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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 was created 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.

From 2015-2019, public land agencies and The Nature Conservancy collectively burned on average 76,000 of land in Minnesota. Grasslands dominated this acreage with 64,000 acres being burned on average. Prescribed burning in Minnesota can be expected to remain at levels or higher 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 is expected to continue, and 3) an SMP may prevent particulate matter (PM) and ozone NAAQS violations due to emissions from managed wildland fires 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 a SMP so that these emissions do not result in non-attainment status with the NAAQS and with State air quality standards. A number of EPA rules 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 and Fuels Working Team (PFFWT). 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 2007. The plan was revised in 2016 and again in 2021.

Environmental regulations under the Clean Air Act such as the NAAQS 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
- 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 $PM_{2.5}$, PM_{10} & ozone air monitors and others including the IMPROVE monitors in Minnesota (See Appendix for Maps). The MPCA will identify ambient monitoring results that exceed the level of the 8-hour ozone NAAQS and the 24-hour $PM_{2.5}$ and PM_{10} NAAQS. Identified exceedance days will be evaluated to determine whether wildland fires significantly contributed to the exceedance.

To evaluate the effectiveness of the SMP, the MNICS Prescribed Fire and Fuels Working Team annually collects and reviews information on wildland fire acres burned. Reports of nuisance complaints or smoke intrusions will be noted and the MNICS PFFWT will use this information to measure the effectiveness of this plan. From 2007 to 2020, no prescribed fire-related monitor exceedances have been documented that have caused concern over the effectiveness of the SMP. For this reason, no substantive changes were made to the 2021 update of this plan.

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CHAPTER 1. INTRODUCTION

1.1 MINNESOTA OVERVIEW

Wildland fire has been managed 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. 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 SMP took 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 was created based on Section VI "Smoke Management Programs" of EPA "Interim Air Quality Policy on Wildland and Prescribed Fires" The program will be reviewed annually and the document amended as deemed necessary to achieve the purposes of the plan. 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 wildfires 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 and consume less fuel and therefore emit less smoke (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 (MnDOT), 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.

The annual acres burned by public land agencies and The Nature Conservancy in Minnesota will be contained in the annual Minnesota Smoke Management Plan Evaluation Report. 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". The NAAQS referred to here are for particulate matter (PM) < 2.5 microns ($PM_{2.5}$), particulate matter < 10 microns (PM_{10}) and ozone.

According to the policy "strong indications" that an 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 managed fires;
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.

Although these conditions may not now exist in Minnesota, the nature of an 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 continue to be 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 in1999 and revised them in 2016 (82 FR 3078). The rules are directed at all man-made sources of visibility impairment. The pollutants most responsible for haze in the Minnesota and Michigan Class I Areas are nitrates and sulfates. Other pollutants that contribute smaller amounts of haze are: soil material, organic carbon, and elemental carbon. The last two are found in smoke from vegetative burning or are derived from components of smoke. 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 every ten years. The MPCA submitted their first regional haze SIP for Minnesota in 2012, which covers the ten-year implementation period through 2018. The next ten-year plan is currently being drafted. Regional transport of smoke from wildfires in the western US and Canada commonly impact visibility in the warm weather months. More uncommonly local wildfires can also affect visibility, such as the Pagami Creek fire that affected the BWCAW monitor for a few weeks in 2011[1]. Smoke from prescribed fires in Minnesota has not been shown to cause or contribute to visibility impairment in any of the Class I areas in Minnesota[2] or Michigan (Sheesley and Schauer 2004).

[1] Five-Year Regional Haze Progress Report State Implementation Plan, December 2014; https://www.pca.state.mn.us/sites/default/files/aq-sip2-17.pdf

[2] Visibility data for Class I areas in Minnesota can be viewed on the MPCA webpage, https://public.tableau.com/profile/mpca.data.services#!/vizhome/RegionalHaze_visibility_metrics_public/Visibilityprogress.

Since fire smoke is not a dominant source of visibility impairment in nearby Class I Areas, and most of it can be argued to be "natural" or otherwise not controllable, it is not a focus of the proposed strategies used by Minnesota or any nearby states to improve visibility.

2) A continued 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 wildland environments.

One factor affecting current and future fire activities are the windstorms. Examples are the ones that affected northeast Minnesota, including the BWCAW, on July 4, 1999 and one in Northcentral Minnesota on July 1, 2012. The USFS will continue to conduct prescribed burns in portions of the wilderness. Burning in this wilderness area, either by wildfire, managed wildfire or prescribed fire, has the potential to affect visibility in this mandatory Class I area. Minnesota's other 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.

The 156 national Class I areas are administered by three different federal land managers (i.e. NPS, USFS, and FWS). These agencies and other federal and state agencies use prescribed fire to improve and maintain the health of the ecosystems. While the other air emission source types that impair visibility are predominately clearly classified as "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 pre-settlement 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 managed wildland fires in Minnesota.

Implementation of an SMP by land management agencies should reduce the number of instances where smoke causes an exceedance thereby avoiding "non-attainment" status with the NAAQS and with state air quality standards.

If an area of a state violates the NAAQS, then the state must prepare a State Implementation Plan (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 $PM_{2.5}$, PM_{10} and ozone collect air samples that are analyzed to measure compliance or non-compliance. 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.

EPA issued the first "Exceptional Events Rule (EER)" on March 22, 2007 (72 FR 13560). 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 all naturally ignited wildland 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).

On May 10, 2013, EPA issued interim guidance to help state, local and tribal governments manage air quality data recorded during "exceptional events". Thereafter, EPA proposed a revision of the EER on November 20, 2105; the revised final rule was published on October 3, 2016 (81 FR 68216). After the finalization of the rule revisions, EPA released several updated guidance documents related to the use of data under the EER, including guidance specifically intended to address wildland- and prescribed fire-related events. The guidance documents are available on the EPA website[3].

