose emissions significantly impact BWCAW and VNP are already undertaking controls and/or will be subject to BART limits. MPCA also identified the indurating furnaces used in taconite pellet production in Northeastern Minnesota as priority sources. These furnaces are subject to BART, but few emission reduction options for SO_2 or NO_X have been investigated and are known to be reasonable.

Control options for various other sources were investigated in the EC/R report for MRPO and MPCA, shown in Appendix 10.5, and by Alpine Geophysics for CENRAP, shown in Appendix 10.6. This includes control measures and projected costs of control for natural gas compressor stations and ICI boilers and other sources identified by CENRAP. Rather than identifying specific emission limits for these sources, incremental control options (above and beyond the 2018 base case) were identified and grouped by cost and emission reductions achieved.[77] See Appendix 10.6 for further information.

Finally, Minnesota identified control options for its priority sources in Northeastern Minnesota, as described later in this Chapter.

<u>Assess Effect of Existing Programs for Priority Sources</u>: The third step was to assess the expected emission reduction from existing control programs for the priority sources, especially for the important visibility impairing pollutants (e.g., SO_2 and NO_X). Minnesota will obtain emission reductions from some of these priority sources under existing and on the books programs. The impact of existing programs is described below, in the long-term strategy section on "Emission reductions due to ongoing air pollution programs." In addition, the EC/R report describes the expected emission reductions that will occur regionally from on the books controls for priority sources.

<u>Evaluate Control Options for Priority Sources</u>: Using the four statutory factors, the next step was to evaluate the control options for all priority sources and determine which measures may be reasonable.

Many control options for priority sources were evaluated in the report in Appendix 10.5. Particular attention was paid in the Northern Class I consultation group to the "EGU1" control strategy proposed by MRPO, which is a 0.15 lb/MMBtu SO_2 limit and a 0.10 lb/MMBtu NO_X limit assumed to take effect in 2013. Many in the Northern Class I consultation group also believe it is important to take a look at ICI boilers, and the control strategies proposed by MRPO for those sources, including a 40% reduction in SO_2 limit and a 60% reduction NO_X by 2013.

CENRAP evaluated control options for all sources that met the so-called Q/5D criteria, i.e. that their level of emissions (in tons) when divided by their distance (in kilometers) from an affected Class I area was less than or equal to five, and focused on control options that were available for less than $5000/ton. CENRAP's analysis indicates that, from sources meeting the Q/5D and less than $5000/ton criteria, Minnesota could reduce 8192 tons of NO_X emissions from the 2002 baseline at an average cost per ton between $2000 and $2500. This analysis did not find any SO_2 emission reductions available matching the specified criteria. Many of the NO_X reductions were found at facilities that are already undertaking emission controls.

Because of the lack of known control options for taconite indurating furnaces, MPCA chose to include these sources in a regional approach to emission reductions, which is described as part of the long-term strategy. See "Plan for Emission Reductions in Northeast Minnesota." Part of the goal of this plan is to spur the development of new control options.

[77] Stella, February and March 2007.

The states in the Northern Class I consultation process have largely agreed on the priority pollutants (SO_2 and NO_X) and sources (EGU, and to a lesser extent ICI boilers), with each state adding some specific priority sources or source categories.

Compare Control Strategies with Uniform Rate of Progress: The final step was to compute the appropriate visibility metrics for the existing/expected controls and the "reasonable" controls for the Class I areas. Compare the expected improvement in visibility with the 60-year glidepath to natural conditions, and determine when areas would meet natural conditions if the annual progress under the RPG is less than the URP.

MPCA included in its long-term strategy all control measures currently believed to be reasonable, and modeled these control strategies to determine if the resulting visibility improvement was equivalent to, better, or worse than the URP. This is documented in the modeling chapter and will be described in more detail later, in the discussion of the RPG.

Share of Emission Reductions

Each state must obtain its share of emission reductions needed to attain the RPG. Between now and 2018, there will be reductions in emissions of SO_2 and NO_X in Minnesota and the region impacting Minnesota's Class I areas due to on the books control strategies, voluntary projects, and additional emission control measures. Many of these additional control strategies have been discussed by the Northern Class I consultation group. However, because of the differences in attainment status for criteria pollutants and contribution towards haze, each state must ultimately make its own decision as to which control measures are reasonable, thereby impacting the reasonable progress goal.

Many of the states that contribute to visibility impairment in Minnesota's Class I areas are tackling multiple SIP issues at once (haze, $PM_{2.5}$ and ozone) and will submit their haze SIPs at a future date. Therefore, at this time Minnesota is establishing a RPG that might be exceeded due to the controls these states develop as they continue to work on their SIPs.

All of the control measures that Minnesota currently plans to undertake are included in the long-term strategy and described in the following section. The MPCA believes this contains all control measures currently known to be reasonable. Therefore, the RPG is set at the visibility level shown to result from the application of all the elements of Minnesota's long-term strategy, along with all currently known controls being applied by other states.

The RPG is documented towards the end of this chapter, after discussion of the long-term strategy. Minnesota believes that the state's long-term strategy when coordinated with other state and Tribes' strategies will be sufficient to meet the reasonable progress goals set out below.

Minnesota's Long-Term Strategy

All of the control strategies that will contribute to meeting the RPG are documented in Minnesota's long-term strategy. MPCA is required by 40 CFR 51.308(d)(3)(v) to consider several factors in developing its long-term regional haze strategy. These are discussed below.

Emission reductions due to ongoing air pollution programs

40 CFR 51.308(d)(3)(v)(A) requires Minnesota to consider emission reductions from ongoing pollution control programs. These emission reductions are reflected in the 2018 modeling inventory.
Minnesota considered the following ongoing or expected programs in developing its long-term strategy:

Clean Air Interstate Rule (CAIR)

Minnesota's electric generating utilities (EGU) were initially covered under the federal Clean Air Interstate Rule (CAIR), designed to reduce emissions of nitrogen oxides and sulfur dioxide. However, on May 12, 2009, EPA published a proposed rule to stay the effectiveness of CAIR in Minnesota, until EPA can determine if Minnesota meets the threshold for inclusion in the CAIR region. If finalized, Minnesota EGUs will not have to comply with CAIR until EPA's repromulgated CAIR rule makes a final ruling on Minnesota's inclusion. CAIR will continue to have an impact on visibility in Minnesota by reducing emissions in surrounding states.

The following table shows predictions of emissions from Midwest EGUs in 2018 using version 3.0 of EPA's IPM modeling, which assumes that CAIR is implemented.

Table 10.3: IPM 3.0 Predictions for 2018

State	Heat Input (MMBtu/year)	SO_2 (tons/year)	SO_2 (lb/MMBtu)	NOx (tons/year)	NOx (lb/MMBtu)
IL	1,310,188,544	277,337	0.423	70,378	0.107
IN	1,509,616,931	361,835	0.479	90,913	0.120
IA	534,824,314	115,938	0.434	59,994	0.224
MI	1,009,140,047	244,151	0.484	79,962	0.158
MN	447,645,758	61,739	0.276	41,550	0.186
MO	893,454,905	243,684	0.545	72,950	0.163
ND	342,685,501	41,149	0.240	44,164	0.258
SD	44,856,223	4,464	0.199	2,548	0.114
WI	675,863,447	127,930	0.379	56,526	0.167

Although Minnesota is likely to be removed from the current CAIR program, the MPCA is aware of several facility-specific pollution control projects that were being undertaken to ease compliance under CAIR; some of these projects will be required to fulfill BART for specific units, others will go forward voluntarily.

Minnesota has also seen a number of voluntary projects being undertaken by EGUs to reduce emissions due to Minnesota statute 216B.1692, which makes the cost of environmental projects at existing large EGUs eligible for rate recovery. Projects completed or going forward under this statute are underlined in the following bulleted list. The statutory language is shown in Appendix 10.2. We believe that IPM 3.0 remains a relatively accurate portrayal of future EGU emissions in Minnesota, despite the potential change in CAIR status. See Chapter 8 for more information.

The MPCA has considered the following emission reductions in developing Minnesota's long-term strategy; these projects have regulatory certainty as they are either already operating or have submitted applications to the Minnesota Public Utilities Commission for rate recovery or permit applications to the MPCA.[78] Appendix 10.3 contains details on how to access relevant Air Emission Permits for these projects.

The projects being undertaken to reduce NO_X and/or SO_2 include:

- Minnesota Power, Boswell – Unit 3 – BACT-like NO_X and SO_2 controls by 2009
- Minnesota Power, Laskin – Units 1,2 – NO_X controls by 2009

[78] For example, documents relating to Minnesota Power's application for a emission reduction rider for pollution control projects at Laskin and Taconite Harbor can be found at https://www.edockets.state.mn.us/EFiling/search.jsp by searching for docket number 05-1678.

