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MN ICS

Prescribed Fire/Fuels Working Team

Minnesota Smoke Management Plan

PRESCRIBED FIRE/FUELS WORKING TEAM

Minnesota Smoke Management Plan

United States Department of Agriculture, Forest Service

United States Department of the Interior, National Park Service

United States Department of the Interior, Fish and Wildlife Service

United States Department of the Interior, Bureau of Indian Affairs

The Nature Conservancy

Minnesota Department of Natural Resources

Minnesota Department of Transportation

Minnesota Department of Military Affairs

and the

Minnesota Pollution Control Agency

EXECUTIVE SUMMARY

Prescribed fire and managed wildfire have been used in Minnesota for many years to improve and maintain natural resources. Those agencies that agree to this Smoke Management Plan (SMP) agree to apply the provisions of the plan to fires that they ignite or to naturally ignited fires that they manage. This Smoke Management Plan is based on Section VI. "Smoke Management Programs " of the U.S. Environmental Protection Agency's (EPA) "Interim Air Quality Policy on Wildland and Prescribed Fires" (April 23, 1998).

The purposes of SMPs are to mitigate the nuisance and public safety hazards (e.g. on roadways and at airports) posed by smoke intrusions into populated areas, prevent deterioration of air quality and National Ambient Air Quality Standards (NAAQS) violations, and address visibility impacts in federal mandatory Class I areas.

In 2006, public land agencies and The Nature Conservancy collectively burned 94,722 acres of land in Minnesota. Grasslands dominated this acreage with 58,826 acres being burned. Total acreage burned by prescription increased 24% from 1999 to 2006. Prescribed burning in Minnesota can be expected to increase from current levels into the foreseeable future. Reasons for burning include: hazardous fuel reduction, site preparation, seed production, wildlife habitat improvement and maintenance, range/pasture improvement and maintenance, disease and insect control (forest health), ecosystem management, restoration and maintenance of biological diversity, restoration of fire as a natural process, research, and training.

Three reasons identified for implementing an SMP for Minnesota are: 1) the regional haze rules to improve visibility in the mandatory Class I areas affect Minnesota, 2) use of prescribed fire as a management tool has increased and can be expected to continue, and 3) the adoption of a Smoke Management Program may prevent particulate matter (PM) NAAQS violations due to emissions from prescribed fire and wildland fires managed for resource benefits, i.e. Wildland Fire Use (WFU), in Minnesota. With the continued need for prescribed burning in Minnesota, particularly in the northern forests inside and nearby Class I areas, it is prudent to set in place an SMP so that these emissions do not result in non-attainment status with the NAAQS and with State air quality standards. Both the EPA interim air quality policy on fire and the Exceptional Events Rule published March 22, 2007 (72 FR 13560) provide certain exemptions for fire emissions for those states that adopt and implement SMPs.

The planning process for this document began early in 1999 with the formation of a subcommittee of the Minnesota Incident Command System (MNICS) Prescribed Fire Working Team. Participants included representatives from the Minnesota Pollution Control Agency (MPCA), National Weather Service (NWS), Minnesota Department of Natural Resources (MNDNR), National Park Service (NPS), U.S. Fish & Wildlife Service (USFWS), U.S. Forest Service (USFS), Minnesota Department of Military Affairs (MNDMA), and the Bureau of Indian Affairs (BIA). A Memorandum of Agreement for the Minnesota Smoke Management Plan was signed and accepted in 2003.

Environmental regulations, including the Clean Air Act and the National Ambient Air Quality Standards have been established to address both visibility standards and criteria pollutants. The MPCA has the authority to implement and enforce federal regulations regarding air quality

standards.

The Commissioner of the MNDNR is granted authority in Minnesota Statutes 88.01 to 88.22 to control open burning in Minnesota. The Commissioner serves as the Central Authority for the State's Smoke Management Plan.

For the purposes of the Smoke Management Plan, prescribed burn plans must 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 or amount of fuel present on the site (tons/acre)
- Fire prescription including smoke management components (see section 4.2.1) and dispersion index
- Criteria the fire manager will use for making burn/no burn decisions
- Safety and contingency plans

The MPCA annually reviews data from the $PM_{2.5}$ & ozone air monitors and the IMPROVE monitors in Minnesota (See Appendix for Maps). Correlations of air quality (visibility and NAAQS) with wildland fire and prescribed fire are assessed for the Prescribed Fire Working Team.

To evaluate the effectiveness of the SMP, the MNICS Prescribed Fire Working Team annually collects and reviews information on acres burned with prescribed fire and/or wildland fire use. Reports of nuisance complaints or smoke intrusions will be noted and the MNICS Prescribed Fire Working Team will use this information to measure the effectiveness of this plan.

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CHAPTER 1. INTRODUCTION

1.1 MINNESOTA OVERVIEW

Prescribed fires and wildland fires managed for resource benefits, i.e., Wildland Fire Use (WFU), have been used in Minnesota for many years to improve and maintain forest, grassland and wetland resources. Several public and private land management agencies in Minnesota have developed and implemented a Smoke Management Plan (SMP) for use with prescribed burning and managed wildland fires throughout the state. This SMP was finalized in 2002 and has been implemented from spring 2002 to the present (2007). Agencies that continue to agree to this plan will apply its provisions to fires that they ignite, or to naturally ignited fires that they manage. The State Air Director certified the original SMP and notification was sent to the U.S. Environmental Protection Agency (EPA) Administrator that the program had been adopted and implemented. The updated SMP will take effect for each agency upon signature of the Memorandum of Agreement by the respective administrator. Tribal land managers in Minnesota may submit an independent SMP to the EPA to address smoke management on tribal administered lands.

Signatory agencies in Minnesota that do prescribed burning prepare individual burn plans. Prescribed burn situations that are governed by state statute require an "open burning" permit. Since the implementation of the SMP in 2002 prescribe fire burn plans have contained smoke management provision consistent with the SMP.

This SMP is based on Section VI "Smoke Management Programs" of EPA "Interim Air Quality Policy on Wildland and Prescribed Fires" (April 23, 1998). The program will be reviewed annually and the document amended as deemed necessary to achieve the purposes of the plan. Such changes may arise from revision of the EPA's interim guidance document to incorporate agricultural burning. At this time, agricultural burning is not addressed by this plan.

1.2 USE OF FIRE AS A LAND MANAGEMENT TOOL IN MINNESOTA

Historically, the ecosystems of Minnesota evolved with fire as a major agent of disturbance (Heinselman 1996). Fire was a very frequent visitor in prairie and woodland ecosystems as well as the conifer forests of northern Minnesota. Because the known frequency of fire in pre-settlement times was many times greater than today, there is evidence that in the Midwest, air quality today is far better from the standpoint of wildland fire generated smoke emissions than in the past (Clark et al. 1996). However, the air is not necessarily cleaner today as our industrialized society has produced new sources of emissions from smokestacks and internal combustion engines. Therefore, utilizing prescribed and managed wildland fire presents the need to weigh the tradeoffs associated with the ecological benefits of these practices vs. the impacts of increased emissions from accelerated burning programs. Part of this tradeoff involves the potential reduction in wildfire emissions by implementing increased prescribed fire programs to reduce fuel buildups

that have occurred as a result of the reduction of naturally occurring wildland fires due to fire suppression. Resulting wildland fires tend to produce greater amounts of emissions because of increased fuel consumption than prescribed fires which normally produce fewer emissions because they are ignited under more moderate weather conditions much less conducive to excess fuel consumption and corresponding increased smoke emissions (EPA 1998).

In Minnesota, both public and private agencies, as well as private industry and individual landowners, use fire as a management tool. Farmers, non-agricultural rural landowners, landscape companies, The Nature Conservancy (TNC), Minnesota Department of Natural Resources (MNDNR), National Park Service (NPS), U.S. Fish & Wildlife Service (USFWS), U.S. Forest Service (USFS), Minnesota Department of Military Affairs (MNDMA), Minnesota Department of Transportation (Mn/DOT), the Bureau of Indian Affairs (BIA), and tribal governments all use fire to accomplish varying goals and objectives. When used for the right reasons and under the right conditions, fire has proven to be a cost effective and "environmentally sound" tool.

In 2006, public land agencies and The Nature Conservancy collectively burned 94,722 acres of land in Minnesota. Grasslands dominated this acreage with 58,826 acres being burned. Total acreage burned by prescription increased 24% from 1999 to 2006. Prescribed burning in Minnesota can be expected to continue at current or higher levels into the foreseeable future as agencies strive to attain their land and resource management goals.

Most vegetation types in the state evolved with fire as a natural process for renewal and maintenance and therefore prescribed fire is frequently utilized as a management tool in these types. Conifer forest, mixed forest, hardwood forest, savanna, grassland, brushland, wetland, and agricultural fields are all treated with fire. Broadcast burning is generally used for large-scale land treatments, however piled slash is also burned throughout the year by all segments of the population. Agricultural interests use fire for debris removal from agricultural fields to enhance growth of perennial crops and to improve grazing. It is also used for site preparation before plowing, disking or planting. Slash, piled or scattered, is burned in the process of land clearing, debris disposal or site preparation. Reasons for burning include: hazardous fuel reduction, site preparation, seed production, wildlife habitat improvement and maintenance, range/pasture improvement and maintenance, disease and insect control (forest health), ecosystem management, restoration and maintenance of biological diversity, restoration of fire as a natural process, research, and training.

Though utilitarian fires are common and widespread, the vast majority of acreage burned by land management agencies is burned for ecological benefits. Grasslands, savannas, pine forests and many other plant communities require fire for maintenance and health. Without fire the treasured pine forests of northern Minnesota would eventually convert to more shade tolerant hardwoods, spruce and fir. Savannas would become forest types and grasslands would degrade. Most ecosystems in Minnesota, from grasslands to forests, are sustained by fire.

1.3 REASONS FOR HAVING A SMOKE MANAGEMENT PLAN IN MINNESOTA

1.3.1 EPA Interim Policy and Guidance

"The purposes of SMPs are to mitigate the nuisance and public safety hazards (e.g. on roadways and at airports) posed by smoke intrusions into populated areas, to prevent deterioration of air quality and National Ambient Air Quality Standards (NAAQS) violations, and to address visibility impacts in mandatory Class I Federal areas" (EPA 1998). The NAAQS referred to here are for particulate matter (PM) < 2.5 microns ($PM_{2.5}$) and particulate matter < 10 microns (PM_{10}).

According to the EPA "Interim Air Quality Policy on Wildland and Prescribed Fires" (April 1998), "strong indications" that a SMP is necessary are the following:

1. Citizens increasingly complain of smoke intrusions;
2. The trend of monitored air quality values is increasing (approaching the daily or annual NAAQS for $PM_{2.5}$ or PM_{10}) because of significant contributions from fires managed for resource benefits;
3. Fires cause or significantly contribute to monitored air quality that is already greater than 85 percent of the daily or annual NAAQS for $PM_{2.5}$ or PM_{10}; or
4. Fires in the area significantly contribute to visibility impairment in mandatory Class I Federal areas.