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 cause or contribute to 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. Formal updates of the SMP have taken place in 2014, 2016, and with this update in 2021.

Participants throughout this process (development of the original 2002 SMP and subsequent updates) included representatives from the MPCA, NWS, MNDNR, NPS, USFWS, USFS, MNDMA, MnDOT, TNC and the BIA. Signatory agencies to the 2002 SMP included MPCA, NWS, MNDNR, NPS, USFWS, TNC, and USFS.

[3] All documents, including the rule, can be found at https://www.epa.gov/air-quality-analysis/final-2016-exceptional-events-rule-supporting-guidance-documents-updated-faqs.

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[4], 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% most impaired days and no degradation of visibility on the 20% least impaired days, as determined by IMPROVE monitoring data. The national goal is to achieve "natural background" visibility in all Class I areas by 2064. All sources in the state, including prescribed burning could be considered for emission reductions depending on a number of factors such as their level of contribution to the problem. Minnesota's Regional Haze SIP was submitted to EPA in May 2012. At the time of the most recent revision of this SMP, the next regional haze SIP was in development. These documents and related information are available on MPCA's website at: http://www.pca.state.mn.us/index.php/air/air-quality-and-pollutants/general-air-quality/state-implementation-plan/minnesota-regional-haze-plan.html. While not required for the Regional Haze SIP, Appendix 10.8 includes an October 2004 letter from EPA to MPCA acknowledging that MPCA submitted Minnesota's Smoke Management Plan to EPA. Emission reductions from prescribed fires in Minnesota have not been required in Minnesota's Regional Haze SIP because prescribed fires were shown to not significantly contribute to visibility impairment in nearby Class I Areas.

2.1.2 Visibility Impairing 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 a person 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

[4] The regional haze rules and related information can be found at this EPA website:http://www.epa.gov/airquality/visibility/program.html

affect visibility derived from vegetative burning are PM_{10}, $PM_{2.5}$, nitrates, organic carbon, and elemental carbon. Approximately 90% of smoke particles from wildland and prescribed fires are PM_{10} and about 70% are $PM_{2.5}$.

Ozone, which is also known as "smog", is not directly produced by fires, but from other combustion products, namely NO_x and volatile organic compounds or VOCs. These ozone precursors may react photochemically to produce ozone in air masses downwind of fires.

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 (and their precursors) from fires can contribute to violations of these air quality standards.

Graphics illustrating Minnesota's progress toward regional haze visibility goals are shown in the Appendix.

2.1.3 National Ambient Air Quality Standards (NAAQS) and Minnesota Ambient Air Quality Standards (MAAQS)

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. EPA is required to regularly review the scientific evidence used to set these air quality standards and revise them as appropriate.

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. More detailed information on National Ambient Air Quality Standards is available at the EPA's website, https://www.epa.gov/naaqs .

Minnesota Ambient Air Quality Standards (MAAQS) are listed in Minnesota Rules 7009.0080.

The Annual Report will contain a detailed evaluation of the air quality monitoring data compared to the NAAQS/MAAQS and wildland fire activity.

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". This is primarily accomplished by implementing the requirements of a SIP that has been approved by the EPA, and where 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[5] to implement a statewide program of continuous improvement in visibility.

As discussed in previous sections of this document a regional haze SIP was prepared by the MPCA describing all measures that will be implemented to reduce regional haze caused by visibility pollutants. This is a separate plan from the NAAQS SIP and both may be submitted simultaneously in some situations.

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. All regional haze reviews and plan revisions can be found at https://www.pca.state.mn.us/air/minnesota-regional-haze-plan. 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

[5] 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.

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 four 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.

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 60 of the 2020 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, MnDOT, 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 an 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 atmospheric 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.

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. Permits are not required for federal management activities wholly on federal lands.

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. The program has been a success in reducing the number of wildfires during the most hazardous periods of the year. The program continues as a standard practice and is available in most counties where prescribed burning occurs.

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 or fuel (e.g. fuel model) to be burned,
- Area (acres) to be burned,

- 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 burning when fuel moistures for 1000 Hour fuels and duff 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, still photography, 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. A graphical depiction of this information is available from each local area office at the following website for Duluth: http://graphical.weather.gov/sectors/**dlh**FireDay.php#tabs. Other local area offices can be accessed by substituting the appropriate three letter office identifier (in bold).

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. Contact a MNICS organization member to access the document.

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)
Single large pile or Scattered small piled fuels	NA	POOR	0.25
	NA	FAIR or BETTER	No limitation
Grass or Leaf litter	< 50	POOR	0.25
	< 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. A great amount of information about prescribed burning can be found on the MNDNR and several Federal agency websites.

The MPCA now has real-time statewide Air Quality Index (AQI) information, in addition to statewide AQI forecasting. Current and forecasted AQI conditions can be viewed on the MPCA website, https://www.pca.state.mn.us/air/current-air-quality. When the AQI reaches unhealthy levels, the information is automatically shared with the National Weather Service, radio stations, and other local media in order to disseminate the information to the public. In addition to the MCPA's website, the MN Air mobile app, available for free for Android and iOS cell phone platforms, provides users with AQI information and notifications for when the AQI in their area reaches unhealthy levels.

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 PFFWT will annually collect and review information on acres burned by fuel type and wildland fire management type. If the PFFWT becomes aware of an increase in reports of nuisance complaints or smoke intrusions, the PFFWT will use this information to measure the effectiveness of this plan.

