

# National Ambient Air Quality Standards and air monitoring

What they are, how they are connected, and MPCA's role

## Key takeaways

- EPA sets national standards for outdoor air quality.
- Minnesota is currently in compliance with the standards.
- The standards limit six air pollutants: lead, ground-level ozone, particulate matter, nitrogen dioxide, sulfur dioxide, and carbon monoxide.
- MPCA is responsible for making sure air pollution in Minnesota is below the limits in the standards.
- MPCA installs stationary monitors to collect air samples and determine compliance with the standards.
- MPCA also monitors pollutants that are not regulated by EPA's national standards.

## Air monitoring

The U.S. Environmental Protection Agency (EPA) is required by the federal Clean Air Act to set limits on the amount of pollution that can be in the air. The limits are part of National Ambient Air Quality Standards, often referred to as 'the NAAQS' (which rhymes with "max").

Air monitors are used to determine states' compliance with the standards, so monitoring must follow EPA protocol for which pollutants are monitored, how samples are collected and tested, and where monitors are located. Minnesota Pollution Control Agency (MPCA) is responsible for monitoring NAAQS-regulated pollutants across Minnesota, reporting results and recommending actions to the EPA, and ensuring ambient air pollution remains below the limits in the standards.

The MPCA also uses the data from air monitors to determine pollutant trends, understand background conditions and how pollution moves around, monitor specific pollution sources, assess population exposure and risk, guide pollution reduction strategies, and forecast and report the [air quality index](#) (AQI).

The EPA defines ambient air as outdoor air that the public has access to. This means the [NAAQS do not apply](#) to indoor air, the air at the exit of a stack, or air within a facility's property boundaries where public access is restricted. However, the air and the pollutants it carries must be below the limits set in the standards after it moves off the property or if the property is accessible to the public.

## Monitored pollutants regulated by NAAQS

There are National Ambient Air Quality Standards for six common pollutants. The limits are based on criteria that protect human health and the environment, so the NAAQS-regulated pollutants are sometimes referred to as criteria pollutants.

The standards apply to these six pollutants in ambient air:

- Lead
- Ground-level ozone
- Particulate matter in two size groups: particles 10 micrometers and smaller in diameter (PM<sub>10</sub>) and particles 2.5 micrometers and smaller in diameter (PM<sub>2.5</sub>)
- Nitrogen dioxide
- Sulfur dioxide
- Carbon monoxide

EPA sets two standards for most NAAQS-regulated pollutants:

1. Primary standards protect human health.
2. Secondary standards protect the environment – including vegetation, animals, crops, visibility, or buildings.

Primary standards are set at pollution levels that will protect human health, including at-risk populations, with a margin of safety. Limits in primary and secondary standards are based on regular reviews by EPA of scientific research and health outcomes. Most of the pollutants have different limits for short-term and long-term timeframes, to protect against short-term (acute) and long-term (chronic) exposures.

Compliance is determined using a calculated value for most of the standards – such as an average across time or locations – rather than a direct, immediate reading from a single monitor.

Current standards are listed on the [EPA NAAQS table webpage](#). Results from Minnesota’s NAAQS pollutant monitoring sites are published on [MPCA’s Criteria Pollutant Data Explorer](#).

**Table 1: Regulatory monitoring sites in Minnesota in 2023.**

Pollutant	Number of monitoring sites in greater Minnesota	Number of monitoring sites in Twin Cities metro	Total number of sites
Particulate matter (PM <sub>2.5</sub> and PM <sub>10</sub> )	18	22	40
Metals including lead, and total particulate	3	16	19
Ozone	11	6	17
Nitrogen oxides	1	5	6
Sulfur dioxide	1	6	7
Carbon monoxide	0	6	6
VOCs	1	17	18
Carbonyls	1	17	18
<b>Totals</b>	<b>26</b>	<b>28</b>	<b>54</b>

## Monitored pollutants not regulated by NAAQS

The MPCA also monitors pollutants that are not regulated by NAAQS.

- Hydrogen sulfide and total suspended particulate are monitored to ensure compliance with Minnesota ambient air quality standards (MAAQs). Hydrogen sulfide can cause irritation to the eyes, nose, and throat, and may cause difficulty breathing for people with asthma.

The MPCA monitors for the following air toxics, which are pollutants known or suspected to cause cancer or other serious health and environmental effects:

- Metals: arsenic, beryllium, cadmium, chromium, cobalt, iron, lead, manganese, nickel, selenium
- Carbonyls such as formaldehyde
- Mercury (via partners as part of the national Mercury Deposition Network)
- Volatile organic compounds (VOCs). There is a NAAQS for ground-level ozone, which forms from interactions of VOCs and nitrogen oxides with sunlight. MPCA monitors for 58 kinds of VOCs.