At this time, these conditions do not present themselves in Minnesota. For example, the annual values of $PM_{2.5}$ concentrations in the forested parts of the state are below 85 % of the standard, based on approximately seven years of data. Although these conditions may not now exist in Minnesota, the nature of a SMP is preventive. The agencies, therefore, agree that a statewide program to reduce potential smoke impacts and address smoke emissions is good public policy and should be developed and implemented at this time.

1.3.2 Reasons Identified for Developing an SMP for Minnesota

1) Regional haze rules to improve visibility in the mandatory Class I areas affect Minnesota.

Section 169A of the Clean Air Act Amendments (CAAA) of 1977 sets forth "…the national goal of preventing any future, and remedying any existing, impairment of visibility in mandatory Class I Federal areas which impairment results from man-made air pollution". The EPA issued rules in 1980 that included language directed at "reasonably attributable" sources of visibility impairment. With the addition of section 169B in the CAAA of 1990, Congress addressed "regional haze" visibility in the nation's national parks and wilderness areas. The EPA has determined that all 156 mandatory Class I areas across the nation demonstrate impaired visibility based on Interagency Monitoring of Protected Visual Environments (IMPROVE) monitoring data. Voyageurs National Park and the BWCAW in Minnesota, as well as Isle Royale National Park and Seney Wilderness in Michigan are "mandatory Class I areas". Voyageurs National Park and the BWCAW have IMPROVE monitors for determining components of haze, which may cause impairment of visibility.

The EPA published final regional haze regulations on July 1, 1999 (64 FR 35714). The rules are directed at four emission sources of visibility impairment: stationary sources (industry), mobile sources (vehicles), area sources (e.g. gas stations, dry cleaners, etc.), and prescribed fire. The pollutants most responsible for haze include nitrates, sulfates, soil material, organic carbon, and

elemental carbon. The last two are found in smoke from vegetative burning or are derived from components of smoke. Ozone also derives from fire emissions and can contribute to downwind particle formation i.e., haze. The goal of the regional haze program is to show continuous improvement in monitored visibility in the Class I areas so that natural background conditions are restored by 2064. The rules require that each state submit a State Implementation Plan (SIP) to the EPA to implement the emissions reductions necessary to improve visibility in the parks and wilderness areas. At this time smoke from prescribed fires has not been shown to cause or contribute to visibility impairment in any of the Class I areas in Minnesota or Isle Royale in Michigan.

2) A continued increase in the use of prescribed fire is anticipated in Minnesota.

There is a nationwide trend among federal and state land managers to increase the use of prescribed fire on the landscape to improve habitat for plant and animal communities, increase biodiversity and productivity, and to reduce fuel loads that are largely due to a long history of fire suppression in wildlands.

Data compiled for prescribed burning for 2006 for five agencies in Minnesota (USFWS, USFS, MNDNR, TNC, and NPS) show that prescribed fire was applied to a total of 94,722 acres. Since the inception of this plan in 2002 there has been a 24% increase in the acres treated with prescribed fire. This increase is due to the concerted efforts of signatory agencies to meet the goals established in their respective land and resource management plans. A smaller increase in acres treated by prescribed fire is anticipated over the next 5 years (2008-2012).

One factor for this increase is the windstorm that blew down approximately 477,000 acres of forest in northeast Minnesota on July 4, 1999. Most of this occurred in the BWCAW where fuels on approximately 367,000 acres within the wilderness increased from 5 to 20 tons per acre before the storm, to 50 to 100 tons per acre following the storm (USFS 2000). Since the inception of this plan there have been a number of prescribed burns as well as large wildfires in the blowdown that have somewhat reduced the likelihood of future large scale wildfires. However "blowdown" fuels continue to present a significant potential hazard for large-scale wildfires. The USFS will continue to propose to conduct prescribed burns in portions of the downed forest in order to reduce the scale of such a fire or fires. Burning in this wilderness area, either by wildfire or prescribed fire, has the potential to affect visibility in this mandatory Class I area. Minnesota's second Class I area, Voyageurs NP, is also in the extreme north of the state, not far from the BWCAW, and could be affected by both wildland and prescribed fires in the BWCAW. Isle Royale NP lies just to the east of areas affected by the windstorm.

The 156 national Class I areas are administered by three different federal land managers (i.e. NPS, USFS, and FWS). Because these agencies and other federal and state agencies use prescribed fire to improve and maintain the health of the ecosystems in the Class I areas, it is essential that they do so in a manner that minimizes the effects of these fires on visibility conditions. The process of improving visibility in the nation's most valued and scenic landscapes will be very lengthy and difficult. As industry, mobile sources, and area sources will be required to reduce visibility pollutants, so land management agencies will also be expected to mitigate the effects of burning by using effective smoke management methods. While the other source types mentioned above are entirely "man-made", it must be remembered that the vegetation types in the BWCAW and Voyageurs NP Class I areas are fire dependent, hence smoke from fires was present presettlement and is a component of natural background visibility in these areas.

3) Adoption of a Smoke Management Program may prevent PM NAAQS violations due to emissions from prescribed fire and wildland fires managed for resource benefits in Minnesota.

Prescribed fire is one activity addressed by the regional haze rules that may contribute to visibility impairment in the Class I areas. Implementation of an SMP by land management agencies should reduce the emissions from prescribed fires thereby avoiding "non-attainment" status with the NAAQS and with state air quality standards. Furthermore, as explained in the EPA interim guidance document, states that implement SMPs and have prescribed fires, which significantly contribute to a violation of the PM_{10} or $PM_{2.5}$ standards, will not have affected areas designated as "non-attainment". This incentive provided by the EPA for implementation of an SMP can be very important if an area of a state were to violate the air quality standards due to smoke from prescribed burning. The EPA is developing new guidance for wildland and prescribed fires that is due to be final July 31, 2008.

In addition, the EPA issued a final rule on March 22, 2007 (72 FR 13560) that addresses "exceptional events". Exceptional events include natural events and other unusual events caused by human activity whose air emissions can be excluded from compliance determination with ozone and PM standards. The rule provides that "wildfires" and "wildfire use" fires are deemed "natural events". Certain prescribed fires may also be considered exceptional events if they meet specific criteria, one of which is the use of a state-certified SMP for those fires (40 CFR Parts 50 and 51, Treatment of Data Influenced by Exceptional Events; Final Rule).

If an area of a state violates the NAAQS, then the state must prepare an SIP and submit it to the EPA for approval. The SIP sets forth measures that the state will undertake to reduce levels of air pollution and return non-attainment areas to compliance with the standards. Air monitors for $PM_{2.5}$ and PM_{10} collect air samples that are analyzed to measure compliance or non-compliance. Monitoring can also be used to correct computer air models. Air modeling is done to determine the sources of the pollutants and the effect of emission reductions on the concentrations of those pollutants. The SIP requirements can include restrictions on the construction of new sources of emissions, or emissions reductions on existing sources whose emissions contributed to the violations. Once the EPA approves the SIP, its conditions also become federally enforceable. At that time, facilities and other sources addressed in the SIP are accountable to both the State and EPA for a compliance schedule of emissions reductions.

As previously stated, with the continued need for prescribed burning in Minnesota, particularly in the northern forests inside and nearby the Class I areas (described above), it is prudent to set in place a SMP so that these emissions do not result in non-attainment status with the NAAQS and with State air quality standards. (These standards are further discussed below.)

1.4 PLANNING PROCESS & PARTICIPANTS

The planning process for this document began early in 1999 with formation of a subcommittee of the Minnesota Incident Command System's (MNICS) Prescribed Fire Working Team. After reviewing the EPA's "Interim Air Quality Policy on Wildland and Prescribed Fires"(April 23, 1998) and existing SMPs from other states, goals for Minnesota's plan were set and work began on the State's SMP. Meetings were held at approximate six week intervals, as schedules allowed. Following final approval of the SMP in 2002, the Prescribed Fire Working team conducted annual

discussions on the effectiveness of the SMP and determined the need for any changes. In mid summer 2007, the Prescribed Fire Working Team undertook a formal update of the SMP.

Participants throughout this process (development of the 2002 SMP and this update) included representatives from the MPCA, NWS, MNDNR, NPS, USFWS, USFS, MNDMA, Mn/DOT, TNC and the BIA. Signatory agencies to the 2002 SMP included MPCA, NWS, MNDNR, NPS, USFWS, TNC, and USFS.

CHAPTER 2. COMPLIANCE AND RESPONSIBILITIES

2.1 ENVIRONMENTAL REGULATIONS

2.1.1 Clean Air Act Amendments (CAAA) and Visibility

The CAAA requirements regarding visibility and regional haze date from 1977 when Congress addressed sources and air pollutants which "...may reasonably be anticipated to cause or contribute significantly to impairment of visibility." In 1980, the EPA issued rules addressing "reasonably attributable" sources of visibility impairment. That is to say, individual sources or groups of sources whose emission "plumes" could be observed to affect the air in Class I areas.

In 1990, Congress amended the CAAA again and added requirements addressing regional haze[1], including rulemaking by the EPA. In 1999, the EPA published final rules that included SIP submittals by all states and implementation of "reasonable progress goals" for all Class I areas. The regional haze SIP will include emission reductions necessary to meet a goal of showing continuous improvement in visibility in the Class I areas on the 20% "worst" days and no degradation of visibility on the 20% "best" days, as determined by IMPROVE monitoring data. The national goal is to achieve "natural background" visibility in all Class I areas by 2064. The emission reductions are to be achieved with all sources in the state, including prescribed burning. Although it is not required, the present SMP may be submitted to the EPA as part of the regional haze SIP. The first SIP is due in December 2007 with review every five years and revision every 10 years. Minnesota's SIP is scheduled to be submitted in May 2008.

2.1.2 Visibility Emissions from Fire

Both the scattering of light and the absorption of light by particles in the atmosphere reduce visibility. Light transmission is inversely related to the concentration of small particles in the air. Given this relationship, measured $PM_{2.5}$ levels can be used to calculate visibility impairment. IMPROVE monitors measure different types of $PM_{2.5}$ and PM_{10} allowing one to determine the effect of different pollutants on visibility.

Vegetative burning produces various chemical compounds. These compounds include nitrogen oxides (NO_x), organic compounds, carbon monoxide, and particulate matter. The pollutants that affect visibility derived from vegetative burning are PM_{10}, $PM_{2.5}$, nitrates, ozone, organic carbon, and elemental carbon. Ozone, which can form "smog" or haze, is not directly produced by fires, but from other combustion products, NO_x and volatile organic compounds or VOCs. These ozone precursors may react photochemically to produce ozone in air masses downwind of fires.