- Minnesota Power, Taconite Harbor – Units 1,2,3 – NO_X and SO_2 controls by 2009
- Ottertail Power, Hoot Lake – Units 2,3 – NO_X controls by 2008
- Rochester Public Utilities, Silver Lake Plant – Unit 4 – NO_X and SO_2 controls by 2009
- Xcel Energy, Allen S. King Plant – Unit 1 – NO_X and SO_2 controls in 2007
- Xcel Energy, High Bridge – Units 3,4,5,6 – Switch from coal to natural gas by 2008
- Xcel Energy, Riverside – Units 6,7,8 – Switch from coal to natural gas by 2009
- Xcel Energy, Sherburne County – Units 1,2,3 – NO_X and SO_2 reductions

Minnesota and the other states participating in the Northern Class I consultation calls believe that in some areas their future EGU emissions were not correctly represented by IPM 3.0, because certain planned reductions were not included. Therefore, these states constructed an IPM 3.0 "will do" scenario, representing EGU emissions with known projects included. In general, known projects are those that have already gone through some kind of regulatory process, such as a permit application or notice to a state utility commission. However, the projects in the IPM "will do" scenario were not known in time to be submitted to EPA in order to be included in the base IPM3.0 projection.

In addition, a few mistakes were noticed in the IPM3.0 predictions; examples of such errors affecting Minnesota facilities include the size of an EGU boiler being understated by 100MW and NO_X emission rates being considerably lower than permit limits. Minnesota included these corrections in the "will do" scenario, resulting in a slight increase in predicted NO_X emissions. Other states also included higher emissions where they felt IPM had inaccurately predicted the 2018 scenario, such as where facilities were shown with controls although utilities had indicated to the state that they would not be installing controls. Overall, these corrections resulted in higher regional emissions.

Table 8.5 shows the base and adjusted emissions, and Chapter 8 also discusses the adjustments made by the states participating in the Northern Class I consultation process. In some cases, states also provided a "may do" scenario, which includes EGU reductions that are possible but have not yet gone through enough procedures within the state to be sure that they will be undertaken. However, Minnesota did not rely on the "may do" scenario in any modeling or determination of the RPG. Therefore, the emissions from the "may do" scenario are not shown here, though they can be seen for the contributing states on page 12 of the consultation letter that is Appendix 3.2.

Best Available Retrofit Technology (BART)

As documented in Chapter 9, Minnesota has several emission sources that are subject to BART. Minnesota has incorporated language into its rules making any standard or other requirement established under section 169A (Visibility Protection for Federal Class I areas) or 169B, including emission limits established in the determination of best available retrofit technology, "an applicable requirement for stationary sources." (See Appendix 9.7)

As mentioned previously, MPCA has made BART determinations for Minnesota's subject to BART EGUs. However, as described in Chapter 9, determining BART for the pellet furnaces at Minnesota's taconite facilities is difficult. MPCA has made BART determinations, but is unable at this time to set a corresponding BART emission limit for most of the pellet furnaces. Therefore, at this time, we cannot predict the full extent of the emission reductions that will result from BART in Minnesota.

The MPCA is requiring the taconite facilities to continuously monitor or use a comparable alternative method to obtain more accurate estimations of their emissions, and report their emission data to MPCA. It has been shown in the past that installation of continuous monitors allows facilities to more efficiently monitor and manage their combustion processes, resulting in less fuel usage and fewer emissions. The

MPCA expects this could result in emission reductions of 5 –30%, depending on the facility, simply due to combustion management.

After a year of emission data is obtained, MPCA will review the data and set necessary BART emission limits; these emission limits will be incorporated into facility Title V permits. In the Five Year SIP review, the MPCA will document those emission limits and the level of reductions they represent from the 2002 base year emission inventory. For more information on BART, see Chapter 9.

The states surrounding Minnesota and the contributing states have made varying decisions about BART, resulting in a wide range of potential emission reductions due to BART. Chapter 8 and the TSD describe the emission reductions from BART in other states that were incorporated into Minnesota's modeling.

Other Federal Programs

Minnesota also anticipates some significant emission reductions resulting from several federal rules that will be implemented in the next several years. These reductions were included in the modeling of predicted 2018 emissions.

- Tier II for on-highway mobile sources
- Heavy-duty diesel (2007) engine standards
- Low sulfur fuel standards
- Federal control programs for nonroad mobile sources

$PM_{2.5}$ and Ozone SIPs

Minnesota is currently in attainment with the NAAQS for $PM_{2.5}$ and ozone, and therefore was not required to submit SIPs showing decreases in these pollutants. However, several of the states that impact BWCAW and VNP are or will be submitting SIPs that include plans to reduce these pollutants and their precursors. These reductions will also reduce precursors to regional haze. Emission reductions included in SIPs from contributing states were not available in time to be included in this SIP. Minnesota has asked contributing states to provide information on emission reductions as they complete their SIPs, so that Minnesota may include this information in future modeling and the Five Year SIP Assessment.

Additional Emission limitations and schedules of compliance

40 CFR 51.308(d)(3)(v)(C) requires Minnesota to identify additional measures to meet visibility goals when ongoing programs alone are not sufficient. It appears that ongoing air pollution control programs are not sufficient to meet the URP at Minnesota's Class I areas, or at Isle Royale, to which Minnesota is a significant contributor, through 2018. Even if they were sufficient to meet the URP, the state is required to investigate other reasonable control strategies.

Certain voluntary emission reductions, not mentioned previously, appear likely to occur among Minnesota's taconite industry. Based on this information, and knowledge of reductions occurring at EGUs, Minnesota adopted the following strategy as a "backstop," ensuring that these planned reductions take place and providing incentives for other emission reductions. The strategy also ensures that Minnesota's sources obtain their fair share of emission reductions and addresses concerns about industrial expansion near the BWCAW and VNP.

Plan for Emission Reductions in Northeast Minnesota

Minnesota's Class I areas are located in the Northeastern region of the state. This area, sometimes known as the Arrowhead or Iron Range, contains some major industrial sources that are high emitters of the two main haze causing emissions – SO_2 and NO_X. These high emitters (as of 2002) include EGUs and the taconite industry, a unique iron ore mining and processing industry with only eight operating facilities in the nation, six of which are located in Northeast Minnesota.

In addition, several new sources are likely to open on the Iron Range in the next few years, adding to the emissions in the region. The combination of geographic proximity, high existing emissions, and potential new sources has led to a high level of concern over the impact of this area on visibility. Therefore, in cooperation with the Federal Land Managers, Minnesota has developed a plan that sets emission reduction targets in the six counties closest to VNP and the BWCAW. The concept plan for Northeastern Minnesota, developed by MPCA and the FLMs and with extensive stakeholder input, is attached as Appendix 10.4. This section of the SIP focuses on implementation of the plan.

Large point sources located in St. Louis, Lake, Cook, Carlton, Itasca and Koochiching counties that emitted over 100 tons per year of either SO_2 or NO_X in 2002, or have the potential to emit over 100 tons per year of either pollutant (if not in existence in 2002), will be subject to a region-wide target for emission reductions compared to the 2002 emission inventory.

The emission reduction target was derived from the URP line for Voyageurs National Park. Many RPOs and states have determined from technical analyses that much of their visibility impairment is caused by sources beyond the state's control – sources like organic carbon from wildfires, windblown dust, or international transport of emissions. In order to try to determine reasonable progress without the impact of non-controllable sources, "species-specific" glide slopes are created. This involves changing the deciview glide path to a glide path for light extinction, and then separating out the different types of particles based on how they contribute to the overall light extinction. Although Minnesota did not use this approach in calculating the RPG, it was used in developing the emission reduction target.

In order to focus solely on controllable impacts, the effects of emissions from outside Minnesota, emissions that are biogenic or otherwise difficult to control, and emissions that are at predicted natural conditions were removed. This resulted in 75% of all visibility impacts assumed to be uncontrollable by the MPCA. This left ammonium sulfate and ammonium nitrate from in-state sources; these particles are caused by SO_2 and NO_X, pollutants with established methods of control. Calculations were done to determine the percent decrease in light extinction due to these particles needed to achieve the 2018 visibility goal, and the assumption made that the extinction coefficient changed in direct proportion to the change in emissions from the region. Since light extinction from these particles needs to decrease by about 28% to reach the glide path, the ultimate target was set as a 30% reduction in emissions.[79]

In short, the emission reduction target is intended to reflect the level of reductions needed in ambient concentrations of sulfate and nitrate in order to meet the URP for those pollutants, adjusted for the level of emissions that are uncontrollable or outside the domain.[80]

Based on this technical analysis, Minnesota is establishing an emission reduction target or goal of a reduction in combined SO_2 and NO_X emissions from the subject sources of 20% by 2012 and 30% by 2018.

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[79] The MPCA would like to thank Scott Copeland of the CIRA/VIEWS Staff for his invaluable assistance in the technical work, such as deriving the species-specific glide path, needed to set the emission reduction target.