By adopting and following this SMP, the burning agencies, in partnership with MPCA, have the opportunity to make the case to EPA that certain air quality monitoring data can qualify a treatment as an exceptional event. 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. The current suggested minimum storage duration is 4 years.

During the year if:

- the MPCA flags any monitoring data for $PM_{2.5}$ and/or ozone and,
- there is a possibility that smoke from Minnesota prescribed or wildfires contributed to the event,

The MPCA will notify the PFFWT so that the corresponding agency can set aside and preserve any records it has pertaining to the fires identified to ensure the documentation necessary to demonstrate an Exceptional Event will be available if necessary later.

In addition, the MPCA will complete a comprehensive annual review of the data from the existing $PM_{2.5}$, ozone, and IMPROVE monitors in Minnesota (See Appendix). Possible correlations of air quality (visibility and NAAQS) with wildfires and prescribed fires will be assessed and a report will be provided to the PFFWT.

The Working Team will also review annually:

- The acres of prescribed burns by fuel type and any associated air quality issues,
- The need for changes in the SMP.

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

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 MPCA designee 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 (EMC)—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 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.

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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APPENDIX

Acronym List

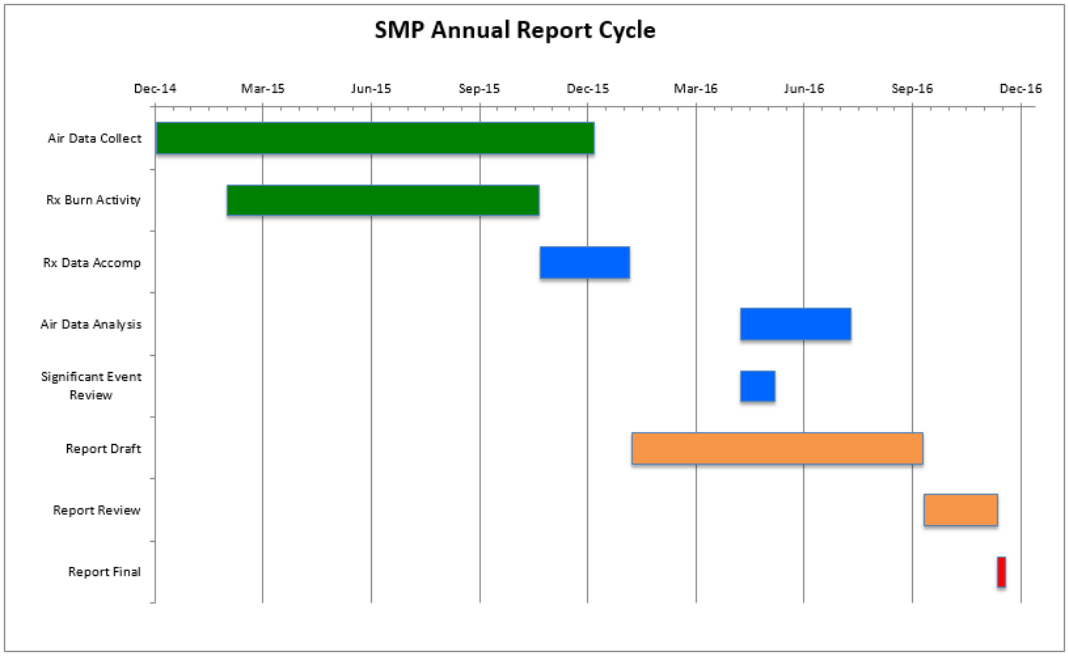
BAM	Beta Attenuation Monitor
BIA	U.S. Department of Interior, Bureau of Indian Affairs
BWCAW	Boundary Waters Canoe Area Wilderness
CAA	Clean Air Act
CAAA	Clean Air Act Amendments
EPA	U.S. Environmental Protection Agency
FOFEM	First Order Fire Effects Model
FRM	Federal Reference Method
IMPROVE	Interagency Monitoring of Protected Visual Environments
MnDOT	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	https://www.weather.gov/mpx/fire	952-361-6671
Duluth, Minnesota	https://www.weather.gov/dlh/fire	218-729-6697
Grand Forks, North Dakota	https://www.weather.gov/fgf/fire	701-795-5198
Aberdeen, South Dakota	https://www.weather.gov/abr/fire	605-225-5547
Sioux Falls, South Dakota	https://www.weather.gov/fsd/fire	605-330-4246
LaCrosse, Wisconsin	https://www.weather.gov/arx/	608-784-8275
National Fire Weather	http://www.weather.gov/fire	

Program evaluation

Section 4.5, Program Evaluation, lays out how the effectiveness of the SMP will be evaluated. The following data were collected between 2003 and 2013. Sources outside of Minnesota impacting monitors inside the state may be identified in the annual Minnesota Smoke Management Plan Evaluation Report. Evaluation of the program will be limited to events related to smoke events originating in the state of Minnesota. Future evaluation of the plan will be contained in the SMP Annual Report based on the example reporting cycle below. Tables, maps, and other information below will serve as examples to be included in the report.