[1] The regional haze rules and related information can be found at this EPA website: http://www.epa.gov/ttn/oarpg/

Approximately 90% of smoke particles from wildland and prescribed fires are PM_{10} and about 70% are $PM_{2.5}$.

Both particulate matter and ozone are "criteria" pollutants, meaning that there are NAAQS established to limit concentrations of these substances in the air. Therefore, emissions of these pollutants from fire can contribute to violations of these air quality standards. There are no national or state air quality standards for organic carbon particles or for elemental carbon particles. However, these pollutants are measured by the IMPROVE monitors as a $PM_{2.5}$ compound, and will be used to assess long-term improvement in visibility. The modules of IMPROVE monitors measure sulfates, nitrates, organic carbon, and elemental carbon which are all $PM_{2.5}$ and PM_{10}. The IMPROVE monitors inside or adjacent to the Class I areas can be considered "compliance" monitors used to assess reduction in regional haze due to all visibility pollutants.

2.1.3 National Ambient Air Quality Standards (NAAQS)

For the NAAQS, the EPA establishes two types of standards: "primary" standards to protect public health and "secondary" standards to protect public welfare, such as visibility impairment and damage to ecosystems. For many of the NAAQS, the two standards are identical for both annual and daily concentrations. States must submit "designation requests" to the EPA, due one year after the effective date of a new standard, with monitoring data to support an attainment or non-attainment decision by the EPA, indicating that the State meets or does not meet the NAAQS. Compliance can be based on a county-by-county or a Metropolitan Statistical Area (MSA) assessment of air quality.

PM_{10} - The EPA issued a revised standard for PM_{10} that took effect on September 16, 1997. The NAAQS for PM_{10} had both an annual and a daily standard with equal primary and secondary values. However, when the new $PM_{2.5}$ standards were issued (below), the EPA revoked the annual PM_{10} standard of 50 micrograms per cubic meter ($\mu g/m^3$), calculated as an arithmetic mean of three years of values. The daily standard is 150 $\mu g/m^3$ calculated as a three-year average with no more than one exceedance per year of measured samples.

There are presently nine PM_{10} monitors operating in Minnesota. Most of these are in the Minneapolis/St. Paul metro area. Only two of these are located in the northern half of the state, in Virginia and Duluth (see Appendix). Presently, the daily standard has not been exceeded at any of the monitoring locations.

$PM_{2.5}$ - The EPA issued a new standard for $PM_{2.5}$ effective December 18, 2006. The NAAQS for $PM_{2.5}$ has both an annual and a daily standard with the primary and secondary standards at equal levels. The annual standard of 15 $\mu g/m^3$, calculated as the arithmetic mean of three years of values, was not revised. The daily standard was changed from 65 $\mu g/m^3$ to 35 $\mu g/m^3$, calculated as a three-year average of the 98th percentile of measured samples. As of October 2007, data have shown no violations of either the daily (old and new) or the annual standards for total $PM_{2.5}$. The highest measurements are at monitors in the metro area of the Twin Cities. Every state must submit a formal "designation request" to the EPA by December 18, 2007 based on air sampling for 2004 through 2006.

There are presently 29 $PM_{2.5}$ monitors around the state (including the two IMPROVE monitors in the Class I areas) that measure total mass. Fifteen of these are Federal Reference Method (FRM) PM monitors that sample one-in-three days. Four FRMs are located in the northern half

of Minnesota and two in the southern half with the remainder in the metro area (see Appendix). In addition to FRM monitors that determine compliance with the NAAQS, there are 14 Beta Attenuation Monitors (BAMs) that sample the air continuously providing one-hour average values. Five are located in the metro area with the other nine located throughout the state (see Appendix).

Minnesota also has two $PM_{2.5}$ speciated samplers located in Rochester and the Phillips neighborhood of Minneapolis. Speciated samplers measure the mass of individual components of $PM_{2.5}$. The four IMPROVE monitors located in Voyageurs NP, the BWCAW, Great River Bluffs State Park (Houston Co.), and Blue Mounds State Park (Rock Co.) are also speciated samplers.

Ozone - The current eight-hour standard for ozone replaced the previous one-hour standard and took effect on September 16, 1997. The NAAQS for ozone is 0.080 parts per million (ppm), calculated as an average of three years of the fourth highest value of the average of eight one-hour samples. However, the EPA proposed a new ozone standard on June 20, 2006. The primary concentration may be reduced to 0.070 to 0.075 ppm and a secondary standard may be between 7 and 21 ppm-hrs according to a "W126" cumulative exposure index based on 12 hr daily exposures for three months. At the same time the EPA also proposed to again make the secondary standard equal to the primary. A final rule is due on March 12, 2008 with designation letters from the states submitted one year later. There are presently 16 ozone monitors in the state four of which surround the metro (see Appendix). Presently, no monitor locations in the state exceed the existing ozone standard and Minnesota is in statewide attainment.

2.2 AGENCY AUTHORITY

2.2.1 MPCA Authority to Implement and Enforce Federal Regulations Regarding Air Quality Standards

The MPCA has authority to implement and enforce federal regulations regarding air quality standards. If an air monitor in a state exceeds the NAAQS for a criteria pollutant, then the area that violates the standard is designated as a "non-attainment" area, meaning it does not "attain" or meet the standard. Under section 110 of the CAA, the State must then submit a SIP to the EPA that details what measures the State will take to reduce emissions affecting the area, in order to meet, and maintain compliance with, the standard. Section 110 requires that each plan include "enforceable emission limitations and other control measures" for facilities and sources that contribute to the violation of the standard. The plan must also regulate the construction and modification of stationary sources within the areas covered by the plan and contain adequate provisions prohibiting any source "or other type of emissions activity within the State from emitting any air pollutant in amounts which will contribute significantly to non-attainment in any other state".

It is chiefly by implementing the requirements of a SIP that has been approved by the EPA, that the MPCA enforces compliance with air quality standards in the State. There are four regulatory instruments that might be included in a SIP to return an area to compliance with an air quality standard.

1. Statutory requirements might be imposed by the State legislature on particular sources that would be enforced by the MPCA with or without rulemaking by the Agency.
2. MPCA rulemaking might be undertaken to impose emissions reductions on particular pollution sources.
3. Administrative orders might be issued to individual facilities with requirements for compliance with lower emission limits.
4. The air emission permit issued to a particular facility, which limits the amount of pollution that can be emitted to the ambient air, might be amended to reduce air emissions affecting regional haze.

Historically, options 3 and 4 have been used when non-attainment areas are small and relatively few sources contribute to the problem. Violations of statutes, rules, orders or permit conditions are subject to enforcement action by the State. As stated earlier, the EPA can also enforce any conditions included in a SIP approved by the EPA. These same measures might be incorporated into a separate regional haze SIP[2] to implement a statewide program of continuous improvement in visibility.

[2] Existing air quality regulatory programs and the regional haze program are related by the implementation plans developed by the states (i.e., SIPs). As described above, areas within a state are subject to designation by the EPA as "attainment" or "non-attainment" with the NAAQS. A SIP must be submitted to, and approved by, the EPA for any areas that do not meet ("attain") any one of the NAAQS. Such a SIP is a separate document from the regional haze SIP.

The regional haze SIP will be prepared by the MPCA to directly address reductions in visibility pollutants in the State. All Class I areas and all states can be considered to be "non-attainment" with regard to impaired visibility and regional haze. A regional haze SIP developed by a state will be a plan that describes all measures the state will implement to reduce regional haze. For this reason, although a NAAQS SIP and the regional haze SIP are two different plans, the haze SIP would also include a SIP that had been submitted for violations of a NAAQS for a visibility pollutant.

Minnesota's SIP for regional haze will be reviewed every five years against the "reasonable progress" goals for visibility improvement in the Class I areas and will be revised every 10 years. The goal of the regional haze rules is to attain natural background visibility in national parks and wilderness area by 2064.

2.2.2 MNDNR Responsibilities and Role as SMP Central Authority

The Commissioner of the MNDNR serves as the Central Authority for the State's SMP and is granted authority in Minnesota Statutes 88.01 to 88.22 to control open burning on non-federal lands in Minnesota. The Commissioner delegates this authority to forest officers in the Division of Forestry and designated fire wardens.

Open burning is controlled through a permitting system. During a period of severe wildfire danger the Commissioner has the authority to cancel all open burning permits on non-federal lands within the state. Notification of this is handled by the three DNR Forestry Regional offices through the Area offices and then to the individuals authorized to issue permits. In similar manner, burning permit direction is determined by the Regional offices and communicated to the individual permit issuers through the Area offices. This normally occurs through mailing of a card with specific instructions as to the type of burning allowed. However, during an emergency more timely methods would be employed. Specifics on permitting can be found in Section 4.1 below.

While not bound by State burning laws, Federal agencies in Minnesota have historically complied with State burning regulations. Procedures for coordinating the establishment of Open Burning Restrictions between the State and Federal agencies is set in Chapter 40 of the MNICS Mobilization Plan. This SMP represents a formal agreement among signatory agencies for State burning regulation compliance for the purposes of smoke management and reduction.

CHAPTER 3. FIRE MANAGEMENT IN MINNESOTA

3.1 AGENCY OVERVIEW

The primary agencies that use prescribed burning as a management tool in Minnesota are the MNDNR, NPS, USFWS, USFS, MNDMA, Mn/DOT, TNC, and the Tribal governments of the eleven reservations in Minnesota. All these organizations are predicting increases in the use of

prescribed fire as a management tool. Two-thirds of the projected acreage to be burned is grass dominated with the remaining third consisting of hardwood or conifer forests.

The reasons for burning are similar among all agencies. Most prescribed fires in Minnesota are burned with objectives relating to ecosystem management such as restoration and maintenance of native plant communities, wildlife habitat improvement, control of undesirable vegetation, forest silvicultural treatments, range/pasture improvement and maintenance, insect and disease control, and improving biological diversity. In addition, reducing the threat or severity of wildland fires is an important objective, primarily in forested ecosystems.

3.2 CLIMATE FACTORS

3.2.1 Overview and Definition of Smoke Dispersion

One of the aspects of a SMP is smoke dispersion. Smoke dispersion is a function of ventilation. Ventilation refers to the process within the atmosphere that mixes and transports smoke away from its source. Ventilation is a function of stability, mixing height, and transport winds. Mixing height is defined as the upper limit of a mixed layer in unstable air, in which upward and downward exchange of air occurs. The transport wind is the arithmetic average (speed and direction) of wind in the mixing layer.

When multiplying the mixing height by the transport wind, a ventilation index is produced. The ventilation index indicates the lower atmosphere's ability to diffuse and disperse smoke. A high ventilation index means smoke should disperse in an efficient manner. A low ventilation index means the dispersion of smoke in the lower atmosphere will be hindered. One word of caution should be noted when using the ventilation index objectively. A high ventilation index can be produced with both a high transport wind and low mixing height or a low transport wind and high mixing height. In either of these situations, smoke dispersion could still be inhibited.