[80] Note that changing the percentage of impacts found to be uncontrollable did not make a major difference in the percent reductions needed to meet the glide path. It should also be noted that the approach does not consider modeling of individual sources, but treats all emissions as though they have equal potential to cause impacts. It also does not explicitly account for differing mass extinction efficiencies of NO, NO2 and SO2.

Although most of the largest sources in this region are subject to BART and many are undertaking voluntary emission reduction projects, this target aims for overall larger emission reductions than are otherwise likely.

Table 10.4: NE Minnesota Emission Reduction Target

Year	Total Emitted (tpy)
2002 – Combined SO_2 and NO_X emissions	95,562
2012 Goal – 20% Reduction	76,450
2018 Goal – 30% Reduction	66,894

This area was targeted for controls under the long-term strategy for several reasons. First, the MPCA's analysis of 2002 emissions from the top 18 emitting point sources within Minnesota show that sources from this region make up just 1/3 of the total emissions but provide 2/3 of the total visibility impact. (See Chapter 8, on modeling.) Therefore, they have a much larger impact on the Class I areas than emissions from farther away. In addition, the taconite facilities may be currently uncontrolled or under-controlled for SO_2 or NO_X, and on the books control strategies are projected to cause fewer emission decreases in this region than in the remainder of the state.

The MPCA will track annual SO_2 and NO_X emissions from all covered sources in the region, both actual emissions (as submitted to the emission inventory) from existing sources and potential emissions from new or modifying sources that have submitted complete permit applications.

Minor sources (<100 tpy) are not included in the Northeast Minnesota plan, and their emissions will not be tracked annually. However, in 2012 and 2018, the MPCA will evaluate the emissions from minor sources that hold individual or registration permits in order to determine how those emissions have changed from the 2002 baseline.

This tracking process will allow the MPCA to take a holistic look at the emission changes in the region, rather than simply addressing the largest sources that individually contribute to visibility impairment.

The existing individual sources whose emissions will be tracked are:

- Minnesota Power Inc - Boswell
- US Steel Corp - Minntac
- Hibbing Taconite Co
- US Steel - Keewatin Taconite
- Northshore Mining Co - Silver Bay
- Minnesota Power - Taconite Harbor
- United Taconite LLC - Fairlane Plant
- Minnesota Power Inc - Laskin
- Arcelor Mittal Mining Co
- Sappi Cloquet LLC
- Boise White Paper LLC - Intl Falls
- Virginia Dept of Public Utilities
- Duluth Steam Cooperative Assoc.
- Minnesota Power Inc - ML Hibbard
- Hibbing Public Utilities
- Blandin Paper/Rapids Energy Center
- Georgia-Pacific - Duluth Hardboard
- Ainsworth Engineered LLC-Cook
- Ainsworth Engineered LLC - GR

The MPCA will make publicly available, most likely electronically, an annual update of actual and forecasted emissions from the tracked sources in the region, along with the most recent monitored visibility conditions available.[81] In addition, the MPCA will do a calculation of emissions in the region and progress towards the reduction target when any new major source applies for a permit to locate in this six-county region, or an existing source requests a major modification that would require a PSD permit. This information will be shared with the FLMs for their review prior to permit issuance, and will be available as part of the public notice process prior to permit issuance.

MPCA is requiring CEMs or a comparable emission estimation method to be applied by the taconite facilities as part of BART. This will allow facilities to closely monitor future emissions. It may also provide information about the accuracy of the 2002 baseline emission levels; there is the potential for adjusting the baseline level from which emissions must be reduced in light of additional information. However, changes in fuel types and physical modifications to the taconite furnaces undertaken since 2002 make accurate emission comparisons challenging. These changes are expected to result in decreased SO_2 and NO_X emissions from the taconite industry as a whole. Because emissions from taconite facilities are believed to have made up 47% of the 2002 emissions from stationary sources in the six-county area, the MPCA will attempt to take the uncertainty about the 2002 emissions into account when determining if additional emission reductions to meet the target are needed.

Based on the BART analyses, MPCA has determined that the six taconite facilities may be undercontrolled, and that very few emission control technologies are known to be effective for the industrial processes involved in taconite production. Minnesota will therefore require these facilities to investigate control technologies and pollution prevention practices for their indurating furnaces through pilot tests or other mechanisms conducted on-site at the facilities, and report to MPCA on the feasibility and cost effectiveness of said technologies and practices.

These reports will likely be structured very much like the facilities' BART analyses, evaluating the feasibility of implementing piloted technology at a large scale, the costs of installing controls, and other impacts. The MPCA will conduct a review of the taconite facilities' reports on the piloted control strategies and pollution prevention options investigated by the taconite facilities. We anticipate that the facility reports and MPCA's subsequent analysis will be made available for public review, through a similar process as used for the BART analyses.

The MPCA will evaluate the piloted potential control strategies using the statutory factors (cost of compliance, time necessary for compliance, energy and non-air environmental impacts, the source's remaining useful life, and visibility impact) and considering the progress towards the overall emission target. That progress will become a sixth factor considered in determining what control strategies or level of emission reductions are reasonable. Also, the degree to which 2002 emissions were over or under-estimated will be considered, at least qualitatively.

The MPCA believes that the pilot tests at existing facilities and installation of emission control equipment at new taconite facilities will demonstrate that feasible, reasonable controls exist for the taconite facilities. Regardless of the status of the overall Northeast Minnesota emission target, such reasonable emission reduction measures will be required to be implemented as part of the state's long-term strategy. The status of the emission target will be used primarily to inform the consideration of cost-effectiveness – if the overall regional emission reduction target is being met, the maximum $/ton cost-effectiveness level considered to be reasonable would likely be lower. Should more reductions be needed to meet the emission target, then a higher $/ton figure may be considered reasonable.

[81] The first annual tracking spreadsheet was posted in January 2009 and is available at: http://www.pca.state.mn.us/publications/aq-sip2-11.pdf

If it appears that other facilities will need to implement control strategies in order for the emission reduction target to be met, even after all voluntary EGU reductions have occurred and the determination of additional reasonable controls on the taconite facilities has been made, the MPCA will do a preliminary cost analysis of feasible pollution prevention and control options to evaluate whether further analysis by the facilities is warranted. If needed, such analysis will be requested by the MPCA. This further analysis would be used to determine reasonable control strategies that should be implemented by those sources. Reasonableness will be evaluated based on the same factors listed above.

Although the regulatory or enforceable mechanism that will be used to require these reasonable emission reductions is not yet known, the MPCA anticipates that the determination of reasonable controls will be included in the Five Year SIP Assessment. Minnesota would likely implement the requirement for additional emission reduction measures, for both the taconite facilities and any other facilities where additional controls are found to be reasonable, through a "reasonable progress" requirement that would ultimately apply an emission limit to each facility where additional controls have been found to be reasonable. This limit could be set through a state rule or through amendments to each facility's Title V air emission permit.

In cooperation with the FLMs, the MPCA has developed a strategy for reporting progress towards the emission reduction goals and for consulting with the FLMs to determine necessary additional actions. The reporting is designed to mesh with the requirements of the Five Year SIP assessment. In that assessment, the MPCA will compare actual emissions to the emission target and determine 1) if the 2012 target has been met and 2) if the 2018 target is likely to be met. Throughout the implementation period for this SIP, if it is projected that either target will not be met, the MPCA will consult with the FLMs, tribes and other stakeholders to determine what actions are needed to meet the 2018 target, taking into account the factors such as the difference between actual emissions and the target, plans for emission reductions between 2013 and 2018, the trends in nitrate and sulfate concentration and visibility in BWCAW and VNP, modeled visibility for 2018, and the availability of cost-effective emission reduction strategies. Actions could range from simply continued tracking to further assessment and potential implementation of additional emission reduction measures by facilities.

The following table lays out the relevant timelines for the interlinked components of BART and the LTS in Northeast Minnesota.

Table 10.5: BART and Northeast Minnesota Plan Timeline

Process	Dates
Begin data collection and reporting for taconite facilities with new CEMs/PEMS, as required by Administrative Orders	November 2008
Begin annual tracking of NE Minnesota Plan emissions	December 2008
MPCA determines remaining BART limits for each taconite facility	By August 31, 2011
MPCA determines if 2012 target will be met, and projects status of 2018 emission reduction target.	January – December 2012
Taconite facilities conduct pilot testing of potential control strategies and pollution prevention	July 2011 – December 2012
Taconite facilities report to MPCA on results of pilot testing	By March 1, 2013
MPCA reviews pilot testing reports and determines if any additional controls are reasonable	March – June 2013
MPCA does preliminary analysis of potentially reasonable reductions from non-taconite facilities in NE Minnesota.	January – June 2013
MPCA develops enforceable mechanism to require any additional control found to be feasible, for both taconite and (if necessary) non-	July 2013 – June 2014

taconite facilities	
MPCA submits 5 year assessment which includes BART limits, determination of additional reasonable controls.	July 2014
Facilities install any additional controls found to be reasonable	2015 and forward

It should be noted that the economic downturn has impacted operations at the taconite facilities. Although some data collection began in November 2008, the majority of the facilities have subsequently idled their operations. The deadlines in Table 10.5 have been revised from the initial draft SIP to recognize that data collection is not likely to begin until lines resume operation, likely in fall of 2009 or early 2010, thereby impacting when the MPCA will be able to set BART limits and when facilities will be able to begin investigating potential controls.