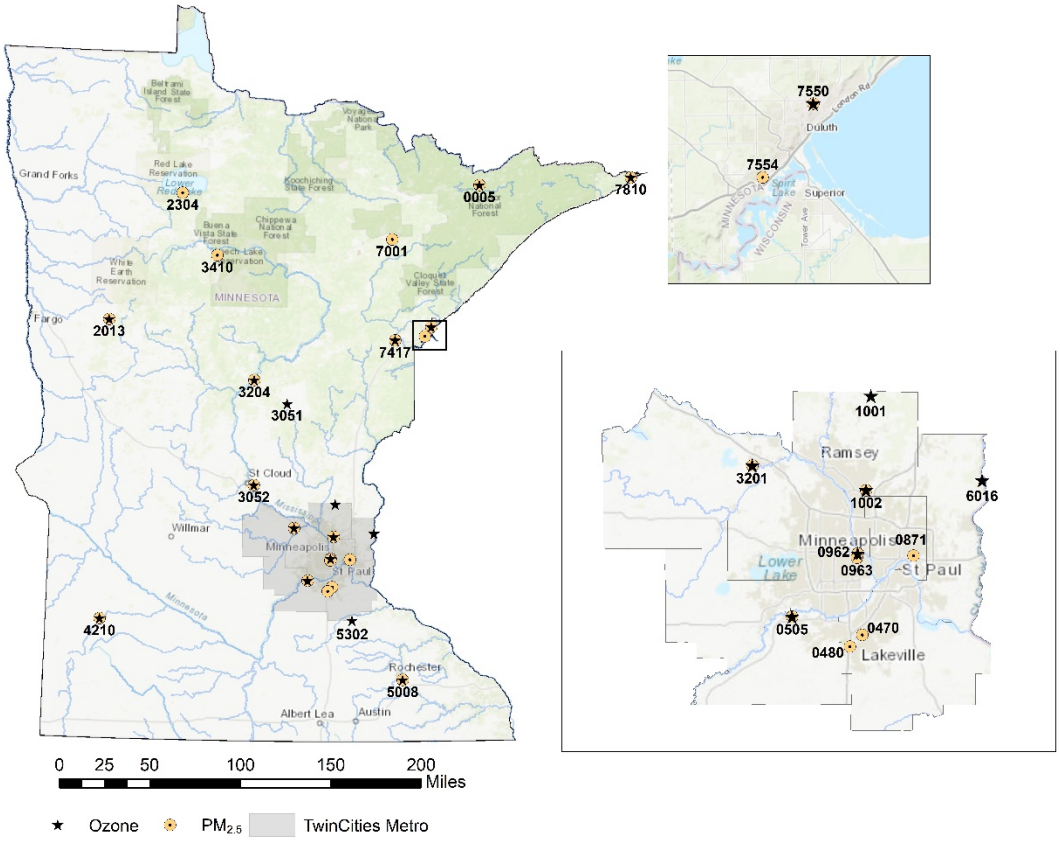
The Air Quality Index (AQI)

The AQI was developed by the EPA to provide a simple, uniform way to report daily air quality conditions. Minnesota AQI results are determined by hourly measurements of five pollutants: $PM_{2.5}$, ground-level ozone, SO_2, NO_2, and CO. The pollutant with the highest value determines the AQI for that hour. The pollutants that most strongly influence AQI are $PM_{2.5}$ and ozone.

Hourly AQI results for Minnesota are available on the web at http://www.pca.state.mn.us/aqi or via the Minnesota Air mobile app, http://www.pca.state.mn.us/9du9wp3. The MPCA also provides statewide AQI forecasts. Air quality forecast information is available on the AQI website, the MN Air mobile app, or by e-mail or text message via the EPA's AirNow EnviroFlash site, http://www.enviroflash.info.

The MPCA regularly monitors air quality conditions and issues an air pollution health alert if an air quality forecast or the actual measured AQI is greater than 100. Upon issuance of an air pollution health alert, the MPCA notifies local media in the impacted region and all EnviroFlash subscribers.

Map of AQI Monitoring Locations (2021)



2020/2021 Sites monitoring PM and ozone – Greater Minnesota

Site ID	City name	Site name	$PM_{2.5}$ FRM	$PM_{2.5}$ FEM	$PM_{2.5}$ Speciation	PM_{10}	Ozone
27-005-2013	Detroit Lakes	FWS Wetland Management District		X			X
27-007-2304***	Red Lake	Red Lake Nation		X			
27-017-7417***	Cloquet	Fond du Lac Band		X			X
27-021-3410***	Cass Lake	Leech Lake Nation: Cass Lake		X			
27-031-7810***	Grand Portage	Grand Portage Band		X			
27-035-3204	Brainerd	Brainerd Lakes Regional Airport		X			X
27-049-5302	Stanton	Stanton Air Field					X
27-075-0005 MN18* BOWA1**	Ely	Boundary Waters		X	X		X
27-083-4210	Marshall	Southwest Minnesota Regional Airport		X			X
27-095-3051***	Mille Lacs	Mille Lacs Band					X
27-109-5008	Rochester	Ben Franklin School		X			X
27-137-0032	Duluth	Oneota Street				X	
27-137-0034 MN32* VOYA2**	International Falls	Voyageurs NP – Sullivan Bay			X		X
27-137-7001	Virginia	Virginia City Hall		X		X	
27-137-7550	Duluth	U of M - Duluth		X			X
27-137-7554	Duluth	Laura MacArthur School		X			
27-145-3052	Saint Cloud	Talahi School		X			X
GRRI1**	Winona	Great River Bluffs			X		