Mixing height, transport winds, and dispersion are included in the twice-daily Fire Weather Planning Forecasts issued by the National Weather Service. These forecasts are available from fire dispatchers via their communication system. Internet links can be found in the appropriate fire plans and fire weather operating plans. See also Section 4.2 for Internet links from specific NWS offices.

3.2.2 Climatology of Smoke Dispersion in Minnesota

Generally speaking, Minnesota receives good atmospheric ventilation throughout the year. During the months when most fires occur, the sun is usually strong enough to either mix out or lift inversions near the surface. Also, transitory weather systems typically pass through the state with sufficient frequency to limit the trapping of smoke. Topography is not a major player in the dispersion of smoke in Minnesota. In mountainous parts of the country, topography plays a significant role in the channeling and trapping of smoke.

An inversion occurs when temperature in the atmosphere increases with height. When rising air or smoke encounters an inversion, the result is a cap that prevents air or smoke from rising any higher in the atmosphere. An inversion that is found aloft is called an elevated inversion.

Overall, winter receives the highest percentage of inversions (surface-based and elevated inversions combined). Due to higher sun angles in summer and short summer nights, surface

based inversions tend to be much weaker and shorter lived than in the other seasons. Typically, inversions burn off by mid to late morning during the summer, but may linger well into the afternoon or not burn off at all in the early spring and fall.

During the late spring and summer, solar heating is usually strong enough to either dissipate or lift most elevated inversions to above 5,000 feet. However, even then, elevated inversions can degrade smoke ventilation in certain situations. In cases of strong high pressure coupled with cloud cover, solar heating may only be able to lift an elevated inversion to around 2,000 feet. Another situation that may pose a problem is when persistent high pressure builds northwestward out of the southeastern states into Minnesota. This creates stagnant air conditions with low transport wind speeds that retard mixing and dispersion of smoke emissions. This condition occurs more commonly in southern portions of Minnesota.

What does this all mean for Minnesota fire weather? In the early spring or fall, fire managers may have to wait longer for inversions to burn off. Also, during this time there will be greater likelihood of days in which an inversion will not break or lift to recommended heights. Stronger solar heating later in the spring and summer allows for a more rapid and effective dissipation of inversions.

3.2.3 Common Weather Patterns that Affect Smoke Dispersion

Stable, high pressure is the dominant weather feature that limits the dispersion of smoke in Minnesota. One such pattern occurs when strong, high pressure from Northern Canada builds southward into Minnesota. When combined with substantial cloud cover, surface heating becomes limited, which can keep mixing heights below 2000 feet. Usually this is only a problem in early spring and late fall, when the sun's angle is still rather low.

Another pattern, which was mentioned above, occurs in mid and late summer, when high pressure builds northwest out of the southeastern states into southern Minnesota. This stagnant high pressure may prevail over the area for several days. While daytime heating can lift surface inversions to well above 2,000 feet, very light flow aloft prevents smoke from dispersing efficiently. As a result, visibilities and air quality may be reduced from a build-up of haze and smoke.

3.2.4 Local Weather Patterns

Lake Superior Influence - Though often not associated directly with smoke dispersion concerns, smaller scale patterns, like the effects from Lake Superior, can also have a major impact on fire weather in general over northeast Minnesota. Cool onshore breezes from Lake Superior can result in as much as a 30 to 40 degree temperature difference between protected inland areas and the waterfront. These cooler temperatures, along with gusty onshore winds and higher relative humidity, can dramatically change fire weather conditions near Lake Superior.

Lake breezes are most common with light flow aloft during the spring and summer months, typically occurring during the afternoon, when the daytime temperature difference between the land and lake is greatest. While not a common occurrence, lake breezes can trigger thunderstorms, especially when the air-mass is unstable.

Lake breezes develop due to the differential heating between the land and water. The land heats up more quickly than water. This creates a higher pressure over the water than land. Since air likes

to travel from high pressure to low pressure, cold air over Lake Superior pushes inland creating a lake breeze. On average, these breezes penetrate five to ten miles inland, but have been known to reach as far inland as Grand Rapids, Hinckley and to near the west end of the Gunflint Trail.

3.3 FUEL LOADING OF MINNESOTA'S FUEL MODELS

Fuel models are composed of fuel size classes. They are named by the length of time it takes for them to reach 63% of the equilibrium moisture content. The sizes of the dead fuel classes are: 1 hour - 0 to 1/4 inch; 10 hour - 1/4 to 1 inch; 100 hour - 1 to 3 inches; 1,000 hour – 3 to 8 inches. Some fuel models also have a live fuel component that adds to the flaming front as it dries from preheating.

To calculate fuel loading during the prescribed fire planning process, agencies should first use site-specific data if it is available. Lacking this type of data, other local sources of information should be used, such as the National Wildfire Coordinating Group's "Stereo Photo Series for Quantifying Natural Fuels, Volume 5". The table below contains fuel-loading information from the Anderson fuel model series, which can serve as a third source of fuel loading information.

*Fuel Loading - Tons per Acre

Fuel Type	1 hr	10 hr	100 hr	Live	**Total**	1000 hr**	**Total including 1000 hr**
1 - Short grass (1 foot)	.74	0	0	0	**.74**	0	**.74**
2 - Timber, grass understory	2.0	1.0	.5	.5	**4.0**	0	**4.0**
3 - Tall grass (2.5 feet)	3.0	0	0	0	**3.0**	0	**3.0**
4 - Immature jack pine	5.0	4.0	2.0	5.0	**16.0**	0	**16.0**
8 - Closed timber litter	1.5	1.0	2.5	0	**5.0**	4.13	**9.13**
9 - Hardwood litter or long needle pine litter	2.92	.41	.15	0	**3.48**	5.45	**8.93**
10 - Timber (litter & understory)	3.0	2.0	5.0	2.0	**12.0**	17.0	**29**
11 - Light slash	1.5	4.5	5.5	0	**11.5**	2.98	**14.48**
12 - Medium slash	4.0	14.0	16.5	0	**34.5**	15.0	**49.5**
13 - Heavy slash	7.0	23.0	28.0	0	**58.0**	33.6	**91.6**

*Fuel models 5, 6 and 7 are not used in Minnesota. This chart is a general reference guide. For more information on fuel loading, refer to "Aids to Determining Fuel Models for Estimating Fire Behavior" by Hal E. Anderson, General Technical Report INT-122, available from the National Interagency Fire Center in Boise, Idaho.

**1,000 hour fuels are not normally included in the National Fire Behavior Prediction System (FBPS) stylized fuel models since they do not contribute significantly to the flaming front of a fire. As they dry out, however, they do continue to burn after the flaming front has passed and therefore are important in smoke emission production. The loading information for 1000 hr. used here was derived from averages of fuel loadings found in Photo series from Minnesota, Michigan and Ontario and plot data from blowdown in the BWCAW (Ottmar and Vihnanek 1999, Stocks et al. 1990, Blank 1982, Ottmar et al. 2000).

CHAPTER 4. GUIDELINES OF THE SMOKE MANAGEMENT PROGRAM

4.1 AUTHORIZATION TO BURN

A written permit signed by a Forest Officer, Township Fire Warden or other authorized person is required for open burning of untreated vegetative materials. These permits may be obtained at MNDNR Forestry offices, Township Fire Wardens or, in some cases, at local fire departments, county dispatch centers, or local government offices.

A written permit is not required for burning untreated vegetative materials when the ground is covered by three or more inches of snow. It is also not required for a campfire, burning in a device designed for cooking, or when using an approved burning barrel between the hours of 6:00 P.M. and 8:00 A.M.

In 2006, the Minnesota Department of Natural Resources implemented a pilot program for a limited number of counties, offering citizens the option to purchase annual open burning permits on-line via the MNDNR web site. Permits obtained through this system are valid for the calendar year in which they are purchased but must be activated each day burning occurs. Permits available on-line are currently only offered for burning small piles of vegetative materials or for burning areas less than one acre in size. Permits for larger areas must still be obtained from a local DNR Forestry office or Township Fire Warden. In most cases, individuals burning with a permit must place a phone call to determine whether or not they can burn on any given day.

4.2 BURN PLANS

4.2.1 Burn Plan Elements

All the organizations burning in Minnesota require prescribed burn plans for each burn. However, if the units are small and the burn objectives and prescription are the same, one plan may cover several burn units. These plans are written following protocols specific to each agency. They will be on file at agency offices and are available upon request. At a minimum, for the purposes of this Smoke Management Plan, these prescribed burn plans must 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 or amount of fuel present on the site (tons/acre),
- Fire prescription including smoke management components (see section 4.2.1) and dispersion index,
- Criteria the fire manager will use for making burn/no burn decisions,

- Safety and contingency plans.

Record keeping is recommended in this SMP to ensure that the minimum information is available to demonstrate an Exceptional Event (see Section 4.5). Records should include: burn plans along with 1) actual acres burned, 2) associated fuel types (models), and 3) any smoke monitoring done, such as visual observations or particulate measurements. These records should be kept on file for a minimum of four years from the date of the fire. It is preferable that 1) and 2) above are determined on a daily basis.

4.2.2 Smoke Management Components of Burn Plans

Actions to Minimize Fire Emissions – The burn plan should document the steps to be taken prior to, during, and after the burn to reduce air emissions. This includes measures taken to reduce residual smoke, such as rapid and complete mop-up, mop-up of certain fuels, etc. Where applicable, utilize one of the following approaches to minimize emissions (Peterson and Leenhouts 1997, EPA 1992).

- Minimize the area burned such as reducing acreage burned per day or by using non-fire treatments.
- Reduce the fuel loading in the area to be burned by mechanical means or by using frequent, low intensity burns to gradually reduce fuels.
- Reduce the amount of fuel consumed by the fire by burning when large fuel moisture and duff moistures are high.
- Minimize emissions per ton of fuel consumed by using mass ignition techniques, using backing fires, and performing rapid mop-up.

Evaluate Smoke Dispersion - Burn plans should evaluate potential smoke impacts at sensitive receptors and time fires to minimize exposure of sensitive populations (i.e. those to whom smoke may present particular health risks) and avoid visibility impacts in mandatory Class I Federal areas. Sensitive receptor sites are usually defined as locations where human population tend to concentrate and where smoke could impact the health of those population or significantly impact visibility that may be detrimental to either health or the enjoyment of scenic qualities of the landscape. These may be residential concentrations in the form of towns or cities, or locations where people tend to gather in groups such as parks. Travel routes such as highways may be labeled as sensitive receptor sites where smoke can be a factor in potential motor vehicle accidents. Particular areas along highways or other locations may be more prone to being declared sensitive receptor sites because of topographic and microclimate features. The plan should identify the distance and direction from the burn site to local sensitive receptor areas where appropriate. Fire prescriptions must specify minimum requirements for the atmospheric capacity for smoke dispersal such as minimum surface and upper level wind speeds, desired wind direction, minimum mixing height, and dispersion index. Utilization of the Dispersion Index is described below.