Air toxics are also called hazardous air pollutants (HAPs), which are individually listed in the Clean Air Act. Instead of developing NAAQS limits for each air toxic, EPA develops National Emission Standards for Hazardous Pollutants (NESHAP) to regulate emissions by industry sector or process. For example, there are NESHAPs for auto body painting, industrial boilers, and taconite processing. NESHAP requirements are incorporated into air permits and many of the NESHAPs must be followed even if a facility isn't required to have an air permit.

The MPCA compares air toxics monitoring results and reported emissions to health benchmarks to assess exposure and risk for residents and guide pollution reduction strategies.

## Monitoring equipment

Regulatory monitors are stationary pieces of equipment, frequently placed on small sheds or rooftops. Site locations depend on EPA requirements as well as logistics such as access, power, internet availability, and equipment security.

The EPA has specific, detailed requirements for regulatory monitors. As a result, they are expensive to buy and they require staff-time to set up and maintain the equipment, retrieve and analyze the samples, and manage the data – all of which limits the number of air monitors MPCA can operate in Minnesota. There are currently more than 50 ambient air quality monitoring sites in Minnesota, including five hosted by tribal partners.



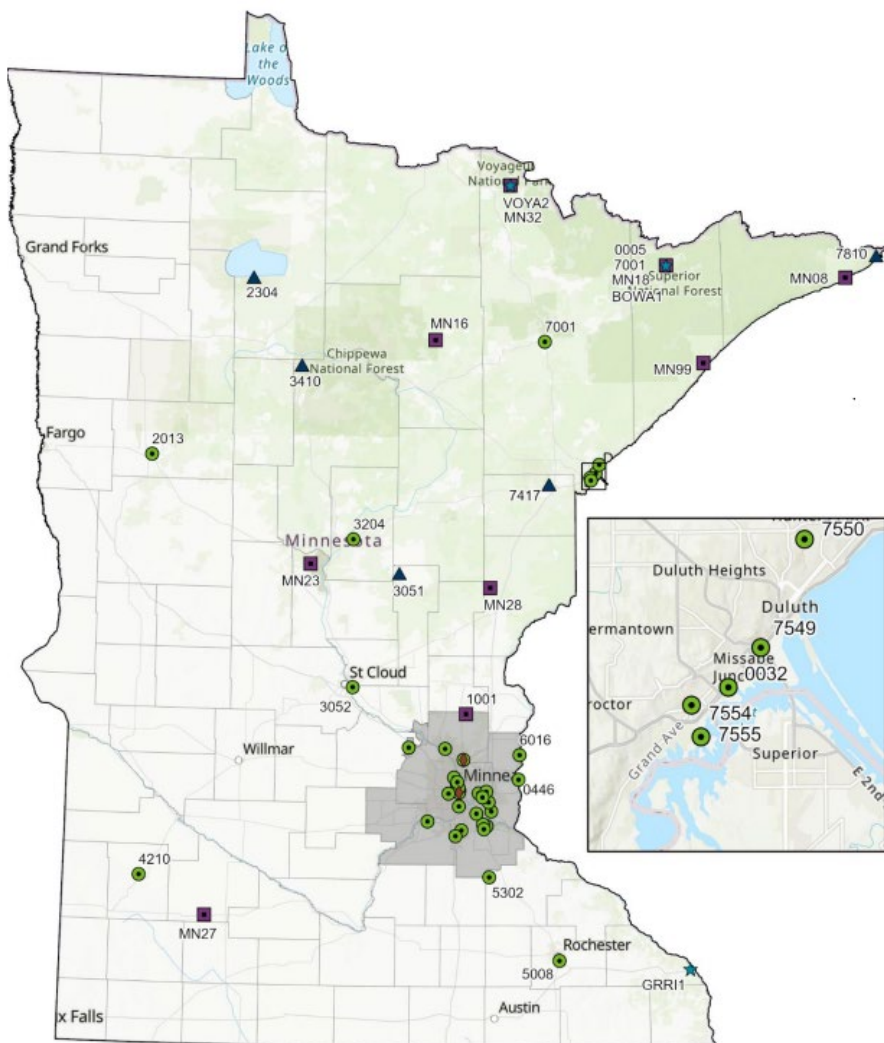
Regulatory monitors are stationary pieces of equipment that gather samples of outdoor air. The samples are retrieved by MPCA staff and brought to the lab for analysis.

Most pollutants come from human activities such as transportation, making energy and heat, and industry. This means air pollution is often worse where more people live, so monitoring sites are concentrated in the Twin Cities metropolitan area (see Table 1 above and Map 1 below).