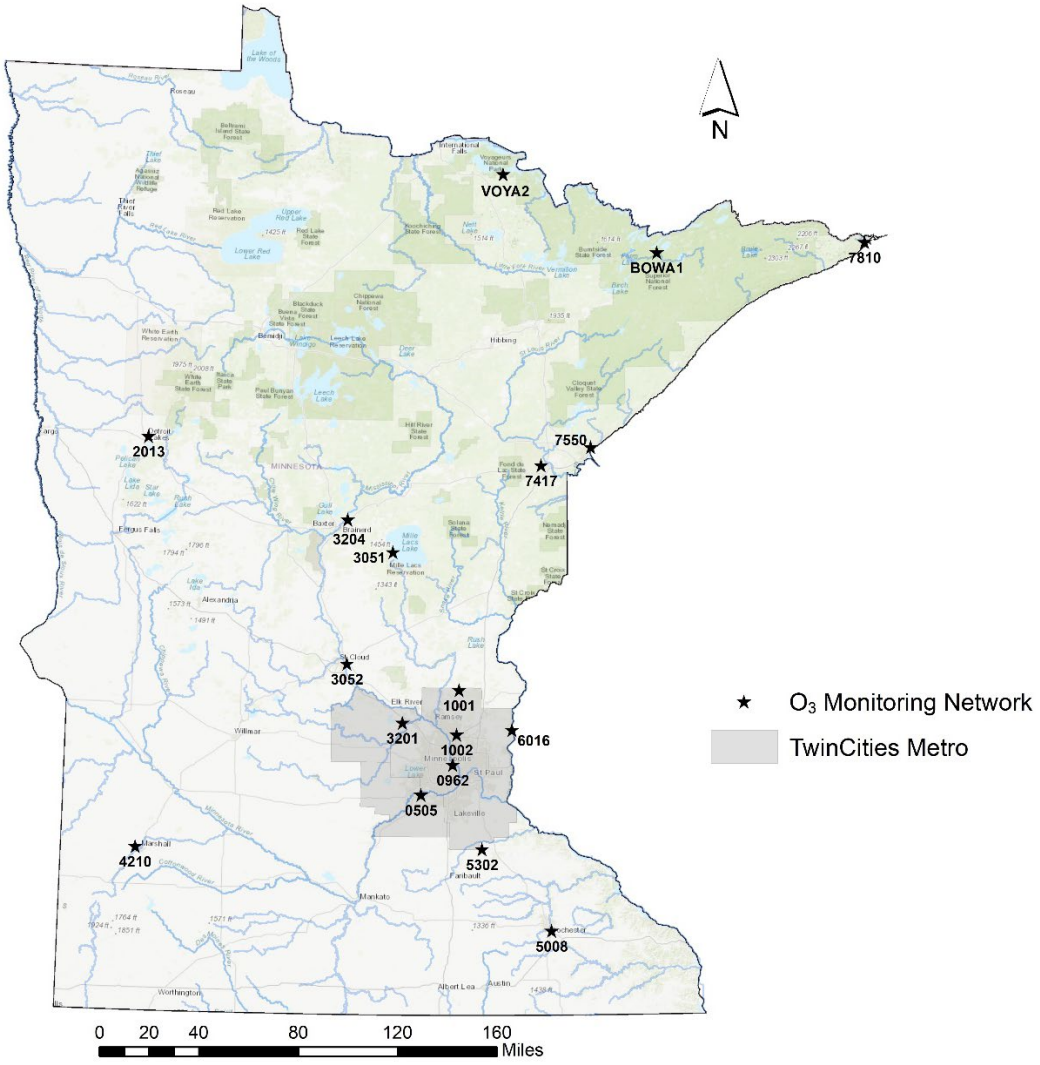
* NADP Site ID
** IMPROVE Site
*** Tribal monitor

2020/2021 Sites monitoring PM and ozone – Twin Cities metropolitan area

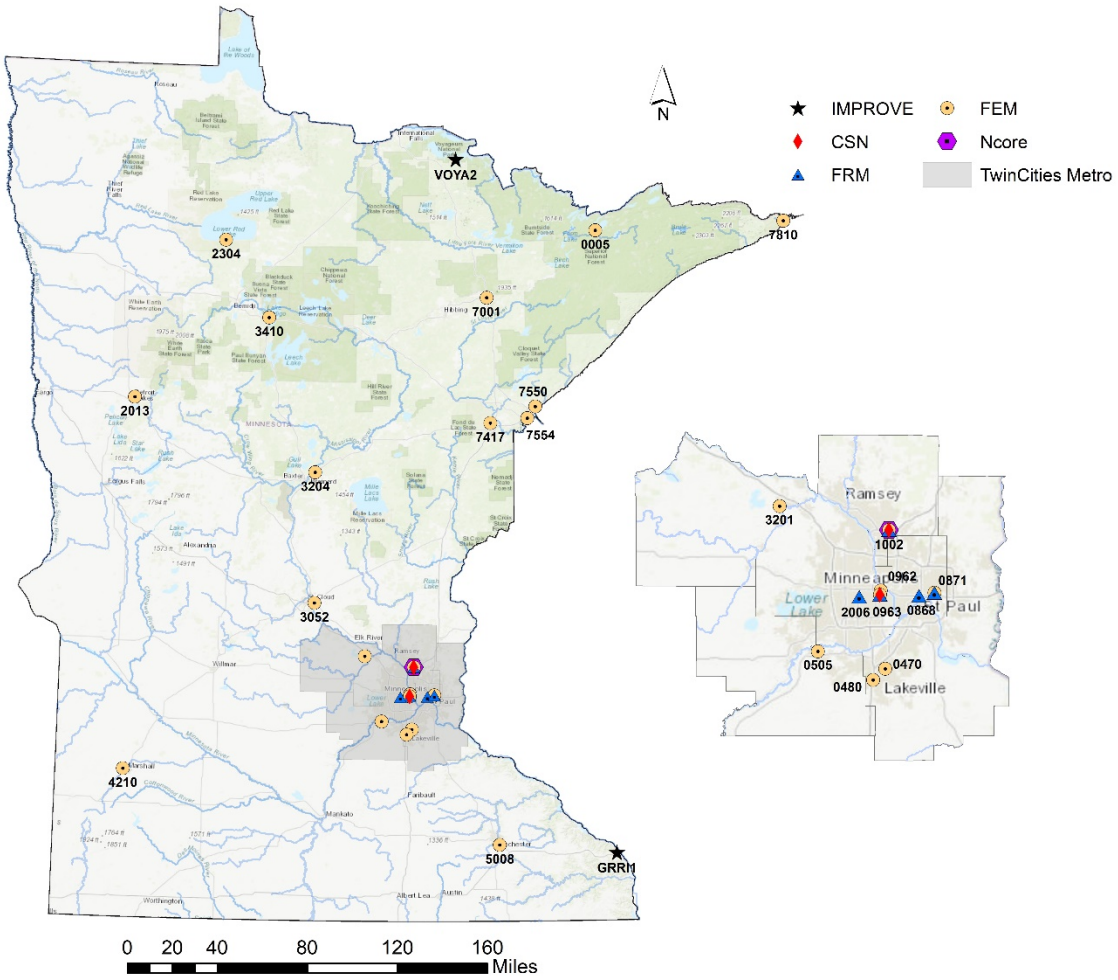
Site ID	City name	Site name	$PM_{2.5}$ FRM	$PM_{2.5}$ FEM	$PM_{2.5}$ Speciation	PM_{10}	Ozone
27-003-1001 MN01	East Bethel	Cedar Creek					X
27-003-1002	Blaine	Anoka Airport	X	X	X	X[C]	X
27-037-0470	Apple Valley	Apple Valley		X			
27-037-0480	Lakeville	Near Road I35		X			
27-053-0909	Minneapolis	Lowry Avenue				X[C]	
27-053-0910	Minneapolis	Pacific Street				X[C]	
27-053-0962	Minneapolis	Near Road I35/I94		X			X
27-053-0963	Minneapolis	H.C. Andersen School	X	X	X		
27-053-0966	Minneapolis	City of Lakes				X	
27-053-1909	Minneapolis	Bottineau / Marshall Terrace				X	
27-053-2006	St. Louis Park	St. Louis Park	X				
27-123-0866	St. Paul	Red Rock Road				X	
27-123-0868	St. Paul	Ramsey Health Center	X			X[C]	
27-123-0871	St. Paul	Harding High School	X	X			
27-139-0505	Shakopee	Shakopee		X			X
27-163-6016	Marine on St. Croix	Marine on St. Croix					X
27-171-3201	Saint Michael	Saint Michael		X			X