Public Notification and Exposure Reduction Procedures - The plan should identify actions that will be taken to notify populations and authorities at sensitive receptors, including those in adjacent jurisdictions, prior to the fire. The plan should also identify contingency actions that will be taken during a fire to reduce the exposure of people at sensitive receptors if smoke intrusions occur.

Air Quality Monitoring - The plan should identify how the effects of the fire on air quality at sensitive receptors, and visibility in mandatory Class I Federal areas will be monitored. The extent of the monitoring plan should match the size of the fire. For small, or short duration fires such as those in grass or leaf litter, visual monitoring of the directions of the smoke plume and monitoring nuisance complaints by the public may be sufficient. Other monitoring techniques include posting personnel on vulnerable roadways to look for visibility impairment and initiate safety measures for motorists, posting personnel at other sensitive receptors to look for smoke intrusions, using aircraft to track the progress of smoke plumes and continued tracking of meteorological conditions during the fire. For fires in fuels where the burning duration is expected to last more than one day, such as in timber litter or slash, locating real-time PM monitors at sensitive receptors may be warranted to facilitate timely response to smoke impacts. For information on the Minnesota Air Quality Index see Appendix.

4.2.3 Smoke Management and Dispersion

The National Weather Service forecast offices serving Minnesota provide twice-daily fire weather forecasts every day during the entire fire season for Northern and Central Minnesota. For the rest of the state, fire weather forecasts are provided twice-daily during the spring season or longer, if requested by land managers. Fire weather forecast offices are located at Grand Forks ND, Chanhassen MN, Duluth MN, Aberdeen SD, Sioux Falls SD, and La Crosse WI. The fire weather forecast includes smoke management information and is available by 0700 hours and again by 1500 hours.

The NWS also provides Smoke Management information via Spot Weather Forecasts. They are issued, as requested by land management agencies, for specific times and locations. See the Appendix, "National Weather Service Fire Weather Web Sites" for addresses and phone numbers. National Weather Service contact information can also be found in the NWS, Minnesota Fire Weather Operations Plan. This document is available at fire weather website maintained by NWS offices. It can also be accessed from the MNICS web site (http://www.mnics.org).

To ensure optimum dispersal of smoke emissions during prescribed burns, the mixing layer must be deep enough and with sufficient transport wind speed to allow for the dilution and dispersal of emission concentrations. The Dispersion Index describes the ability of the atmosphere to disperse emissions and is the product of the mixing height (ft) and transport wind speed (kts). The dispersion information is included as part of the daily fire weather forecast. The morning forecast provides the mixing height, transport wind speed and Dispersion Index for the current afternoon and the following afternoon. The afternoon forecast provides these parameters for the following afternoon. Prescribed burn managers who intend to ignite burns in the morning should consult their local Weather Service office to determine the anticipated dispersion at the time of ignition.

Table 4.2.a Dispersion Index Categories

DISPERSION INDEX	DISPERSION CATEGORY
<13,000	Poor
13,000 – 29,999	Fair
30,000 – 59,999	Good
60,000 or greater	Excellent

NOTE: In using the Dispersion Index, exercise caution with high transport wind and low mixing height or low transport wind and high mixing height which, although they combine to give an acceptable category, can cause smoke dispersion problems as well as potential control problems.

Guidance for Using the Dispersion Index - In utilizing the dispersion index it is important to take into consideration the total fuel load being burned; both in terms of fuel loading (tons of fuel per acre) and total area to be burned (see Section 3.3). In addition, the proximity of downwind smoke sensitive areas to the burn unit should also be considered. In general, the lower the expected total fuel consumption and the greater the distance from smoke sensitive areas, the lower the dispersion index can safely be and vice versa. In addition, steps taken which reduce the total fuel available for consumption can lower the acceptable dispersion category.

Below are two methods of utilizing the Dispersion Index for mitigating smoke impacts during burn plan formulation. The first method uses the Dispersion Index as a guide to screen for downwind smoke sensitive receptors. This method is recommended for burns with low to moderate potential for smoke impacts. The second method is more rigorous and is recommended for complex prescribed burns with a high degree of potential for smoke impacts.

Method A: Recommended for prescribed burns where there is a low to moderate degree of potential for smoke impacts.

Use table 4.2.b below to determine the recommended minimum distance to downwind smoke sensitive areas for the planned burn(s).

1. On a map, locate any downwind sensitive receptors that could be impacted from your smoke. If none exist within 1 mile downwind of your burn and the dispersion index is fair or better, there is no need to use the table.
2. Using table 4.2.b select the general fuel category of the burn area (e.g. grass, leaf litter, timber, slash, piled fuels). For burns with multiple fuel categories, utilize the fuel model which best characterizes the majority of the area.
3. In the second column select the acreage to be burned for the single day. Note this is on a daily basis.
4. Finally select the proper Dispersion Index Category and follow that row to the right to determine the recommended minimum distance the burn should be upwind of a sensitive receptor.

Note that these are voluntary guidelines which may vary by the local unit's definition of smoke sensitive receptor and the ability to mitigate potential smoke problems such as by instituting traffic controls when smoke could impact major roads or by burning under fuel moisture conditions which limit consumption of heavier fuels.

Table 4.2.b – Minimum Distances to Smoke Sensitive Areas

General Fuel Category	Daily Fire size (acres)*	Dispersion Index Category	Minimum dist. to downwind smoke sensitive areas (miles)
Primarily grass fuels (see Grass or Leaf litter below for larger acreage)	< 50	POOR	0.25
	< 50	FAIR or BETTER	No limitation
Single large pile or	NA	POOR	0.25
Scattered small piled fuels	NA	FAIR or BETTER	No limitation
Grass or Leaf litter	< 50	POOR	No burning
	< 50	FAIR or BETTER	No limitation
	50 - 150	POOR	No burning
	50 - 150	FAIR or BETTER	No limitation
	150 - 500	POOR	No burning
	150 - 500	FAIR	0.25
	150 - 500	GOOD or BETTER	No limitation
	500+	POOR	No burning
	500+	FAIR	0.75
	500+	GOOD	0.50
	500+	EXCELLENT	0.25
Timber, slash, or piled fuels	< 50	POOR	No burning (See above exception for pile(s))
	< 50	FAIR	0.50
	< 50	GOOD or BETTER	No limitation
	50 -150	POOR	No burning
	50 - 150	FAIR	0.50
	50 - 150	GOOD or BETTER	No limitation
	150 - 500	POOR	No burning
	150 - 500	FAIR	0.75
	150 - 500	GOOD	0.50
	150 - 500	EXCELLENT	0.25
	500+	POOR	No burning
	500+	FAIR	1.0
	500+	GOOD	0.75
	500+	EXCELLENT	0.50

Note: On Poor Category days no burning is suggested within ¼ mile of any downwind smoke sensitive area and is not recommended in general.

*Assumes no more than one unit within a 5-mile radius.

As an example of Method A; for a 1,000 acre burn in grass fuels, a minimum distance that a burn should occur upwind of a sensitive receptor would be: greater than 0.25 miles with Excellent Dispersion, greater than 0.5 mile with Good Dispersion, greater than 0.75 miles with Fair Dispersion and there should be no burn under Poor Dispersion.

Method B: Recommended for Complex Prescribed Burns where there is a high potential for smoke impacts.

1. Estimate the fuel loading for the area to be burned. This may be done formally, utilizing site-specific survey data if available or by consulting the fuel model information found in section 3.3.
2. Determine the acreage to be burned in one day.

3. Estimate the expected fuel consumption using models such as FOFEM or CONSUME. Selection of higher fuel moistures (such as higher 100 and 1,000 hour fuel moisture), which will reduce the fuel available for consumption, should be factored into the calculations.
4. Determine the total PM_{10} and $PM_{2.5}$ emissions per day based on outputs from #3.
5. Locate downwind sensitive receptors that could be impacted from your smoke.
6. Utilize a dispersion-modeling program to screen for the potential to exceed the ambient air quality standards.

4.3 PUBLIC EDUCATION AND AWARENESS

The MNICS organization, through its Prescribed Fire and Information Working Teams, will establish and maintain a program to explain the use and importance of fire for ecosystem management, the implications to public health and safety, and the goals of the Minnesota Smoke Management Program. This program will utilize posters, videos, pamphlets as well as news releases and public presentations to highlight actual prescribed burns as well as post fire results and air quality impacts or mitigation.

To date this has included the development and distribution of a poster on Prescribed Fire in Minnesota, a video at the Minnesota DNR booth at the State Fair, and information regarding the blowdown in the BWCAW. Review of the material pertinent to this program will be part of the Prescribed Fire and Information Working Teams' annual program of work.

4.4 SURVEILLANCE AND ENFORCEMENT

Prescribed burning is conducted under the direct supervision of an agency certified burn boss. This burn boss ensures that the prescribed burning is conducted in accordance with the burn plan. If the actions of any agency burn boss or the burn plan/prescription violates any provision of the guidelines of this SMP, or threatens the public health and safety, he/she will be subject to agency specific review protocols.

4.5 PROGRAM EVALUATION

To evaluate the effectiveness of the SMP, the MNICS Prescribed Fire Working Team will annually collect and review information on acres burned by fuel type with prescribed fire and/or wildland fire use. Reports of nuisance complaints or smoke intrusions will be noted and the MNICS Prescribed Fire Working Team will use this information to measure the effectiveness of this plan. The team recommends that member agencies maintain records necessary to demonstrate an Exceptional Event, per Environmental Protection Agency 40 CFR Parts 50 and 51, Treatment of Data Influenced by Exceptional Events; Final Rule, for the necessary time that the MPCA is required to report data to the EPA. In 2007, the duration was 4 years.

In addition, the MPCA will review data from the existing $PM_{2.5}$, ozone, and IMPROVE monitors in Minnesota (See Appendix). Correlations of air quality (visibility and NAAQS) with wildland fire and prescribed fire will be assessed for the Prescribed Fire Working Team. In the event an

exceedance (PM_{10}, $PM_{2.5}$, or ozone) is recorded, MPCA will notify the principal contacts listed in the Memorandum of Agreement via the Prescribed Fire Working Team Chair to ensure the documentation necessary to demonstrate an Exceptional Event is collated and available.

The Working Team will also review annually:

- The acres of prescribed burns by fuel type and any associated air quality issues,
- The need to expand the scope of the program to include authorization of other open burning,
- The need for changes in the SMP.

This SMP is an evolving document and will undergo ongoing evaluation using the MNICS Prescribed Fire Working Team and other agency representatives. Issues shall be discussed at the quarterly meeting of the MNICS Prescribed Fire Working Team.

Upon implementation of this plan, information on acres burned and complaints registered and any other pertinent information will be provided to the MNICS Task Force and the state Air Quality Director on an annual basis.