Emissions from the six-county region covered by the Northeast Minnesota plan will continue to be held to a level 30% below 2002 levels beyond 2018. In future SIP revisions, the MPCA will consult with the FLMs and evaluate the necessity of maintaining emissions from Northeast Minnesota at this level and the possibility of continuing reductions from the area in order to reach the long-term visibility goals.

Measures to mitigate the impacts of construction activities

40 CFR 51.308(d)(3)(v)(B) requires Minnesota to consider measures to mitigate the impacts of construction activities. Some of the main impacts of construction activities include the impacts of emissions from nonroad mobile and diesel engines and fugitive emissions resulting from land clearing and construction. Emissions from nonroad mobile sources and diesel engines will be decreased between now and 2018 due to federal on the books control strategies.

The impact of construction activities will continue to be mitigated through the federal general and transportation conformity rules, which are included into Minnesota's SIP. In addition, Minnesota has a state rule, Minnesota Rule 7011.0150, which requires all reasonable measures to be undertaken to prevent particulate matter from becoming airborne. This rule is already included in Minnesota's SIP.

> 7011.0150 PREVENTING PARTICULATE MATTER FROM BECOMING AIRBORNE.
>
> No person shall cause or permit the handling, use, transporting, or storage of any material in a manner which may allow avoidable amounts of particulate matter to become airborne.
>
> No person shall cause or permit a building or its appurtenances or a road, or a driveway, or an open area to be constructed, used, repaired, or demolished without applying all such reasonable measures as may be required to prevent particulate matter from becoming airborne. All persons shall take reasonable precautions to prevent the discharge of visible fugitive dust emissions beyond the lot line of the property on which the emissions originate. The commissioner may require such reasonable measures as may be necessary to prevent particulate matter from becoming airborne including, but not limited to, paving or frequent clearing of roads, driveways, and parking lots; application of dust-free surfaces; application of water; and the planting and maintenance of vegetative ground cover.

Measures to mitigate the impacts of new sources

In terms of the construction of new major sources, the visibility impacts of such sources will continue to be managed in conformance with existing requirements pertaining to New Source Review and Prevention of Significant Deterioration, for which Minnesota operates a delegated PSD program. The PSD program requires the installation of BACT and modeling of the project's impacts on local air quality. New sources or major modifications outside the Northeast Minnesota Plan also need to screen their emissions. If they are judged to have a potential adverse impact on visibility, those projects will need to perform more sophisticated modeling and analysis of their proposed impacts on Class I areas, including their effects on visibility.[82]

Sources covered by the Northeast Minnesota Plan that propose PSD modifications for haze pollutants will have to install BACT and ensure that their emissions fit into the budget for the Plan. The PSD regulations also require the consideration of other impacts to the environment. The proximity of new and modified facilities to Minnesota's Class I areas, even those covered by the Plan, necessitates consideration of visibility in this step. (Historically, the MPCA has incorporated similar environmental factors into the BACT determination by adjusting the cost-effectiveness threshold.) This can lead to the application of more effective control strategies and thus lower emission rates. In addition, the MPCA could cite the visibility section of the PSD rule in order to ask for controls. Through the PSD process, which includes review by and input from the Federal Land Managers, particularly on appropriate BACT determinations and determinations of adverse visibility impact, the MPCA will be able to minimize the impact of new sources on visibility.

The Northeast Minnesota plan attempts to move from the incremental approach of the traditional PSD visibility program towards a more holistic approach. If emissions are declining under the Northeast Minnesota Plan, visibility should be improving; this is a better approach than determining if simply the addition of pollutants will not have too great an impact on the Class I area.

For sources subject to the Northeast Minnesota plan described previously, the intent is for the MPCA to sign a Memorandum of Agreement with the FLMs that would not require new or modifying facilities in that Northeast Region to conduct a detailed visibility analysis under PSD, as long as the region as a whole is meeting the stated emission reduction goals. Should the Northeast region fail to meet the reduction goals, full visibility analysis would be required under the PSD program. Until the memorandum is signed, the MPCA will continue to require new or modifying facilities to undertake a visibility analysis as needed.

Source retirement and replacement schedules

Source retirement and replacement schedules, which must be considered under 40 CFR 51.308 (d)(3)(v)(D) in developing reasonable progress goals, will be managed in conformance with existing requirements under the PSD program, much as described above.

Agricultural and forestry smoke management

Under the requirements of 40 CFR 51.308(d)(3)(v)(E) Minnesota must consider smoke management techniques for the purposes of agricultural and forestry management in developing the long-term strategy to achieve the reasonable progress goal.

Impact of Fires on Visibility

Vegetative burning produces NO_X, organic compounds, carbon monoxide, carbon dioxide, and particulate matter. Approximately 90% of smoke particles from wildland and prescribed fires are PM_{10}, while about

[82] This determination is generally made by the Federal Land Managers.

70% are $PM_{2.5}$.[83] Of the pollutants that derive from vegetative burning, those that mainly impact visibility are nitrates, ozone, organic carbon (OC), and elemental carbon (EC). Ozone, while not directly produced by fires, may form downwind of fires due to photochemical reactions of combustion products (NO_X and VOCs). Ozone can also participate in nitrate and sulfate particle formation.

Of the main visibility impairing pollutants, OC and EC are formed from fire; however, neither are unique products of fire. EC, for example, is a primary product of the combustion of any carbon fuels, and therefore can come from diesel emissions as well as vegetative burning. Organic aerosols can be the outcome of either primary emissions or secondary formation from gas phase emissions. OC can be attributed to human sources of VOCs or to biogenic emissions from both conifer and broad-leaved trees in the summer growing season.

At both VNP and BWCAW, OC is the largest component of $PM_{2.5}$ mass measured in summer by the IMPROVE monitors. When light extinction is calculated from the filter measurements, OC is proportionally less significant but still an important pollutant – roughly equal to sulfate in its effect on summertime visibility (Figure 10.3, Appendix 3.1.)

Both OC and EC are products of fire and monitoring data on days affected by fire will show increases in these pollutants. In general, biogenic emissions of OC are not easily distinguished from emissions from fire,[84] but several studies have been done to determine the causes of high OC in the Class I areas. It appears that most OC seen in the Northern Class I areas is biogenic, coming from plants as opposed to fire.

Sheesley and Schauer conducted a study at Seney Wilderness that examined the sources of organic carbon affecting the area.[85] Using a marker species associated with vegetative burning, they found the highest levels of this marker in the winter months, likely indicating burning due to use of wood stoves and fireplaces. There was a lesser peak from June through September; the summertime levels of the marker species indicate high secondary organic aerosols, not primary emissions of wood smoke or other sources. These findings were reviewed in a 2005 MRPO issue paper, which concluded "the contribution of fires to annual average $PM_{2.5}$ concentrations and visibility impairment in the Upper Midwest is relatively small. Nevertheless, fires may cause problems on an episodic basis."[86]

To further investigate the impact of fire, a MRPO contractor developed an inventory of fire emissions from agricultural, prescribed, and wildfire burning in 2001 – 2003 for the Midwest states; the report shows that Minnesota has the greatest emissions of the eight states due to burning.[87] In addition, total acres burned by both wildfire and prescribed fire increased in each successive year, and total acres burned in Minnesota were usually more than twice the next highest state.[88]

Because of the relatively high levels of burning and the fact that prescribed burning is likely to continue to increase, it is important to assess the effects of fires in Minnesota on the visibility data, especially for the 20% worst days.

The following table identifies days among the worst 20% visibility days of the baseline period that have the highest levels of organic and elemental carbon.

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[83] EPA, 1998
[84] Debell, et al., 2006.
[85] Sheesley & Schauer, 2004.
[86] MRPO, 2005a, p 9.
[87] Boyer, et al, 2004. Table 8-2, p 67.
[88] Boyer, et al, 2004. Table 8-3, p 70.

Table 10.6: W20% Days with Highest OC and EC Light Extinction (Baseline Years)*

Class I area	Species	2000	2001	2002			2003			2004	
		Sept 30		June 1	June 28	July 19	June 5	Aug 7	Aug 25	July 17	July 26
BWCAW	OC	26.64	NA	NA	66.50	125.56	27.87	28.52**	55.67	71.68	34.36
	EC	9.24			5.74	7.13	3.58	2.02	4.68	3.40	3.50
VNP	OC	30.58		89.38	71.23	169.82	25.56	32.05	57.51	80.58	44.83
	EC	10.68		8.29	5.93	8.58	4.86	3.44	6.71	4.53	4.05

* Threshold value= light extinction (B_{ext}) for OC + EC > 50% of total daily B_{ext} AND total B_{ext} > 50 Mm^{-1}
** For this date, total B_{ext} was < 50 Mm^{-1}, but the day was investigated due to high OC + EC impact.