[C] PM_{10} Continuous

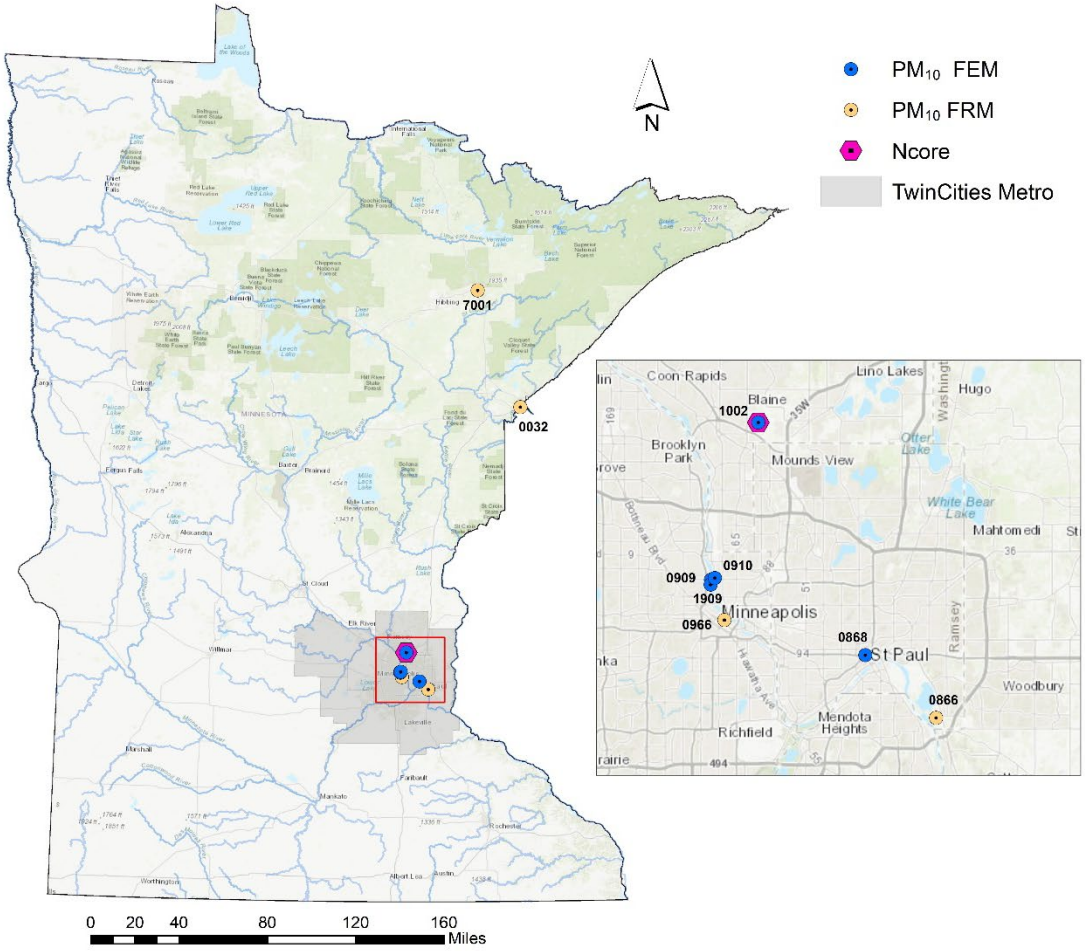
Ozone Monitoring Sites in Minnesota — (2021)



$PM_{2.5}$ Monitoring Sites in Minnesota — (2021)