4.6 OPTIONAL AIR QUALITY PROTECTION

Agencies may establish specific, more stringent protections for special protection areas such as Class I areas, areas of wildland urban interface, or any area requiring special protection. These protections at a minimum will be documented in specific burn plans and applicable environmental documents and may be added to this plan as addenda when formalized. These plans may serve as templates for other agency use.

GLOSSARY

Administrative Unit—A unit of land (forest, refuge, park, etc.) under the administration of a public land management agency.

Air Quality Manager—The regulatory body responsible for managing the air quality protection program for a State, local or tribal government.

Air Quality—The characteristics of the ambient air (all locations accessible to the general public) as indicated by concentrations of the six air pollutants for which national standards have been established and by measurement of visibility in mandatory Federal Class I areas. For the purposes of this policy, concentrations of PM are taken as the primary indicators of ambient air quality.

Air Quality Related Values (AQRV)—Those special attributes of a mandatory Class I Federal area that deterioration of air quality may adversely affect. Some examples of AQRV include: flora and fauna, water, visibility, and odor.

Ambient Air—That portion of the atmosphere, external to buildings, to which the general public has access.

Attainment area—A geographic area in which levels of a criteria air pollutant meet the health-based primary standard (national ambient air quality standard, or NAAQS) for the pollutant. An area may have an acceptable level for one criteria air pollutant, but may have unacceptable levels for others. Thus, an area could be both attainment and non-attainment at the same time. Attainment areas are defined using pollutant limits set by the EPA.

Class I Area—An area set aside under the Clean Air Act (CAA) to receive the most stringent protection from air quality degradation. Mandatory Class I Federal areas are (1) international parks, (2) national wilderness areas that exceed 5,000 acres in size, (3) national memorial parks that exceed 5,000 acres in size, and (4) national parks that exceed 6,000 acres and were in existence prior to the 1977 CAA Amendments. The extent of a mandatory Class I Federal area includes subsequent changes in boundaries, such as park expansions.

Combustion—Burning. Many important pollutants, such as sulfur dioxide, nitrogen oxides, and particulates (PM_{10}) are combustion products, often products of the burning of fuels such as coal, oil, gas, and wood

Complexity—A system for rating the potential difficulty of a prescribed burn by analyzing the cumulative elements that may be involved in the burn such as safety, threats to boundaries, fuel types, values to be protected, organization needed, air quality values to be protected, etc. Complexity is usually rated as Low, Moderate, or High. Qualifications of prescribed burn practitioners are usually specific to the different complexity levels.

Criteria air pollutants—A group of common air pollutants regulated by the EPA on the basis of criteria (information on health and/or environmental effects of pollution) and for which NAAQS have been established. In general, criteria air pollutants are widely distributed over the country.

They are: particulate matter (PM), carbon monoxide (CO), sulfur dioxide (SO_2), ozone (O_3), nitrogen oxides (NO_x), and lead (Pb).

Emission—Release of pollutants into the air from a mobile source (e.g. vehicle), stationary source (e.g. industry), or area sources (e.g. gas stations, chimneys, vegetative burning).

Equilibrium Moisture Content—The value that the actual moisture content approaches if the fuel is exposed to constant atmospheric conditions of temperature and relative humidity for an infinite length of time. EMC determines the amount of water vapor that a specific piece of wood can hold.

Exceptional Event—Exceptional events are events for which the normal planning and regulatory process established by the Clean Air Act (CAA) is not appropriate.

Federal Land Manager (FLM)—With respect to any lands in the United States, the Secretary of the Federal department with authority over such lands. Generally, the Secretaries delegate their authority to specific elements within each department. For example, the National Park Service and the Fish and Wildlife Service manage those areas under the authority of the Department of the Interior.

Fire Management Plan (FMP)—A strategic plan that defines a program to manage wildland and prescribed fires, and documents the FMP to meet management objectives outlined in the approved land use plan. The plan is supplemented by operational procedures such as preparedness plans, burn plans, and prevention plans.

Fire Dependent Ecosystem—A community of plants and animals that must experience recurring disturbances by fire to sustain its natural plant succession, structure, and composition of vegetation; and maintain appropriate fuel loading and nutrient cycling, thereby ensuring proper ecosystem function.

Fuel—Includes combustible vegetative matter such as grass, trees, shrubs, limbs, branches, duff, and stumps.

Haze—An atmospheric aerosol of sufficient concentration to be visible. The particles are too small to see individually, but reduce visual range by scattering and absorbing light.

IMPROVE—Interagency Monitoring of Protected Visual Environments is a program that uses air monitors in Class I areas or outside Class I areas (IMPROVE protocol) to measure visibility pollutants including sulfates, nitrates, organic and elemental carbon, and PM_{10}.

Inversion—A layer in the atmosphere where the temperature increases with altitude.

Land Use Plan—A broad scale, long-range plan (e.g., forest plan, refuge plan, or resource management plan) that identifies the scope of actions and goals for the land and resources administered by a land owner/manager.

Mobile sources—moving objects that release pollution; mobile sources include cars, trucks, buses, planes, trains, motorcycles and gasoline-powered lawn mowers. Mobile sources are divided into

two groups: road vehicles, which include cars, trucks and buses, and non-road vehicles that include trains, planes and lawn mowers.

Monitoring (monitor)—Measurement of air pollution is referred to as monitoring. The EPA, state and local agencies measure the types and amounts of pollutants in the ambient air.

National Environmental Policy Act (NEPA)—Establishes procedures that Federal agencies must follow in making decisions on Federal actions that may impact the environment. Procedures include evaluation of environmental effects of proposed actions, and alternatives to proposed actions, involvement of the public and cooperating agencies.

National Ambient Air Quality Standards (NAAQS)—Standards for maximum acceptable concentrations of "criteria" pollutants in the ambient air. Standards are established to protect public health with an adequate margin of safety (primary standard), and to protect public welfare (secondary standard) from any known or anticipated adverse effects of such pollutants (e.g., visibility impairment, soiling, materials damage, etc.).

Nonattainment area—A geographic area in which the level of a criteria air pollutant is higher than the level allowed by the federal standards. It has been estimated that 60% of Americans live in nonattainment areas.

Nuisance Smoke—Amounts of smoke in the ambient air that interfere with a right or privilege common to the public, including the use or enjoyment of public or private resources.

Ozone—A gas consisting of three oxygen atoms. Ground-level ozone is a product of reactions among chemicals produced by burning coal, gasoline and other fuels, and chemicals found in products including solvents, paints, hair sprays, etc. Ozone is the main component of smog.

Particulate Matter (PM)—A mixture of very small particles that are suspended in the atmosphere, except uncombined water, which exists as a solid or liquid at standard conditions (e.g., dust, smoke, mist, fumes, or smog).

PM_{10}—Particles with an aerodynamic diameter less than or equal to a nominal 10 micrometers (including $PM_{2.5}$). Concentrations in the air are measured as micrograms per cubic meter of air ($\mu g/m^3$).

$PM_{2.5}$—Particles with an aerodynamic diameter less than or equal to a nominal 2.5 micrometers. Concentrations in the air are measured as micrograms per cubic meter of air ($\mu g/m^3$).

Prescribed Fire—Any fire ignited by management actions to meet specific objectives (i.e., managed to achieve resource benefits).

Prescription—Measurable criteria that guide selection of appropriate management response and actions. Prescription criteria may include the meteorological conditions affecting the area under prescription, as well as factors related to the state of the area to be burned such as the fuel moisture condition and other physical parameters. Other criteria which may be considered include safety, economic, public health, environmental, geographic, administrative, social or legal considerations, and ecological and land use objectives.

Project Plan—A strategic plan for accomplishing specific actions and goals (objectives) established in a land use plan. A project may include several activities such as cutting and hauling trees and shrubs, planting trees, building trails, and fire treatment.

Regional Haze—Generally, concentrations of fine particles in the atmosphere from multiple sources extending hundreds of miles across a region and causing wide-spread visibility impairment, including mandatory Class I Federal areas where visibility is an important value.

Sensitive populations—Those populations to whom smoke may present particular health risks.

Sensitive Receptors—Locations where human population tend to concentrate and where smoke could impact the health of those population or significantly impact visibility that may be detrimental to either health or the enjoyment of scenic qualities of the landscape. These may be residential concentrations in the form of towns or cities, or locations where people tend gather in groups such as parks. Travel routes such as highways may be labeled as sensitive receptor sites where smoke can be a factor in potential motor vehicle accidents. Particular areas along highways or other locations may be more prone to being declared sensitive receptor sites because of topographic and microclimate features.

Smoke Management Program or Plan—Establishes a basic framework of procedures and requirements for managing smoke from fires that are managed for resource benefits. The purposes of SMPs are to mitigate the nuisance and public safety hazards (e.g., on roadways and at airports) posed by smoke intrusions into populated areas; to prevent deterioration of air quality and NAAQS violations; and to address visibility impacts in mandatory Class I Federal areas in accordance with the regional haze rules.

Source—Any place or object from which pollutants are released. A source can be a power plant, factory, dry cleaning business, gas station or farm. Cars, trucks and other motor vehicles are sources, and consumer products and machines used in industry can also be sources. Sources that stay in one place are referred to as stationary sources; sources that move around, such as cars or planes, are called mobile sources.

*State implementation plan (*SIP)—A detailed description of the programs a state will use to carry out its responsibilities under the Clean Air Act. State implementation plans are collections of the regulations and emission reduction measures used by a state to reduce air pollution in order to attain and maintain NAAQS or to meet other requirements of the Act. The Clean Air Act requires that the EPA approve each state implementation plan. Members of the public are given opportunities to participate in review and approval of state implementation plans.

Stationary source—A place or object from which pollutants are released and which does not move around. Stationary sources include power plants, gas stations, incinerators, etc.

Suppression—A management action intended to protect identified values from a fire, extinguish a fire, or alter a fire's direction of spread.

Temperature inversion—One of the weather conditions that are often associated with serious smog episodes in some portions of the country. In a temperature inversion, air doesn't rise because it is trapped near the ground by a layer of warmer air above it. Concentrations of pollutants increase in the lower atmosphere. See also inversion.

Tribal Implementation Plan (TIP)—A document authorized by the CAA in which eligible tribes adopt emission reduction measures necessary to attain and maintain NAAQS, and meet other requirements of the CAA for lands within tribal jurisdictions.

Utilitarian fires—Fires with only economic or cultural goals and objectives.

Volatile Organic Compounds (VOC)—Any organic compound that participates in atmospheric photochemical reactions. Photochemical reactions of VOCs with oxides of nitrogen and sulfur can produce O_3 and PM.

Wildfire— An unplanned, unwanted wildland fire including unauthorized human-caused fires, escaped wildland fire use events, escaped prescribed fire projects, and all other wildland fires where the objective is to put the fire out.

