Air quality

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2025 Minnesota Air Monitoring Network Overview

2026 Minnesota Air Monitoring Network Plan

MINNESOTA POLLUTION CONTROL AGENCY

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Acronyms, abbreviations, and definitions

AIRNow – EPA website for air quality data
Air toxics – suite of parameters that includes VOCs, carbonyls, and metals
AQI – Air Quality Index
AQS – Air Quality System: EPA's repository of ambient air quality data
AmoN – Ammonia gas Network
CAA – Clean Air Act
CAS – Chemical Abstracts Service
CASTNET – Clean Air Status and Trends Network
CFR – Code of Federal Regulations
Class I area – remote area with pristine air quality
CO – carbon monoxide
Criteria pollutants – the six pollutants regulated by the 1970 Clean Air Act (particulate matter, ozone, nitrogen dioxide, sulfur dioxide, carbon monoxide, and lead)
CSN – Chemical Speciation Network
DNR – Department of Natural Resources
EPA – U.S. Environmental Protection Agency
FEM – Federal Equivalent Method
FRM – Federal Reference Method
H_2S – hydrogen sulfide
HAP – Hazardous Air Pollutant
Hg – mercury
IMPROVE – Interagency Monitoring of Protected Visual Environments
MAAQS – Minnesota Ambient Air Quality Standard(s)
MDH – Minnesota Department of Health
MDN – Mercury Deposition Network
MLN – Mercury Litterfall Network
MOA – Memorandum of Agreement
MPCA – Minnesota Pollution Control Agency
MSA – Metropolitan Statistical Area
NAAQS – National Ambient Air Quality Standard
NADP – National Atmospheric Deposition Program
NCore – National Core Monitoring Network
NDDN – National Dry Deposition Network
NO – nitric oxide
NO_2 – nitrogen dioxide
NO_x – oxides of nitrogen
NO_y – total reactive nitrogen
NTN – National Trends Network
O_3 – ozone
PAMS – Photochemical Assessment Monitoring Stations
PFAS – Per- and polyfluorinated compounds
PFN – PFAS network
Pb – lead
$PM_{2.5}$ – particulate matter less than 2.5 microns in diameter (fine particulate matter)
$PM_{10-2.5}$ – particulate matter between 2.5 and 10 microns in diameter (coarse particulate matter)
PM_{10} – particulate matter less than 10 microns in diameter
ppb – parts per billion by volume
ppm – parts per million by volume

PQAO – Primary Quality Assurance Organization
Primary Standard - NAAQS set to protect public health
QAPP – Quality Assurance Project Plans
QA/QC – Quality Assurance/Quality Control
QMP – Quality Management Plan
Secondary Standard - NAAQS set to protect the environment and public welfare (i.e. visibility, crops, animals, vegetation, and buildings)
SIP – State Implementation Plan
SLAMS – State and Local Air Monitoring Stations
SO_2 – sulfur dioxide
TRS – total reduced sulfur
TSP – total suspended particulate matter
U of M – University of Minnesota
USDA – United States Department of Agriculture
VOC – volatile organic compound

Introduction

The MPCA monitors outdoor air quality throughout Minnesota. The data collected by the MPCA are used for a variety of purposes including monitoring compliance with the National Ambient Air Quality Standard (NAAQS), public reporting of the Air Quality Index (AQI), air quality forecasting, assessing population exposure and risk, determining pollution trends, monitoring specific emissions sources, investigating background conditions, and evaluating computer models. Data are also used to address ways to reduce pollution levels.

More information including current air quality, forecasts, tools to explore data from our monitoring network, and this report can be found on our [Air quality webpage (https://www.pca.state.mn.us/air)](https://www.pca.state.mn.us/air).

1.Network overview

There are 62 sites for ambient air quality monitoring in Minnesota (Figure 1). This includes seven tribal sites, three Interagency Monitoring of Protected Visual Environments (IMPROVE) sites, two Chemical Speciation Network (CSN) sites, one national multi-pollutant monitoring (NCore) site, one ozone precursor measurements site (PAMS), and 10 National Atmospheric Deposition Program (NADP) sites. In addition to these sites, there is a network of industrial air quality monitors that are owned and operated by the specific industrial facility and adhere to their air permit requirements for monitoring ambient air.