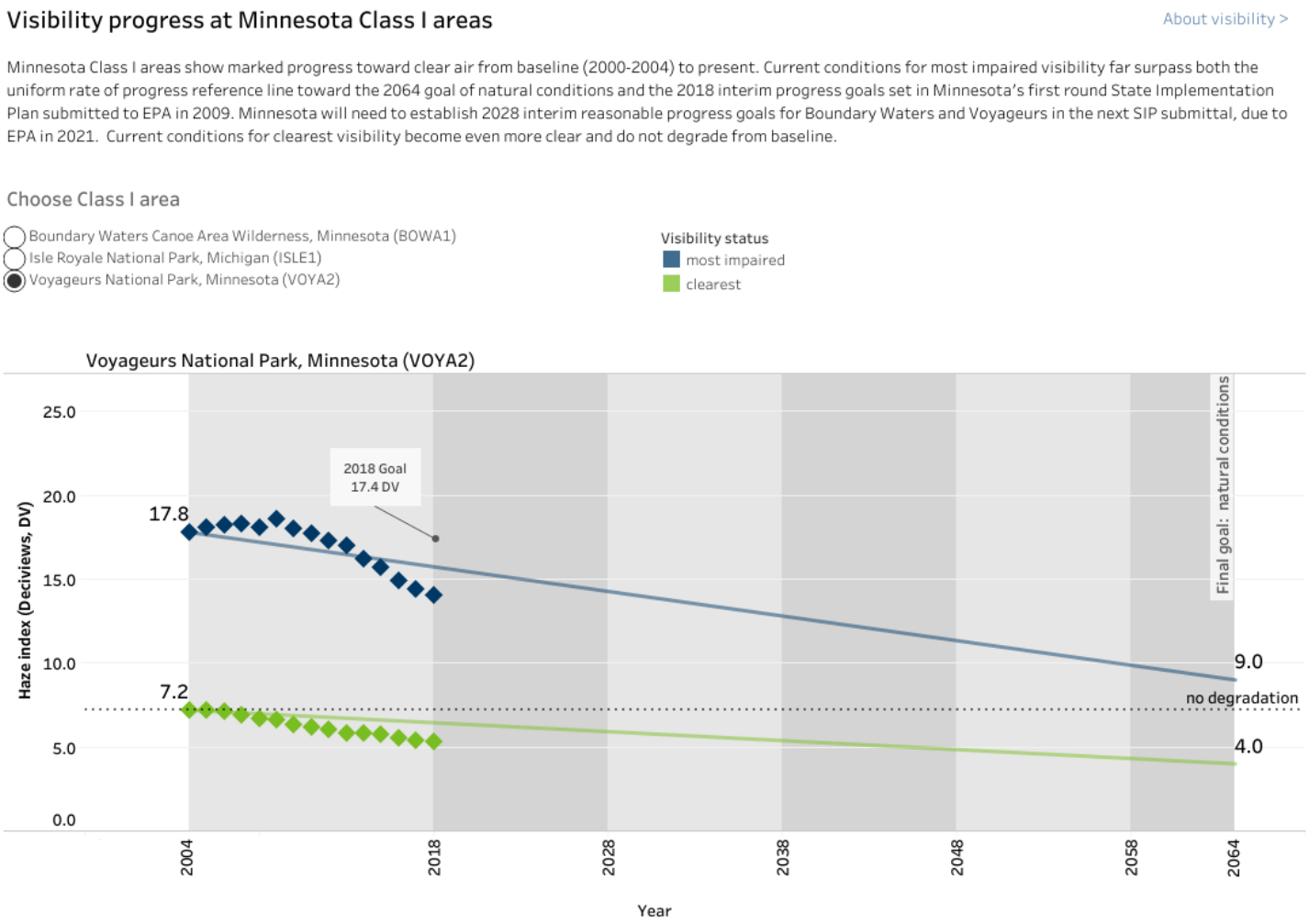


PM_{10} Monitoring Sites in Minnesota — (2021)