Some monitors provide air pollution readings continuously on a real-time basis, such as every 5 minutes or every hour. Other monitors use 24-hour average samples, collected midnight to midnight once every three days or once every six days. MPCA staff pick up samples at monitoring sites and bring them back to MPCA’s lab for analysis. The data is then reviewed to confirm the monitor was working correctly, the sample wasn’t contaminated after it was collected, and the analysis was conducted and reported properly.

Air sensors are often smaller, cheaper, more portable, and easier to operate compared to regulatory air quality monitors. You may recognize them by the brand names PurpleAir, AirBeam, or AQMesh. Sensors have the same limitations as regulatory monitors such as the pollutants they can detect, the need for access to electricity and internet, and a secure place to put them where people and animals can’t tamper with them. Sensors are non-regulatory, which presents a challenge for regulatory agencies like MPCA – we cannot use the data from sensors to enforce rules. However, as sensor technology and accuracy evolve, sensors can and will be used to supplement understanding of local air quality.

**Map 1. Air quality monitoring sites in Minnesota.** This map and a detailed map of the monitors in the Twin Cities metro area are in the Air Monitoring Network Plan on [MPCA’s Air quality monitoring webpage](#).



# Computer models help fill gaps in monitoring

Some pollutants cannot be monitored and instead are tracked by emissions reporting and modeling. Models can predict pollution levels for pollutants that are difficult to monitor, can't be monitored because the technology doesn't exist, or are in the areas between air quality monitors. MPCA uses models to set appropriate emission limits for facility air permits, study the way pollution moves around the region and across state borders, and forecast daily air quality in Minnesota.

## Modeling at facilities

Certain facilities with new or changing air permits must prove their emissions will not contribute to air pollution going over NAAQS pollution limits. This is confirmed by computer modeling before the permit is issued and afterward by requiring some facilities to have regulatory monitors on-site as part of their permit requirements.

- Modeling is required before a permit is issued for facilities that are large or located in areas where pollution concentrations are already over the NAAQS limits.
- The modeling analysis includes background air pollution, nearby sources of pollution, and meteorological data such as temperature, wind direction, and wind speed.
- Facility-specific data used in the modeling analysis includes pollutant emission rates, heights, temperatures, and velocities, wind erosion from storage piles, and the effects of nearby buildings and terrain.
- If a facility's proposed emissions will contribute to ambient air being over the limits in the NAAQS, the facility must adjust its planned processes and restrict emissions of that pollutant to levels that keep ambient air below the NAAQS limits.
- More information about modeling is on [MPCA's Air quality modeling webpage](#).

Modeling is sometimes done for air toxics (hazardous air pollutants) and their potential to impact human health. This is called an air emission risk analysis (AERA). More information about AERAs, including when they are required, is on [MPCA's Air emission risk analysis webpage](#).

# NAAQS regulations are more than just limits

## State implementation plans

The EPA reviews states' monitoring results and determines which areas in each state are above or below the limits in the standards.

Areas where air quality is over the limits in the standards are in "nonattainment" because they have not attained, or met, the standard. States must develop a customized plan for how to clean up the air in that area within a certain amount of time. The plans usually focus on a single pollutant in a specific area. All the sources of air pollution that contribute to the area being in nonattainment are considered, including those outside the area or even outside the state. Minnesota currently has only one nonattainment area, in [Dakota County for lead](#).

Areas below the limits of the standards are referred to as being in "attainment." For these areas, states develop a general plan to demonstrate how they will stay below the limits of the standards and not contribute to areas of the state or areas of other (usually downwind) states being over the limits. All regulations and actions that the state believes are necessary to stay below the limits of the standards are included in the plan, such as requiring permits.

Plans are reviewed and approved or disapproved by the EPA, and are collectively called state implementation plans, or SIPs. You can read more about [Minnesota's state implementation plans on MPCA's website](#). Air toxics, or hazardous air pollutants, are regulated under a different part of the Clean Air Act and are not included in state implementation plans.

## What MPCA is and is not authorized to do

Minnesota's state implementation plan includes all the requirements of the EPA's NAAQS program and MPCA's air permitting program, including:

- Rules requiring facilities to determine if they need an air permit and get one if they do.
- Requirements to review new sources of air pollution in nonattainment areas and prevent significant deterioration of air quality in attainment areas, such as by requiring stricter pollution limits in permits.
- Rules requiring permitted facilities to report their pollutant emissions to MPCA annually.
- Technical standards for certain facility types to follow if they aren't required to have permits.
- Requirements governing the number, type, and location of air monitors.
- Rules about emissions from cars and other mobile sources.
- Statutes prohibiting open burning of garbage.

The full list of requirements and actions are in [Minnesota's general SIP on the EPA website](#). All requirements and actions included in the SIP are legally binding and enforceable at state and federal levels.