MRPO examined five of the days shown above to assess whether OC from fire may cause or contribute to these elevated values.[89] Using back trajectories and satellite maps of fires, it appears that monitoring data for four of the five days was highly influenced by wildfires in Manitoba and Saskatchewan.

The MPCA analyzed those days not analyzed by MRPO. Overall, most of the nine days shown above with the highest light extinction due to OC and EC appear to be influenced by fires in Canada. There are only two days, June 5, 2003 and July 26, 2004, where it is reasonable to conclude that fires within Minnesota contributed to the elevated concentrations of OC and EC. On these days, a small prescribed burn and a wildfire upwind of the monitor, respectively, appear to affect the IMPROVE data.

In Minnesota, federal and state land managers generally conduct prescribed burning during a spring season (March 15 - May 31) and a fall season (Sept 15 - Oct 31). None of the 20% worst days shown in Table 10.5 occur in these intervals. Elevated concentrations of OC in the summer can be due in part to wildfires, but can also be due to high biogenic emissions. Because of the extensive forests to the north of Minnesota, it is likely that some of the high OC measured in summer at the IMPROVE monitors is biogenic secondary organic aerosol that originates in Canada. Further details on the visibility impact of fires can be found in Appendix 10.7.

MRPO determined that subtracting the five days of high OC concentration from the 20% worst days, in general, had a relatively small effect on visibility impairment for the baseline average – a range 0.3 dv at Minnesota's Class I areas to less than 0.2 dv at Michigan's Class I areas.[90]

Although the data show that fires do have some impact on visibility in Minnesota's Class I areas, the impacts on the 20% worst days tend to be only a few poor visibility days in the summer caused by wildfires. Often these wildfires occur in Canada. For this reason, Minnesota determined that OC particles are not good candidates for additional controls as part of the long-term strategy. Emissions from wildfires should be included in natural condition estimates, and any transboundary fire impacts must be addressed by EPA. Emissions from prescribed and managed fires within Minnesota are managed in conformance with Minnesota's Smoke Management Plan, described below.

Agricultural Smoke Management

Agricultural burning requires an open burning permit from the Minnesota Department of Natural Resources. In general, agricultural burning in Minnesota is limited to grass and stubble burning, particularly of bluegrass and timothy grass. This light fuel type produces short-term smoke events

[89] MRPO, 2007b; LADCO, 2008.
[90] MRPO, 2007b; LADCO, 2008, pg 45.

without a lot of combustion of biomass and smoldering. In addition, most agricultural burning occurs in the northwest area of the state, away from the Class I areas.

Agricultural burning is not covered by Minnesota's Smoke Management Plan, and EPA's *Interim Air Quality Policy on Wildland and Prescribed Fires* specifies that it does not apply to agricultural burning.[91] Minnesota is not addressing agricultural burning in this SIP, as an analysis of the days during the baseline visibility period with the highest concentrations of organic and elemental carbon shows that none of these days were attributed to agricultural burning within Minnesota.

EPA is due to issue new final guidance for wildland and prescribed fire, and separate guidance is likely to be issued to address agricultural burning. Should agricultural fires become an important contributor to poor visibility, Minnesota will address agricultural fires in future SIP revisions.

Forestry Smoke Management

Minnesota's various ecosystems are dependent on and adapted to fire disturbance, and prescribed burning has become a common management tool for these ecosystems. Prescribed burning is also used to reduce the frequency, size, and intensity of wildfires and consequently reduce total emissions from vegetative burning. This benefit to air quality is promoted by the application of the Smoke Management Plan (SMP), whereby practices to reduce the impact of burning on air quality are added to the "prescription" that determines the conditions for igniting and managing the fire.

Most open burning in Minnesota is required to have a burn permit, and a process is in place for authorizing those permits and granting approval to manage fires. The Commissioner of the Minnesota Department of Natural Resources (DNR) is granted authority in Minnesota Statutes 88.01 to 88.22 to control open burning; the DNR reviews burn applications and issues burn permits for all open burning in Minnesota, except on federal and tribal lands.[92]

More importantly for management of fire emissions, Minnesota has a Smoke Management Plan that has been in effect since 2002; although briefly described here the MPCA is not proposing that it be formally incorporated into Minnesota's SIP. The SMP is subject to occasional updating and revision, and was updated in December 2007.

The MPCA works with state and federal land managers as part of the Minnesota Incident Command System (MNICS) Prescribed Fire Working Team[93] to develop the SMP. The SMP is implemented through a Memorandum of Agreement between the U.S. Department of Agriculture, Forest Service; U.S. Department of the Interior, National Park Service; U.S. Department of the Interior, Fish and Wildlife Service; The Nature Conservancy; Minnesota Department of Natural Resources; and the MPCA. The signatory agencies agree to apply the provisions of the SMP to all prescribed fires that they ignite and all naturally occurring fires that they manage.

Minnesota believes this program addresses visibility impairment due to fires. Minnesota certified in a letter to the EPA on September 2, 2004 that a basic program has been adopted and implemented. EPA's reply is included in Appendix 10.8. The key provisions of the 2002 SMP are described below, and a complete copy of the SMP can be found on the web.

According to EPA's guidance, "The purposes of SMPs are to mitigate the nuisance and public safety hazards…posed by smoke intrusions into populated areas, to prevent deterioration of air quality and

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[91] U.S. EPA, 1998.
[92] For more information, see Minnesota DNR, *Burning Questions* (webpage).
[93] Now Prescribed Fire/Fuels Working Team

NAAQS violations, and to address visibility impacts in mandatory Class I Federal areas."[94] Similarly, Minnesota's SMP sets out "regional haze rules to improve visibility in the mandatory Class I areas" as a primary reason for implementing a smoke management plan in the state. Minnesota considers the SMP to be an important tool to achieve the purposes of the Regional Haze Rule. In addition to addressing NAAQS and regional haze issues, Minnesota's SMP was developed due to predicted significant increases in the use of prescribed burning.

Minnesota's SMP is based on EPA's Interim Air Quality Policy.[95] It includes the following requirements as laid out in that guidance:

- Authorization to burn
- Minimizing air pollutant emissions
- Smoke management components of burn plans
- Actions to minimize emissions
- Evaluation of smoke dispersion
- Air quality monitoring
- Public education and awareness
- Surveillance and enforcement
- Program evaluation

Under the SMP, all prescribed fires must have burn plans that include the following elements:

- Location and description of the area to be burned
- Personnel responsible for managing the fire
- Type of vegetation to be burned
- Area (acres) to be burned
- Amount of fuel to be consumed (tons/acre)
- Fire prescription including smoke management components and dispersion index
- Criteria the fire manager will use for making burn/no burn decisions
- Safety and contingency plans

The SMP requires calculation of a dispersion (or ventilation) index based on mixing height and transport winds to mitigate smoke impacts. Dispersion index category is used with fuel type and daily size of fire to determine minimum proximity to nearest downwind receptors. Prescribed burns cannot be ignited outside these conditions.

Minnesota's SMP gives the MPCA responsibility for an annual assessment of the effect of prescribed burning on air quality within Minnesota. This annual review includes an examination of both $PM_{2.5}$ and ozone (O_3) monitoring data in Minnesota, including data from the IMPROVE monitors, for correlations between air quality and wildland and prescribed fires. This report is provided to the Prescribed Fire/Fuels Working Team of MNICS as part of the annual evaluation of the SMP.

The four step process generally used is as follows:

1) Examine the air sample data from monitors at geographically appropriate sites for high values of $PM_{2.5}$ and ozone during the prescribed fire season;

[94] U.S. EPA, 1998.
[95] U.S. EPA, 1998.

2) Determine the wind speed and direction during the day and the hours of elevated $PM_{2.5}$ and ozone concentrations;
3) Determine the time, location, and size of prescribed burns conducted by SMP-participating agencies with respect to the time and location of the recorded air concentrations (includes evaluation of wildfires); and
4) Use back-trajectory mapping to determine the movement of higher-elevation air parcels with respect to the location of potential fire sources.

The Working Team also looks at the acres of prescribed burns planned for the next five years, the need to expand the scope of the program to include authorization of other open burning, and the need for changes in the SMP.

Future of SMP and Fires

The Prescribed Fire/Fuels Working Team of MNICS completed a review and revision of Minnesota's SMP in December 2007.