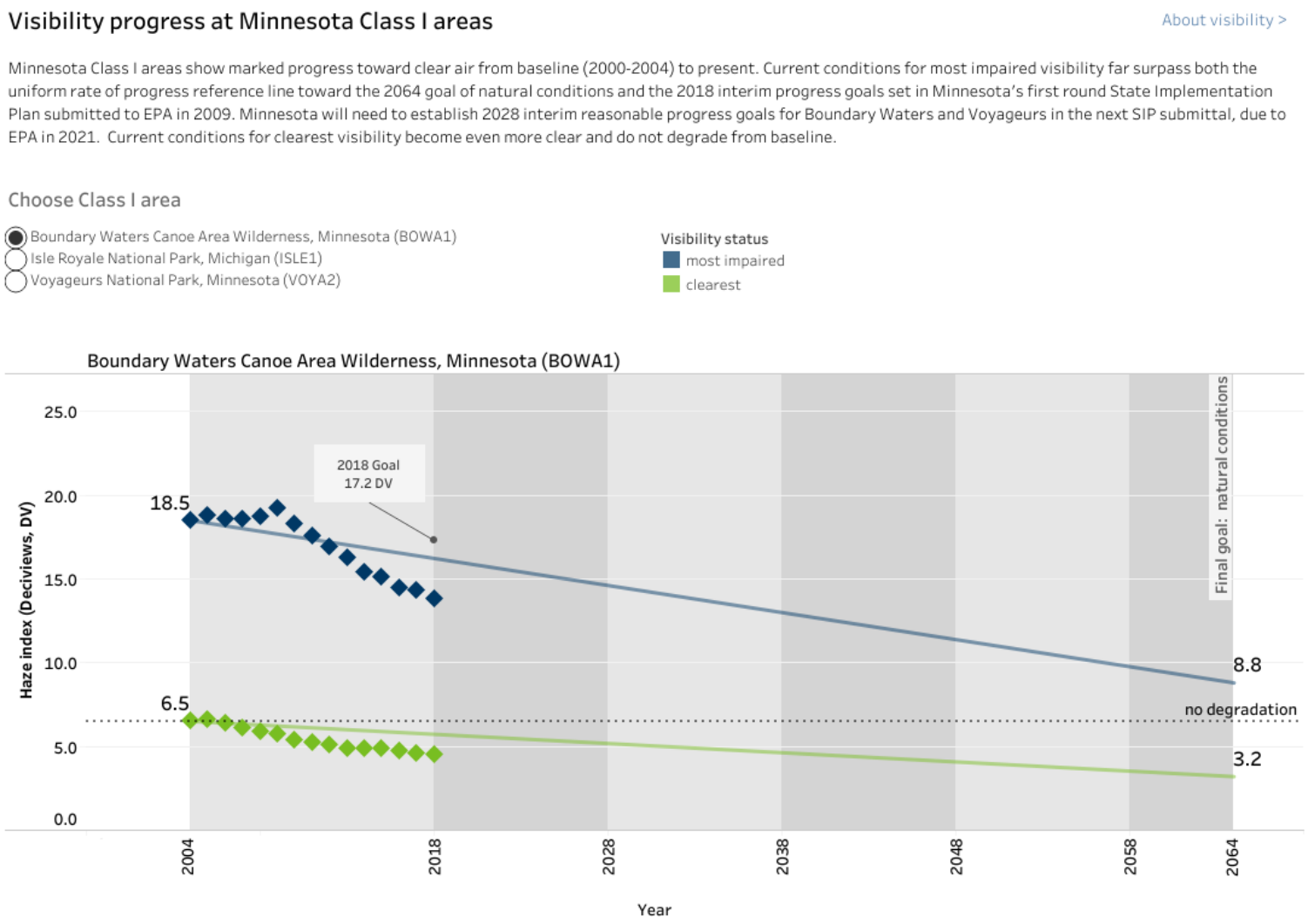


Progress toward regional haze visibility goals in Minnesota

Measured progress toward meeting "reasonable progress" goals at Voyageurs National Park for the most impaired and least impaired days.



Measured progress toward meeting “reasonable progress” goals at the Boundary Waters Canoe Area Wilderness for the most impaired and least impaired days.



Acres Burned

Table A. Acres Burned in Minnesota by Fuel Type.

Year	Grass	Brush	Timber	Slash	Total	Reported Smoke Complaints
2011	72,442	3,463	7,466	991	**84,362**	0
2012	60,268	3,679	5,225	317	**69,489**	0
2013	40,672	4,414	5,281	1,669	**52,036**	0
2014	56,487	5,033	6,501	915	**68,878**	1
2015	41,169	1,850	3	153	**43,175**	0
2016	54,119	5,755	3,296	233	**63,403**	0
2017	71,846	7,381	4,461	495	**84,183**	0
2018	88,488	6,478	9,498	360	**104,824**	0
2019	66,208	6,345	11,824	1,604	**85,981**	0
2020*	10,163	737	1,637	616	**13,153**	0
Averages†	**61,300**	**4,933**	**5,951**	**749**	**72,926**	0

*Acres reported for 2020 were limited due to most agencies canceling prescribed burning after mid-March 2020 in response to the Covid-19 pandemic.
†2020 was omitted from the averages as an outlier.

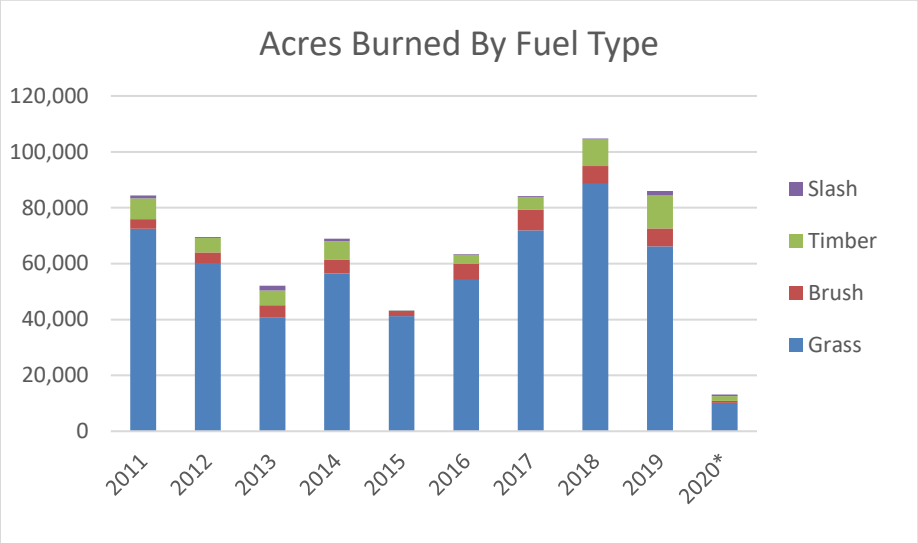


Table B. 2015-2020 Prescribed or Managed Wildland Fire Total Acreage

Agency	Grass	Brush	Timber	Slash	Total
TNC	1,888	424	0	1	2,313
USFS	5,555	845	2,068	2,297	10,765
NPS	0	0	0	0	0
USFWS	105,266	1,696	963	561	108,486
DNR	147,650	25,169	16,510	593	189,922
DOT	117	0	20	0	137
DMA	38,009	1,810	11,685	71	51,575
					363,198

Data as reported in MN DNR Prescribed Fire Reporting System