Under current federal and state rules:

- MPCA cannot shut down facilities that are meeting the requirements of their permits except under [emergency conditions](#).
- MPCA cannot deny permit applications if they meet requirements, contain the conditions necessary for complying with the requirements, and the MPCA has a reasonable assurance that the applicant will comply with the permit conditions. Grounds for [denying](#) or [revoking](#) permits are in state rule.
- MPCA cannot require facilities to have stricter limits in their permits unless there is a specific reason to do so, such as a potential NAAQS exceedance or circumstances identified during an [environmental review](#). Voluntary tightening of limits in permits must be agreed to by the facility.
- MPCA can ask facilities to voluntarily make changes that will improve ambient air quality, but they are not required to make the changes. Facilities can reduce their emissions as low as they want or are able to, as long as they remain below their permit limits. MPCA regularly offers grants to encourage facilities to make voluntary changes.

## NAAQS and monitors updated regularly

[EPA reviews the pollution limits in the standards](#) and supporting science every five years. Recent reviews have resulted in stricter standards as health impacts are documented at lower levels of air pollution. Current standards are listed on the [EPA NAAQS table webpage](#). When the standards are updated, states have a set period of time to reevaluate and determine if they are complying with the new standard. EPA reviews states' determinations as well as new and updated state implementation plans.

## Connection to the AQI

NAAQS regulations underpin air quality forecasting and alerts for the [Air Quality Index \(AQI\)](#). The standards for particulate matter and ground-level ozone are linked to the breakpoints in the air quality index. For example, if PM<sub>2.5</sub> in the air is measured or forecast to be over the NAAQS daily primary limit, MPCA and our partners will issue an air quality alert and the [AQI forecast will be color-coded](#) orange, red, purple, or maroon to show the amount of particle pollution in the air. The alert levels in the AQI are updated when NAAQS limits are revised.

## Air monitoring network reviewed regularly

The EPA requires states to evaluate the regional network of air monitors every five years. Minnesota has collaborated with other states in our region to conduct this evaluation, under the direction of the Lake Michigan Air Directors Consortium (LADCO). The [results can be found on LADCO's website](#). Findings from the 2020 Network Assessment included:

- Moving or shutting down existing PM<sub>2.5</sub> and ozone monitoring sites is very difficult due to stringent EPA criteria.
- Minnesota’s criteria pollutant monitoring network is not dense enough to measure neighborhood-level disparities in air quality, but MPCA is increasing its use of small air quality sensors to cover gaps in the air monitoring network, especially in areas of concern for environmental justice.
- Minnesota’s air toxics network is concentrated in the Twin Cities and Duluth due to logistical challenges with transporting samples. Within those areas, the air toxics network is generally representative of the air quality experienced in different neighborhoods. MPCA is expanding its capacity to identify potentially problematic facilities contributing to poor air quality and conduct short-term air monitoring studies to determine if additional action is necessary in these areas.

Learn more about Minnesota’s air monitoring networks on [MPCA’s air monitoring webpage](#).

## Definitions

**Air toxics** – another name for hazardous air pollutants, a group of 188 specific pollutants that cause or may cause cancer or other serious health effects or adverse environmental and ecological effects.

**Ambient air** – outdoor air that is generally accessible to the public. Note that if the air is above land owned or controlled by the source of pollution and the public is prevented from going there, [EPA regulations exclude this air from ambient air](#). This could exclude indoor air, the air at the exit of a stack, or air within a facility’s property boundaries where public access is restricted.

**Attainment area** – an area where air pollution is below the limits in the NAAQS. Sometimes described as ‘meeting the NAAQS’, ‘in attainment’, or ‘in compliance with the NAAQS.’

**Criteria air pollutants** – six common pollutants known to cause harm to human health and the environment that are regulated by NAAQS: lead, ground-level ozone, particulate matter, nitrogen dioxide, sulfur dioxide, and carbon monoxide.

**Design value** – result of the calculation used to designate and classify nonattainment areas, as well as to assess progress toward meeting the NAAQS.

**Maintenance area** – an area that was previously in nonattainment but is now in attainment with the NAAQS and has ongoing requirements to prevent backsliding.

**NAAQS** – National Ambient Air Quality Standards, federal regulations that set limits on the amount of pollution in ambient air.

**Nonattainment area** – an area where air pollution is above the limits in the NAAQS.

**Primary standard** – limit on the amount of a pollutant in the ambient air that will protect human health, including the health of sensitive groups such as children, the elderly, and people with asthma.

**Secondary standard** – limit on the amount of a pollutant in the ambient air that will protect parts of the environment such as vegetation, crops, animals, buildings, and visibility.

**State implementation plan (SIP)** – a general plan to maintain the standards or a specific plan to attain the standards for each area designated nonattainment.