Wildland Fire— Any non-structure fire that occurs in the wildland. Three distinct types of wildland fire have been defined and include wildfire, wildland fire use, and prescribed fire.

Wildland Fire Use—The application of the appropriate management response to naturally ignited wildland fires to accomplish specific resource management objectives in pre-defined designated areas outlined in Fire Management Plans.

Wildland/Urban Interface—A line, area, or zone where structures and other human development meet or intermingle with the wildland.

Wildland—An area where development is generally limited to roads, railroads, power lines, and widely scattered structures. The land is not cultivated (i.e., the soil is disturbed less frequently than once in 10 years), is not fallow, and is not in the United States Department of Agriculture Conservation Reserve Program. The land may be neglected altogether or managed for such purposes as wood or forage production, wildlife, recreation, wetlands, or protective plant cover.

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Acronym List

BAM	Beta Attenuation Monitor
BIA	U.S. Department of Interior, Bureau of Indian Affairs
BWCAW	Boundary Waters Canoe Area Wilderness
CAA	Clean Air Act
CAAA	Clean Air Act Amendments
EPA	U.S. Environmental Protection Agency
FOFEM	First Order Fire Effects Model
FRM	Federal Reference Method
IMPROVE	Interagency Monitoring of Protected Visual Environments
Mn/DOT	Minnesota Department of Transportation
MNDMA	Minnesota Department of Military Affairs
MNDNR	Minnesota Department of Natural Resources
MNICS	Minnesota Incident Command System
MPCA	Minnesota Pollution Control Agency
NAAQS	National Ambient Air Quality Standards
NPS	U.S. Department of Interior, National Park Service
NWS	National Weather Service
PM	Particulate Matter
SIP	State Implementation Plan
SMP	Smoke Management Plan
TNC	The Nature Conservancy
TEOM	Tapered Element Oscillating Microbalance
USFS	U.S. Department of Agriculture, Forest Service
USFWS	U.S. Department of Interior, Fish and Wildlife Service

National Weather Service, Fire Weather Web Sites

Chanhassen Minnesota	http://www.crh.noaa.gov/mpx/fireWx.php	952-361-6671
Duluth, Minnesota	http://www.crh.noaa.gov/dlh/firewx.php	218-729-6572
Grand Forks, North Dakota	http://www.crh.noaa.gov/fgf/forecast/firewx.php	701-795-5119
Aberdeen, South Dakota	http://www.crh.noaa.gov/abr/?n=fire_weather.php	605-225-5547
Sioux Falls, South Dakota	http://www.crh.noaa.gov/fsd/?n=fireindex	605-330-4246
LaCrosse, Wisconsin	http://www.crh.noaa.gov/arx/firewx.php	608-784-8292

The Air Quality Index (AQI)

The AQI is a health-based index that provides a measure of air quality. The index is available at http://aqi.pca.state.mn.us/hourly/. This site provides a map of AQI monitoring sites in MN, an explanation of the AQI and AQI pollutants with links to EPA websites and tables explaining the five categories of the index and the corresponding concentrations in ppm or $\mu g/m^3$ (breakpoints) for each pollutant. Clicking on any of the eight monitoring locations will provide the types of air samplers and a map of the monitor site. Access to hourly air data collected at that site for any date is also available, with the concentration value and the corresponding AQI value as well as AQI bar graphs.

Recently a link "AQI Site Help" (http://aqi.pca.state.mn.us/hourly/AQIhelp03.pdf) that opens an "AQI Data Navigation Overview Guide" was added to the AQI homepage.

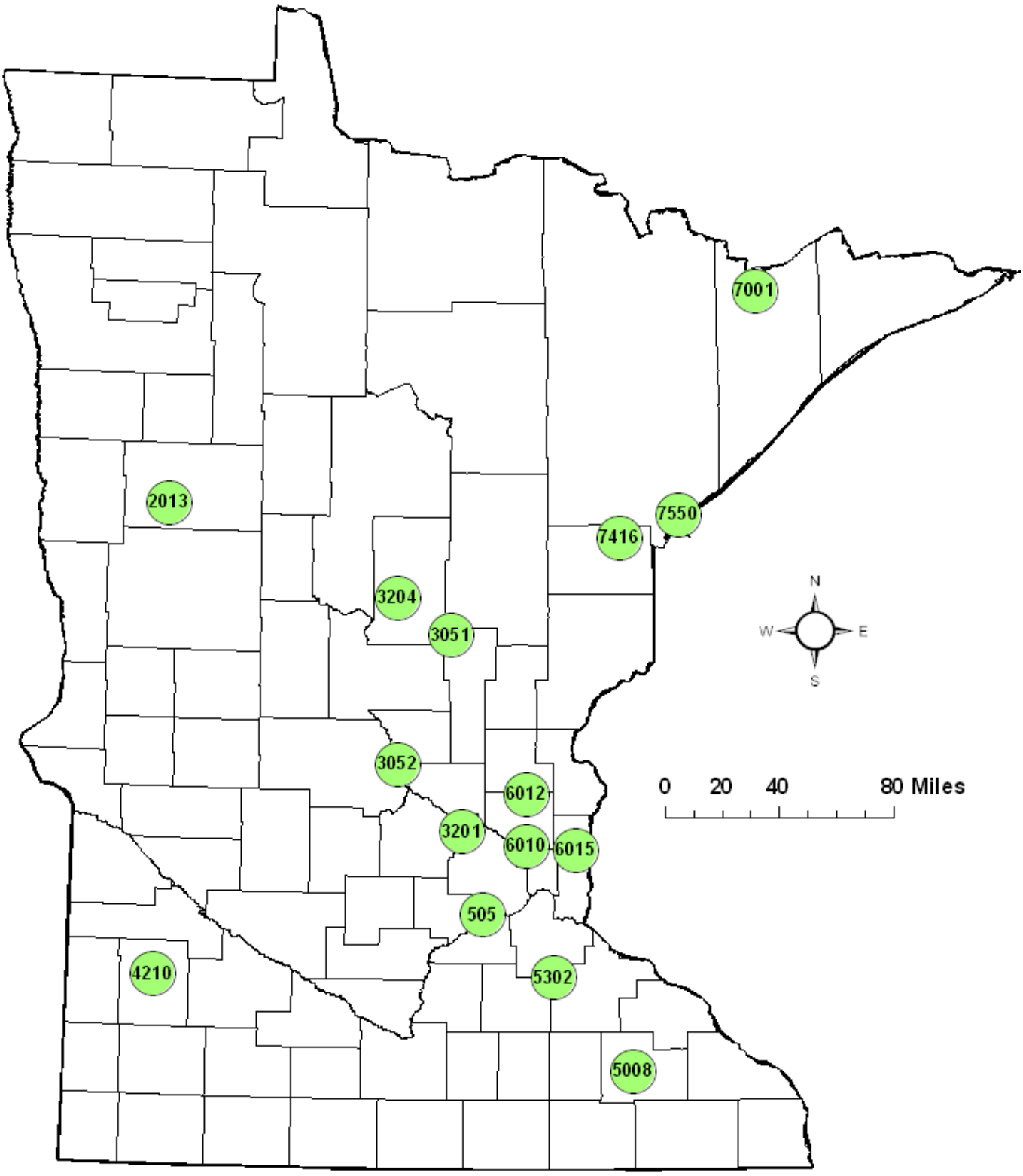
There are nine AQI sites equipped with collocated $PM_{2.5}$ BAM and continuous ozone monitors: Ely, Grand Portage, Detroit Lakes, Brainerd, Duluth, St Cloud, Marshall, Rochester, and the Minneapolis/St. Paul metro area. The metro area has five AQI sites: Phillips, St Michael, Harding HS, Blaine, and Apple Valley. Only the Grand Portage site does not have an O_3 monitor. The latest additions are Ely (activated Aug 2005) and Grand Portage (activated Oct 2005). These two sites in the previous large empty space in northern Minnesota mean that Duluth or Detroit Lakes are no longer the nearest locations for AQI determinations.