Following is a summary of the major changes made to the SMP:

- Additional participating agencies (Minnesota Department of Military Affairs and Minnesota Department of Transportation)
- Update of acres burned by prescribed fire
- Update of PM_{10}, $PM_{2.5}$, and O_3 NAAQS description
- Revision of "climate of smoke dispersion in Minnesota" section
- Addition of references to EPA's Exceptional Events Rule (March 2007) and effects on prescribed burning (including record keeping in burn plans to demonstrate exceptional events)
- Revision of table in 4.2.3 "Smoke Management & Dispersion" and combination of dispersion index categories, fuel type/burn acres, and distance to receptors charts
- Addition of the EPA's Air Quality Index (AQI) information to Appendix
- Update of PM_{10}, $PM_{2.5}$, and O_3 monitors and locations table and maps in Appendix

As necessary, the SMP will continue to be updated periodically by the participating agencies.

Enforceability of emission limitations and control measures

40 CFR 51.308(d)(3)(v)(F) requires Minnesota to ensure that emission limitations and control measures used to meet RPG are enforceable.

Appendix 9.7 contains the state rulemaking that made both BART and CAIR applicable requirements for stationary sources. The Administrative Orders requiring CEMs or a comparable method of emissions measurement from the taconite facilities are included in Appendix 9.7. Minnesota requests EPA approval of these measures.

Minnesota will submit additional enforceable documents in the Five Year SIP Assessment. Once established, BART emission limits will be included in each taconite facility's Title V permit and submitted to EPA. In addition, the MPCA will develop enforceable documents such as permits, Administrative Orders, or a state rule that will require the taconite facilities to conduct the research into additional emission reduction measures (if such is not already being undertaken voluntarily and reported to the MPCA) and implement control strategies found to be reasonable.

Anticipated net effect on visibility resulting from projected changes to emissions

40 CFR 51.308(d)(3)(v)(G) requires Minnesota to address the net effect on visibility resulting from changes projected in point, area and mobile source emissions by 2018.

The emission inventory for Minnesota projects changes to point, area and mobile source inventories by the end of the first implementation period resulting from population growth; industrial, energy and natural resources development; land management; and air pollution control. These changes, and their net effect on visibility, are described in Chapter 8.

Potential Future Projects and Impacts

Other actions are likely to take place over the next 10 years that will impact visibility in the Class I areas in 2018, but which are not included in the RPG.

For example, Minnesota expects several surrounding states to submit additional control measures in order to meet their responsibilities under the Regional Haze Rule and for attainment of the $PM_{2.5}$ and ozone NAAQS. As these control measures are not yet proposed or implemented, they were not included in the RPG. The MPCA also intends to further investigate control measures that were shown by the EC/R report to be potentially reasonable under the four factors. This is discussed further below.

In addition, there are the potential impacts of both climate change and regulations to reduce greenhouse gases. Climate change may well impact the meteorology of the area, affecting the transport of precursor pollutants. However, these impacts are extremely difficult to predict and are more likely to be seen over the long-term of the Regional Haze program (to 2064) rather than over the next ten years. In addition, research suggests that the "sensitivities of ozone and $PM_{2.5}$ formation to precursor emissions are found to change only slightly in response to climate change."[96] This indicates that control strategies put in place to reduce precursor emissions (NO_X and SO_2), such as those in this SIP, will continue to be effective in reducing $PM_{2.5}$, and haze, even if the climate has changed.

Minnesota has implemented some rules and laws in order to reduce greenhouse gas emissions, and more such policies are likely to be forthcoming. For example, there is now a new Renewable Energy Standard, Minnesota Statute 216B.1691, requiring 25% of the state's energy to come from renewable sources by 2025. This is likely to lead to more non-fossil fuel based energy generation, perhaps leading to lower future emissions from electricity generation than currently predicted. (See Appendix 10.2).

In addition, Minnesota has been engaged in a statewide process of determining what actions the state should take in response to global climate change. Although any measures undertaken as a result of this process will be intended to reduce emissions of carbon dioxide and other greenhouse gases, it is likely that some of them may have the added benefit of reducing emissions of fine particulate matter and its precursors, thereby helping to reduce regional haze.

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[96] Liao, et al., 2007. p 8355.

Reasonable Progress Goals

At this time, based on the aforementioned information, Minnesota is setting the reasonable progress goals at the deciview levels shown in the following table.

Table 10.7: Reasonable Progress Goals for Class I areas

Class I area	2018 Visibility 20% Worst Days (dv)	2018 Visibility 20% Best Days (dv)	Projected Annual Improvement 2004-2018 (W20%, dv)	Projected Improvement by 2064 (W20%, dv)	Year Reaching Natural Conditions (W20%)
BWCAW	18.6	6.4	0.09	5.6	2093
VNP	18.9	7.1	0.04	2.6	2177

The RPG provides for less annual progress towards the ultimate visibility goals than the URP.

The RPG set in this SIP is the minimum visibility improvement Minnesota considers to be reasonable, and contains emission reductions resulting from all controls currently known to be reasonable – namely BART, CAIR, other on the books and national strategies, and emission reductions due to the Northeast Minnesota Plan, all of which are described above in the long-term strategy. The MPCA anticipates that the levels indicated in this table represent an interim decision on the reasonable level of visibility improvement.

Factors Impacting RPG

International Emissions

There is some indication, particularly from the modeling performed by CENRAP, that Minnesota's two Class I areas may have significant visibility impacts resulting from Canadian emissions.[97] However, estimates of this international impact vary due to difficulties quantifying Canadian emissions and discrepancies between models. (For more information, see Chapter 8 and the TSD.) The MPCA requests that EPA work with Canada in order that future SIP revisions for regional haze will be able to include more accurate emission estimates and modeling in order to better quantify any international impact on visibility. Where necessary, EPA should then work with Canada and support reductions in haze-causing emissions.

Emissions from Contributing States

At this time, Minnesota believes that the RPG in Table 10.6 is an appropriate goal because of uncertainty surrounding future levels of emission reductions. Some impacting states are working on a multi-SIP approach and have yet to determine what reductions are reasonable in their states for both haze and NAAQS attainment purposes. Although we cannot compel other states to undertake reductions, Minnesota believes that some additional emission reductions from other states have been shown to likely be reasonable, and that further emissions reductions will occur due to attainment SIPs, resulting in larger visibility improvement.

Minnesota has used the EC/R five factor analysis report (see Appendix 10.5) the control cost analysis carried out by Alpine Geophysics for CENRAP and the CENRAP Control Sensitivity Model run (Appendix 10.6) to identify potentially reasonable region-wide emission reduction strategies that could be adopted in future years to strengthen Regional Haze SIPs. Minnesota has therefore asked the contributing states to evaluate whether these control strategies are reasonable, under the four factors, and to report the results of this analysis in their SIPs or Five-Year Assessments. (See Appendix 3.2)

[97] ENVIRON/UCR, 2007. pp 1-23 to 1-24 and p 5-2.

Preliminary indications from the contributing states are that those states are, at this time, unlikely to undertake additional emission reductions for regional haze purposes. Of the contributing states, Missouri has indicated in its SIP that it does not believe that it is a significant contributor to visibility in either of Minnesota's Class I areas. Iowa has indicated that it does not feel that additional controls are cost-effective due to their cost in $/deciview, and that further review of some controls is unwarranted due to the uncertain status of federal regulation. (See Appendix 3.2.) Although Minnesota has continued to consult with these states, we have been unable to resolve these disagreements. Therefore, Minnesota asks EPA to make a determination as to whether controls from these states to address visibility impairment in Minnesota's Class I areas are appropriate.

It should be noted that although modeling was done to evaluate the visibility conditions if the contributing states commit to certain control strategies that Minnesota has deemed to be potentially reasonable, Minnesota is not yet asking the contributing states to make such commitments. Instead, Minnesota has simply asked the contributing states to look at the reasonableness of those control strategies that could improve visibility in Minnesota's Class I areas.

In addition, the MPCA intends to continue to research control strategies and other means to strengthen the Regional Haze SIP. Should such strengthening measures be found, or should other states commit to control measures, Minnesota intends to revise the RPG for 2018 in the Five Year SIP Assessment, in order to reflect the additional control strategies found to be reasonable.

Specific Control Strategies to Be Reviewed

The specific strategies that at this time appear potentially reasonable, despite a lack of information to fully evaluate them at this time, and Minnesota's expectation for each of these strategies for both Minnesota and the contributing states, are outlined below.

EGU SO_2 Reductions

Minnesota has asked the contributing states to continue to look at their EGU emissions of SO_2, with a particular focus on possible reductions in states with emission rates that appear to be higher than average among the Midwestern states. Although the MPCA recognizes that contributing states face a variety of regulatory demands and fuel types, making it perhaps difficult to attain uniform emission performance, it appears that an emission rate of about 0.25 lb/MMBtu should be achievable in a cost-effective manner. This is the level being achieved in Minnesota and Illinois, and the EC/R report shows that the "EGU1" scenario, a 0.15 lb/MMBtu emission rate, is generally achievable in the Midwest at a reasonable $/ton figure, estimated to range from $560 - $2,900/ton.[98]

Minnesota would expect the identified states to demonstrate that reductions are occurring or being undertaken that will allow the state to reach the above-mentioned emission rates, or to evaluate strategies for reaching the emission rates and state in their SIPs or Five-Year SIP Assessments why further reductions of SO_2 from EGUs are not reasonable. Further reductions may not be reasonable due to the cost of implementation or lack of impact on visibility impairment, but they should be evaluated for each state's specific circumstances.