Table and Maps of $PM_{2.5}$, PM_{10}, and Ozone Monitoring Sites in Minnesota

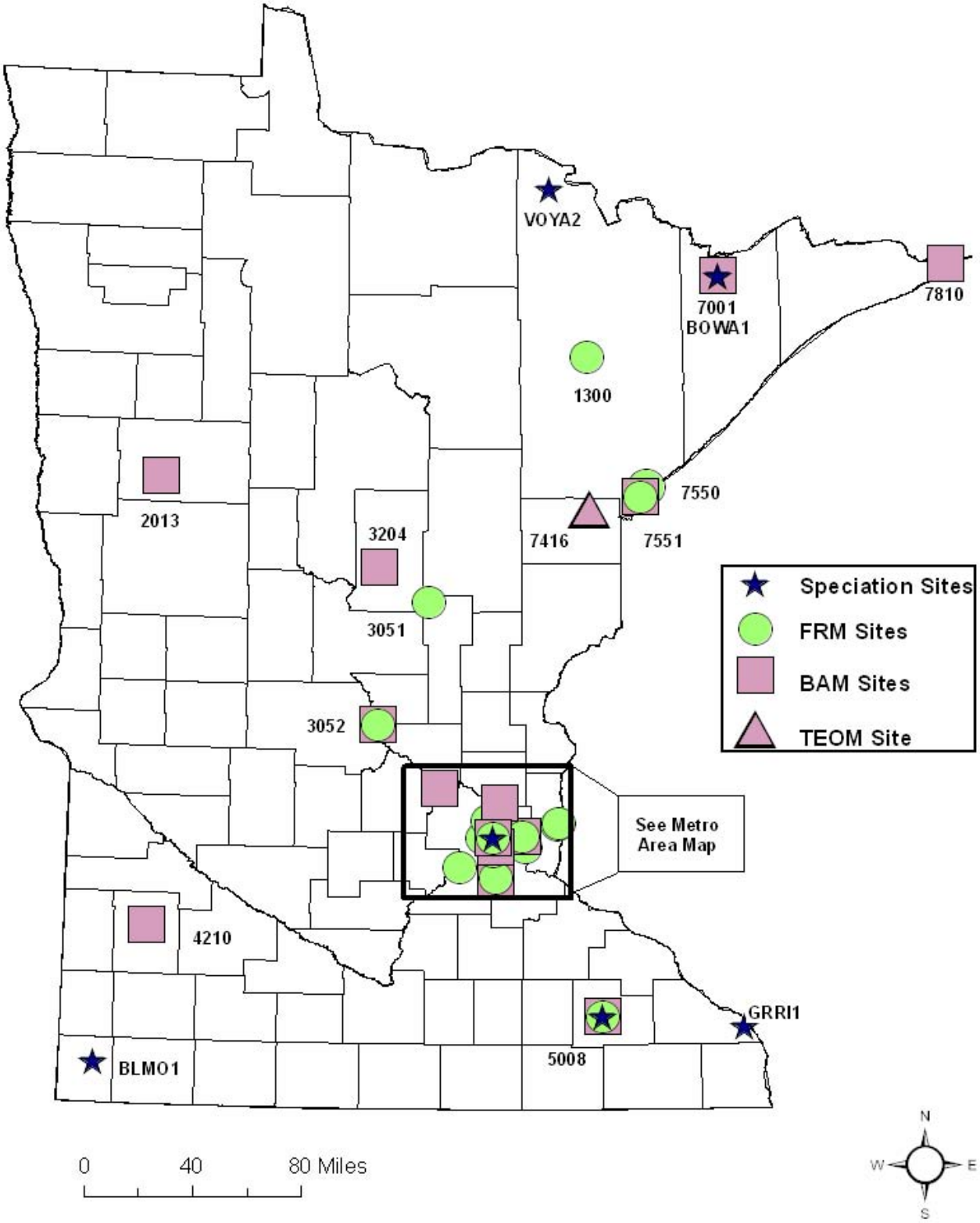
MPCA Site ID	$PM_{2.5}$ FRM	$PM_{2.5}$ BAM	$PM_{2.5}$ Speciation**	PM_{10}	Ozone	City	Site name	AQS Site ID	Address
250	1					St Louis Park	St. Louis Park	27-053-2006	5005 Minnetonka Blvd
435				1		Saint Paul Park	MPC 435	27-163-0009	7th Ave & 5th St
445	1					Bayport	Andersen School	27-163-0445	309 N 4th St
446	1					Bayport	Point Road	27-163-0446	22 Point Rd
470	1	1				Apple Valley	Apple Valley	27-037-0470	225 Garden View Dr
505	1				1	Shakopee	B.F. Pearson School	27-139-0505	917 Dakota St
801				1		Saint Paul	Vandalia Street	27-123-1003	2179 University Ave
820				1		Saint Paul	Ross Avenue	27-123-0021	1038 Ross Ave
866	1			1		Saint Paul	Red Rock Road	27-123-0866	1450 Red Rock Rd
868	1			1		Saint Paul	Ramsey Health Center	27-123-0868	555 Cedar St
871	1	1				Saint Paul	Harding High School	27-123-0871	1540 East 6th St
907	1			1		Minneapolis	Humboldt Avenue	27-053-1007	4646 N Humboldt Ave
961	1					Richfield	Richfield Intermediate School	27-053-0961	7020 12th Ave S
963	1	1	STN			Minneapolis	H.C. Andersen School	27-053-0963	2727 10th Ave S
966				1		Minneapolis	City of Lakes	27-053-0966	309 2nd Ave S
969		1				Minneapolis	Wenonah School	27-053-0969	5625 23rd Ave S
1300	1			1		Virginia	Virginia	27-137-7001	327 First St S
2013		1			1	Detroit Lakes	Detroit Lakes	27-005-2013	26624 N Tower Rd
3051	1				1	Mille Lacs	Mille Lacs	27-095-3051	HCR 67 Box 194
3052	1	1			1	Saint Cloud	Talahi School	27-145-3052	1321 Michigan Ave N
3201		1			1	St. Michael	St. Michael	27-171-3201	101 Central Ave W
3204		1			1	Brainerd	Brainerd Airport	27-035-3204	16384 Airport Rd
4210		1			1	Marshall	Marshall Airport	27-083-4210	West Highway 19
5008	1	1	STN		1	Rochester	Ben Franklin School	27-109-5008	1801 9th Ave SE
5302					1	Stanton	Stanton Air Field	27-049-5302	1235 Highway 17
6010		1			1	Blaine	Anoka Airport	27-003-1002	2289 CO Rd J
6012					1	East Bethel	Cedar Creek	27-003-1001	2660 Fawn Rd
6015					1	Stillwater Township	Washington County	27-163-6015	11660 Myeron Rd N
7001 BOWA1*		1	IMP		1	Ely	Fernberg Road	27-075-0005	Fernberg Rd
7416		1***			1	Cloquet	Cloquet	27-017-7416	175 University Rd
7526					1	Duluth	Torrey Building	27-137-0018	314 W Superior St
7545				1		Duluth	Oneota Street	27-137-0032	37th Ave W & Oneota St
7550	1					Duluth	WDSE	27-137-7550	1202 East University Circle
7551	1	1			1	Duluth	Lincoln Park School	27-137-7551	2424 W 5th St
7810		1				Grand Portage	Grand Portage	27-031-7810	27 Store Rd
BLMO1*			IMP			Luverne	Blue Mounds	27-133-9000	Blue Mounds State Park
GRRI1*			IMP			Winona	Great River Bluffs	27-169-9000	Great River Bluffs State Park
VOYA2*			IMP			International Falls	Voyageurs	(none)	Voyageurs National Park - Sullivan Bay

*IMPROVE Site ID; **STN = Speciation Trends Network, IMPROVE = Interagency Monitoring of Protected Visual Environments; ***$PM_{2.5}$ TEOM

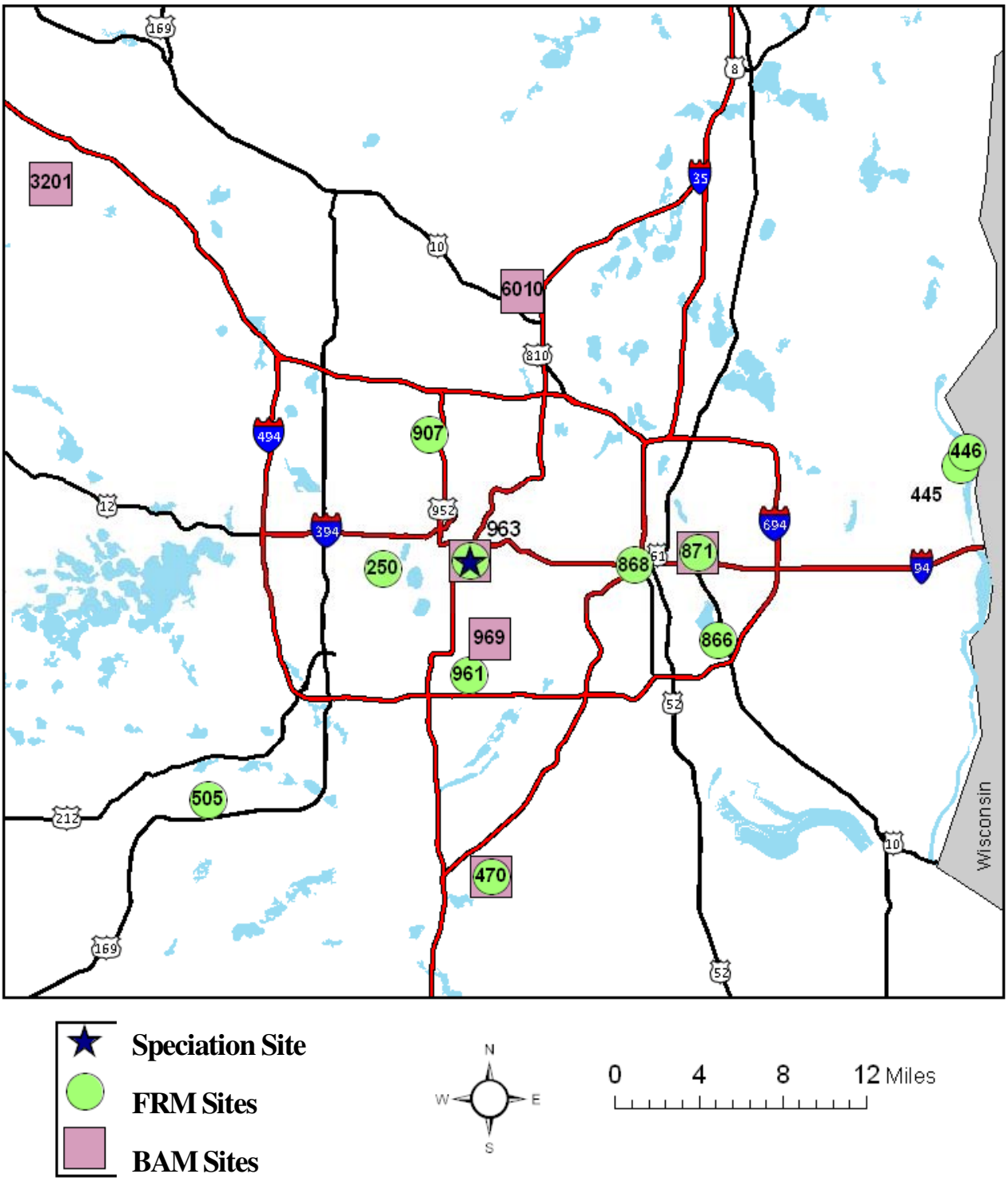
Ozone Monitoring Sites in Minnesota—(November 2007)



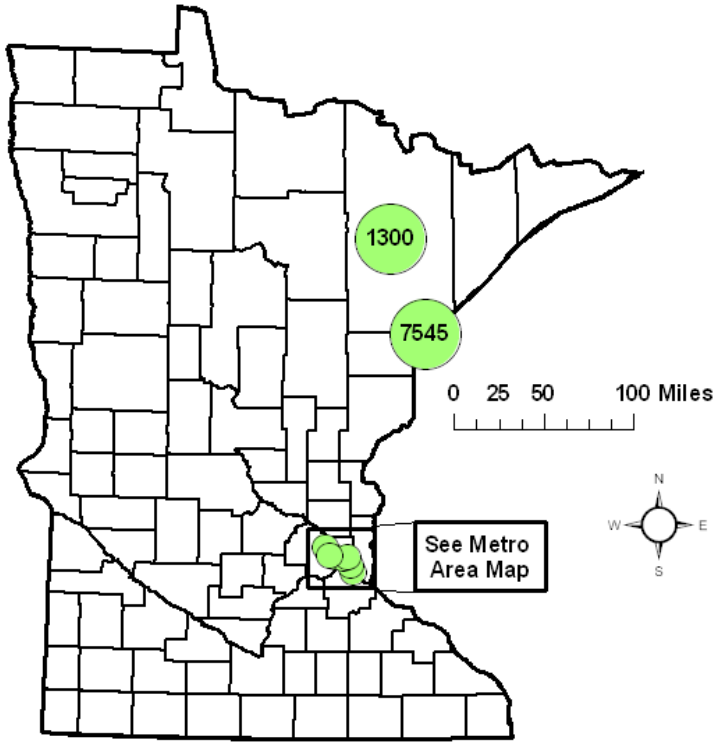
$PM_{2.5}$ Monitoring Sites in Greater Minnesota—(November 2007)



$PM_{2.5}$ Monitoring Sites in the Twin Cities Metro Area—(November 2007)



PM_{10} Monitoring Sites in Greater Minnesota—(November 2007)



PM_{10} Monitoring Sites in the Twin Cities Metro Area—(November 2007)