At present, it appears as though Illinois has planned or proposed reductions that appear reasonable. It appears that more cost effective reductions are possible in Iowa, Missouri, North Dakota, and Wisconsin. Since Wisconsin is the largest non-Minnesota contributor to visibility impairment in Minnesota's Class I areas, their efforts to reduce EGU SO_2 emissions are particularly important.

[98] Battye, et al, 2007, pp 27 – 28.

EGU NO_X Reductions

In general, dispersion models have been less reliable in predicting the nitrate component of particulate matter (as compared to the sulfate component). Wisconsin, Missouri, and Illinois have already reduced NO_X emissions to alleviate ozone standard violations, and Iowa appears to already have relatively low EGU NO_X emissions. Minnesota has asked these states to share information on any NO_X controls being undertaken as part of their ozone SIPs, in order for Minnesota to fully include any information on the resulting emission reductions.

Minnesota has asked North Dakota to evaluate their EGU emissions of NO_X and to describe in their SIP or Five-Year SIP Assessment why further reductions of NO_X from EGUs are not reasonable. Again, an emission rate of approximately 0.25 lb/MMBtu appears to be a reasonable benchmark. Further reductions may not be reasonable due to the cost of implementation in $/ton or $/deciview or lack of impact on visibility impairment, but they should be evaluated for North Dakota's specific circumstances. The EC/R report indicates that control strategies to reach a NO_X level of 0.10 lb/MMBtu may be available in North Dakota in a range of $760 – $3,300/ton.[99]

Again, Minnesota acknowledges that each state is in a unique situation in terms of regulatory background and a general EGU fuel mix. The use of emission rates to identify areas where additional emission control strategies should be investigated does not mean that Minnesota expects all contributing states to achieve the same emission rates.

However, Minnesota believes contributing states with higher emission rates need to evaluate potential control measures, and should, in their initial SIPs or Five Year SIP Assessments, show either enforceable plans to reduce emissions or a rationale for why such emission reductions are not reasonable.

Should the five contributing states reach the 0.25 lbs/MMBtu EGU emission levels, and if:

- States in the MRPO commit to the reductions asked of them by MANE-VU; and
- Controls are installed at Xcel Energy, Sherburne plant;[100]

then modeling shows the future visibility conditions are likely to be better than described in the RPG. These conditions are shown below, in Table 10.7.

Table 10.8: Alternate Goals for Class I areas

Class I area	2018 Visibility 20% Worst Days (dv)	2018 Visibility 20% Best Days (dv)	Projected Annual Improvement 2004-2018 (W20%, dv)	Projected Improvement by 2064 (W20%, dv)	Year Reaching Natural Conditions (W20%)
BWCAW	18.3	6.4	0.11	6.9	2079
VNP	18.7	7.1	0.06	3.4	2127

Several other control strategies were shown to be potentially reasonable, though no modeling was performed on the resulting visibility improvement.

ICI Boiler Emission Reductions

Minnesota will commit to a more detailed review of potential NO_X and SO_2 reductions from large ICI boilers in order to determine if reasonable measures exist that could further strengthen this Regional Haze SIP. For ICI Boilers, the EC/R report indicated that cost-effectiveness ranges from $1,149 to $3,021/ton

[99] Battye, et al, 2007, pp 27 – 28.
[100] If emissions are controlled to the levels used in the modeling. See the TSD for more details.

of SO2 and \$699 - \$5,478/ton of NO_X reductions in the Midwest.[101] If significant cost effective reductions prove feasible from this sector, regulations or permit limits will be developed by 2013. Minnesota expects the five contributing states to also commit to this future evaluation.

Other Point Source Emission Reductions

Reciprocating engines and turbines appears to be a sector with potential cost effective NO_X controls; the EC/R report estimates the cost of NO_X controls to be between \$240 - \$8,200/ton.[102] Minnesota commits to reviewing this sector in more detail and if, after consideration of planned federal control programs, cost effective reductions appear feasible, Minnesota commits to develop regulations or permit limits for major sources by 2012 in order to strengthen the SIP. Minnesota will expect the five other contributing states to make a similar commitment.

Mobile Source Emission Reductions

There appear to be relatively few additional cost effective NO_X controls on mobile sources available to states, partially due to the large reductions resulting from federal requirements. Minnesota commits to work with MRPO states to implement appropriate cost effective NO_X controls to improve visibility and lower ozone levels in non-attainment areas.

NOx Modeling, Ammonia, Agricultural Sources

It is not appropriate to commit to control of ammonia sources at this time. However, there is a clear need to improve 1) our understanding of the role of ammonia in haze formation, 2) our understanding of potential ammonia controls, and 3) the accuracy of particulate nitrate predictions. Minnesota does not believe that conducting such research solely on a state-based level would be appropriate at this time, as information on ammonia's role particulate formation and potential controls is needed throughout the U.S., and regional similarities are likely. Minnesota therefore strongly encourages EPA and the regional planning organizations to continue work in these areas and commits to work with EPA and the RPOs to these ends. The MPCA hopes also to re-evaluate the growth factors used in predicting agricultural ammonia emissions and include that information in the Five Year SIP Assessment.

To summarize, Table 10.8, below, contains all the relevant visibility conditions given throughout this SIP.

Table 10.9: Visibility Conditions, URP and RPG for Minnesota's Class I areas (dv)

	Baseline W20%	Baseline B20%	2018 URP W20%	2018 RPG W20%	2018 Alt Goal W20%	Natural W20%	Natural B20%
BWCAW	19.9	6.4	18.0	18.7	18.3	11.6	3.4
VNP	19.5	7.1	17.8	19.0	18.7	12.1	4.3

Steps in Reviewing Control Strategies and Revising RPG

In reviewing additional control strategies to determine additional strengthening measures that are reasonable under the Regional Haze rule, the MPCA commits to further evaluation of reasonable control strategies that are possible within Minnesota. In addition, Minnesota will focus on strategies that will result in emission reductions in those other states that contribute more than 5% to visibility impairment in BWCAW and VNP: Wisconsin, Iowa, N. Dakota, Missouri and Illinois. The MPCA will work with these contributing states through their submittals of the first haze SIP and through 2013 to develop additional reasonable control strategies.

[101] Battye, et al, 2007, pp 45.
[102] Battye, et al, 2007, pp 57.

In the Five Year SIP Assessment, the MPCA would submit enforceable documents for any additional control measures found to be reasonable within Minnesota. In addition, that report would contain a listing of the additional control measures to be implemented by the other contributing states. Minnesota would then submit modeling that includes all these enforceable measures and would revise the 2018 RPG if the modeling shows, as expected, a larger degree of visibility improvement resulting from the chosen control strategies.

Timeline for Reviewing Control Strategies

Minnesota commits to reviewing these control strategies on such a timeline that the Five Year SIP Assessment will include the four factor analysis for these additional control strategies and that any control strategies deemed to be reasonable by Minnesota or any contributing states will be in place to strengthen the SIP with an enforceable document (state rule, Order, or permit conditions). Although any control measures ultimately deemed to be reasonable may not be fully implemented by 2013, they will clearly be "on the way" and the SIP Report will include estimates of emission reductions and projected 2018 visibility conditions.

Acknowledging the different timelines among states, especially the fact that some states are far along in the process of writing their Regional Haze SIPs, Minnesota expects that all other contributing states would commit to a similar timeline of reviewing potential emission reductions for the Five Year SIP report, allowing for predictions of the emission reductions and visibility improvement resulting from the implementation of reasonable control measures by 2018 to be contained in that report.

Minnesota has determined, based on the reasons delineated above, that the rate of visibility improvement by 2018 shown in Table 10.6 is reasonable and hereby adopts it as the reasonable progress goal (RPG) for the listed Class I areas. The RPG provides for an improvement in visibility for the most impaired days and ensures no degradation in visibility for the least impaired days.

Chapter 11. Periodic Plan Revisions and Determination of Adequacy

2018 SIP Revision

Each state is required by 40 CFR 51.308(f) to revise its regional haze implementation plan and submit a plan revision to EPA by July 31, 2018, and every 10 years thereafter. In accordance with the requirements listed in 40 CFR 51.308(f) of the federal rule for regional haze, Minnesota commits to revising and submitting this regional haze implementation plan by July 31, 2018, and every 10 years thereafter.

Five Year Report

In addition, 40 CFR 51.308(g) requires periodic reports evaluating progress towards the RPG established for each mandatory Class I area. In accordance with these requirements, Minnesota commits to submitting a report to EPA every five years following the initial submittal of the SIP, with the first report due December 15, 2014; this report will evaluate the progress made towards the RPG for each mandatory Class I area located within Minnesota and in each mandatory Class I area located outside Minnesota which may be affected by emissions from within Minnesota. The report will be in the form of a SIP revision, with the first report to be submitted within five years after submittal of this SIP revision. All requirements listed in 40 CFR 51.308(g) shall be addressed in the SIP revision for reasonable progress, including consultation with Federal Land Managers during the preparation of that SIP revision.

Actions to be Taken Prior to Five Year Report

In order to meet our commitments laid out in Chapter 10 of this SIP and to ensure the most accurate estimation of 2018 visibility is made in the Five Year Assessment, the actions laid out in the following table need to occur. The table begins with those activities where MPCA is the responsible party (and to which MPCA is committing in this SIP), and moves on to recommended actions for other parties, such as EPA and the RPOs. These actions are described in detail elsewhere in the SIP.

Table 11.1: Activities to be Completed Prior to Five Year SIP Assessment

Description	Responsible Party
Ongoing tracking of emissions for Northeast Minnesota Plan	MPCA
Analysis of NO_X and SO_2 emissions from taconite facilities obtained through Administrative Orders	MPCA
Remaining BART emission limit determinations for taconite facilities	MPCA
Estimation of NO_X and SO_2 emission limits to be obtained from implementation of BART for taconite facilities (compared to 2002 baseline)	MPCA
Incorporation of BART emission limits into facility permits	MPCA
Development of enforceable mechanism to require pilot testing of emission reductions/control strategies at taconite facilities	MPCA
Research and pilot testing into control strategies and methods to reduce taconite emissions	Taconite facilities
Reporting on outcomes of pilot testing into emission reduction methods for the taconite facilities	Taconite facilities
Evaluation of pilot test reports and determination of additional reasonable controls or emission reductions from taconite facilities.	MPCA
Determination if 2012 Northeast Minnesota Plan target is being met and projection if 2018 target will be met; evaluation of minor source emissions	MPCA
If necessary, evaluation of control strategies for sources in the Northeast Minnesota plan that have not otherwise investigated control strategies.	MPCA and facilities
Evaluation of control strategies for ICI Boilers, other point sources (such as	MPCA

reciprocating engines) and mobile sources to determine if reasonable control strategies are available	Contributing states RPOs
Research to improve understanding of overall ammonia emissions, growth and control, and role of ammonia in haze formation	EPA RPOs
Evaluation of reasonable control strategies to reach an emission rate of 0.25 lbs/MMBtu for NO_X and SO_2 from EGUs	Contributing states
Better quantification of international emissions	EPA RPOs

Contents of Five Year Report

In the five year report, Minnesota will undertake an emission review in order to determine if the emission reductions projected to occur through the application of BART, CAIR (or a revised CAIR rule), voluntary control measures, and the other components of Minnesota's long-term strategy have occurred. The review will also look at what new emission sources have begun operation.

The MPCA, perhaps in conjunction with the RPOs, also hopes to assess the accuracy of the emission growth factors for certain SCCs, such as agricultural operations.

Minnesota's five year SIP report will contain the following items:

BART Limits

As discussed in the section on the application of BART in Minnesota, although Minnesota has determined that BART for the taconite facilities is good combustion practices, along with some facility-specific measures as described, at this time the necessary information is not available to set emission limits associated with existing controls. Because facilities will be required to operate CEMs or undertake a testing method of comparable accuracy in the next few years, MPCA commits to establishing BART emission limits by September 2011, prior to the five year SIP report.

More accurate emission measurements will help provide knowledge of emission formation to understand how modifications to operation and furnace design could result in lower NO_X and SO_2 emissions. The BART limits in conjunction with more accurate measurement of emissions will allow the MPCA to estimate the emission reductions that will result from BART implementation. This information will be provided in the five year report.

Northeast Minnesota Plan Evaluation and Taconite Retrofit Requirements

A major portion of the five-year SIP adequacy and determination report will be an evaluation of progress towards meeting the Northeast Minnesota emission reduction target, described previously. The Northeast plan contains a target of 20% emission reductions by 2012; Minnesota will include emission inventory numbers to determine if this target is being met, along with future emission projections for the area to determine if the 30% reduction goal for 2018 will be met.

In addition to the emission reduction target, Minnesota commits in its current long-term strategy to potentially require controls on taconite facilities regardless of whether the emission reduction goal is being met. As described previously in Chapter 10, the taconite facilities will be required to investigate control technologies and pollution prevention practices through pilot tests and other mechanisms, and to report to MPCA on feasible emission reduction strategies. MPCA will then undertake a BART-like review of these reports and control strategies and evaluate them based on the statutory factors and the status of progress towards the emission target. The five year SIP report will likely include the results of the analysis, a determination of any control strategies or pollution prevention projects that are reasonable at each of the taconite facilities, and enforceable mechanisms for requiring application of these measures.

In addition to the emission reduction measures that will be required from the taconite facilities, Minnesota will review emission projections for the area. If the 2012 emission target is not met, the MPCA will consult with FLMs, tribes, and stakeholders to consider the following information:

- The degree to which emissions are over the 2012 target.
- Plans for emissions reductions from control upgrades or emission increases from newly permitted sources (in 2013-2018) that will determine if the 2018 target will be met
- The trend in ammonium nitrate and sulfate concentrations measured by monitors for BWCAW, VNP, and Isle Royale.
- Predicted visibility improvement in 2018 at Class I receptors as determined by modeling performed for the 2012 SIP Report.
- The availability of cost-effective control measures.

Based on this information and consultation, the MPCA would determine what actions need to be undertaken and described by the five-year SIP report. There could be many possible actions, including:

- Assessing availability of additional cost-effective emission reductions
- Requiring individual facilities to propose and implement some kind of available retrofit technology
- Encouraging voluntary implementation of control measures
- Continued tracking of emissions and emission reduction projects and establish a year for next check-in, e.g. 2015 or 2018.

If the review of emissions shows that the 2012 target is met, the SIP report will assess permit applications approved and under review and project whether 2018 targets will be met. If it appears that the 2018 emission target will not be met, the state will follow the same procedures as described above. If the 2012 target is met in 2012 the 2018 is projected to be met, the state will continue to track emissions through 2018.

Reasonable Progress Update

It is likely that Minnesota's Class I areas will show visibility improvement beyond the RPG set in Chapter 10 of this SIP revision. As stated in Chapter 10, is it not clear at this time which control measures those states that impact Minnesota's Class I areas are likely to find to be reasonable. The MPCA has worked with those states to express our opinion as to what is reasonable.

However, the 2018 RPG set in Chapter 10 is the minimum visibility improvement that Minnesota considers to be reasonable. If additional control strategies are undertaken in Minnesota, the Five Year SIP Assessment will include enforceable measures for these strategies. In addition, between the submission of this SIP and the Five Year SIP assessment, Minnesota will have implemented BART emission limits for the taconite facilities, and will have a better sense of additional controls that will be taken at the taconite facilities, under the Northeast Minnesota plan, or to meet other regulatory requirements, such as a repromulgated CAIR rule.

Therefore, in the Five Year SIP assessment, the MPCA will revise the RPG to reflect the further visibility improvement expected by 2018. This will include any additional controls strategies being implemented in Minnesota or surrounding states.

Adequacy Determination

Depending on the findings of the five-year report on progress towards the goals established for each Class I area, Minnesota commits to determining the adequacy of this existing SIP and undertaking one of the actions listed in 40 CFR 51.308(h). The findings of the five-year progress report will determine which action is appropriate and necessary, and could result in several different actions, depending on the progress towards the visibility goals and the location of the emissions impacting that progress.

Should it be determined that the controls and strategies within the existing SIP are improving visibility in BWCAW, VNP and Isle Royale so that they are on track to meet the reasonable progress goal set in this SIP for 2018, Minnesota will determine that the existing SIP requires no further substantive revision in order to achieve established goals. Should it be determined that the controls and strategies within the existing SIP are improving visibility in the Class I areas so that they will exceed the RPG for 2018 set in this SIP, Minnesota will likely revise the RPG to show more visibility improvement expected by 2018, and determine that the existing SIP requires no further substantive revision. Minnesota will then provide to the Administrator a negative declaration, stating that further revision of the SIP (beyond the Five Year SIP Assessment) is not needed at this time.

Should the MPCA determine that the strategies implemented in the existing SIP appear to be inadequate to ensure reasonable progress due to emissions from other states which participated in the regional planning process or the Northern Class I consultation process, Minnesota will provide notification of that fact to the Administrator and the relevant states. Minnesota will then collaborate with those states through the regional planning process to address the deficiencies in the SIP.

Similarly, should Minnesota determine that the current SIP may be inadequate to ensure reasonable progress due to emissions from another country, the MPCA will provide such notification, along with available information, to the Administrator.

If Minnesota determines that the existing SIP is inadequate to ensure reasonable progress due to emissions within Minnesota, the MPCA will revise its SIP within one year in order to address the plan's deficiencies.