Site location is partly dependent upon population density; therefore, most sites are in the Twin Cities metropolitan area. For the purposes of this report, any sites in the following seven counties considered the Twin Cities metropolitan area: Hennepin, Ramsey, Anoka, Washington, Dakota, Scott, and Carver. The area that lies outside the Twin Cities metropolitan area is commonly referred to as Greater Minnesota.

The maps included in this plan show sites labeled according to their AQS, NADP, or IMPROVE site identification numbers, in Greater Minnesota (Figure 1 and Table 1) and in the Twin Cities metropolitan area (Figure 2 and Table 2). Throughout the report, sites are referred to using the site name or the city where the site is located and the AQS, NADP, or IMPROVE site identification number.

Table 1. Site information for Greater Minnesota sites active in 2025

Site ID	City	Site name	Address/location	LAT	LONG	Year started
27-005-2013	Detroit Lakes	FWS Wetland Management District	26624 N Tower Rd	46.8499	-95.8463	2004
27-007-2304***	Red Lake	Red Lake Nation Hospital	24760 Hospital Drive	47.8782	-95.0292	2014
27-007-2305***	Red Lake	Red Lake Nation: DNR	15761 High School Drive	47.8796	-95.0166	2024
27-013-5510	Mankato	Rosa Parks Elementary	1001 Heron Drive	44.1364	-93.9813	2024
27-017-7417***	Cloquet	Fond du Lac Band	28 University Rd	46.7137	-92.5117	2015
27-021-3410***	Cass Lake	Leech Lake Nation: Cass Lake	200 Sailstar Dr	47.3844	-94.6016	2018
27-031-7810***	Grand Portage	Grand Portage Band	27 Store Rd	47.9701	-89.6910	2005
27-035-3204	Brainerd	Brainerd Lakes Regional Airport	16384 Airport Rd	46.3921	-94.1444	2004
27-049-5302	Stanton	Stanton Air Field	1235 Highway 19	44.4719	-93.0126	2003
27-075-0005 MN18* BOWA1**	Ely	Boundary Waters	Fernberg Rd	47.9466	-91.4956	1977
27-083-4210	Marshall	Southwest Minnesota Regional Airport	West Highway 19	44.4559	-95.8363	2004
27-095-3051***	Onamia	Mille Lacs Band	43408 Oodena Dr	46.2052	-93.7594	1997
27-109-5008	Rochester	Ben Franklin School	1801 9th Ave SE	43.9949	-92.4504	1997
27-109-xxxx	Rochester	Folwell School	603 15th Ave SW	TBD	TBD	2025
27-115-3061***	Hinckley	Lake Lena	63144 MN-48	46.0116	-92.4873	2024
27-137-0032	Duluth	Oneota Street	37th Ave W & Oneota St	46.7516	-92.1413	1985
27-137-0034 MN32* VOYA2**	International Falls	Voyageurs NP – Sullivan Bay	Voyageurs National Park - Sullivan Bay	48.4128	-92.8292	2000
27-137-7001	Virginia	Virginia City Hall	327 First St S	47.5212	-92.5393	1968
27-137-7550	Duluth	U of M – Duluth	1202 East University Circle	46.8182	-92.0894	1998
27-137-7554	Duluth	Laura MacArthur School	720 N Central Ave	46.7437	-92.1660	2012
27-137-7555	Duluth	Waseca Road	Waseca Industrial Rd	46.7306	-92.1634	2001
27-145-3052	Saint Cloud	Talahi School	1321 University Ave SE	45.5497	-94.1335	1998
27-169-9000 GRRI1**	Winona	Great River Bluffs	43605 Kipp Dr	43.9373	-91.4052	2002
27-171-3201	St. Michael	St. Michael Elementary School	101 Central Ave W	45.2092	-93.6690	2003
MN02*	Red Lake	Red Lake	State Hwy 1	47.8638	-94.8352	2015
MN06*	Not in a city	Leech Lake	Boy Lake Dr NE	47.1580	-94.1509	2014
MN08*	Hovland	Hovland	(open field)	47.8472	-89.9625	1996
MN16*	Balsam Lake	Marcell Experimental Forest	Marcell Experimental Forest	47.5311	-93.4686	1978
MN23*	Pillager	Camp Ripley	(open field)	46.2494	-94.4972	1983
MN27*	Lamberton	Lamberton	U of M SW Agricultural Research and Outreach Center	44.2369	-95.3010	1979
MN99*	Finland	Wolf Ridge	6282 Cranberry Rd	47.3875	-91.1958	1996

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

Figure 1. 2025 air quality monitoring sites in Greater Minnesota

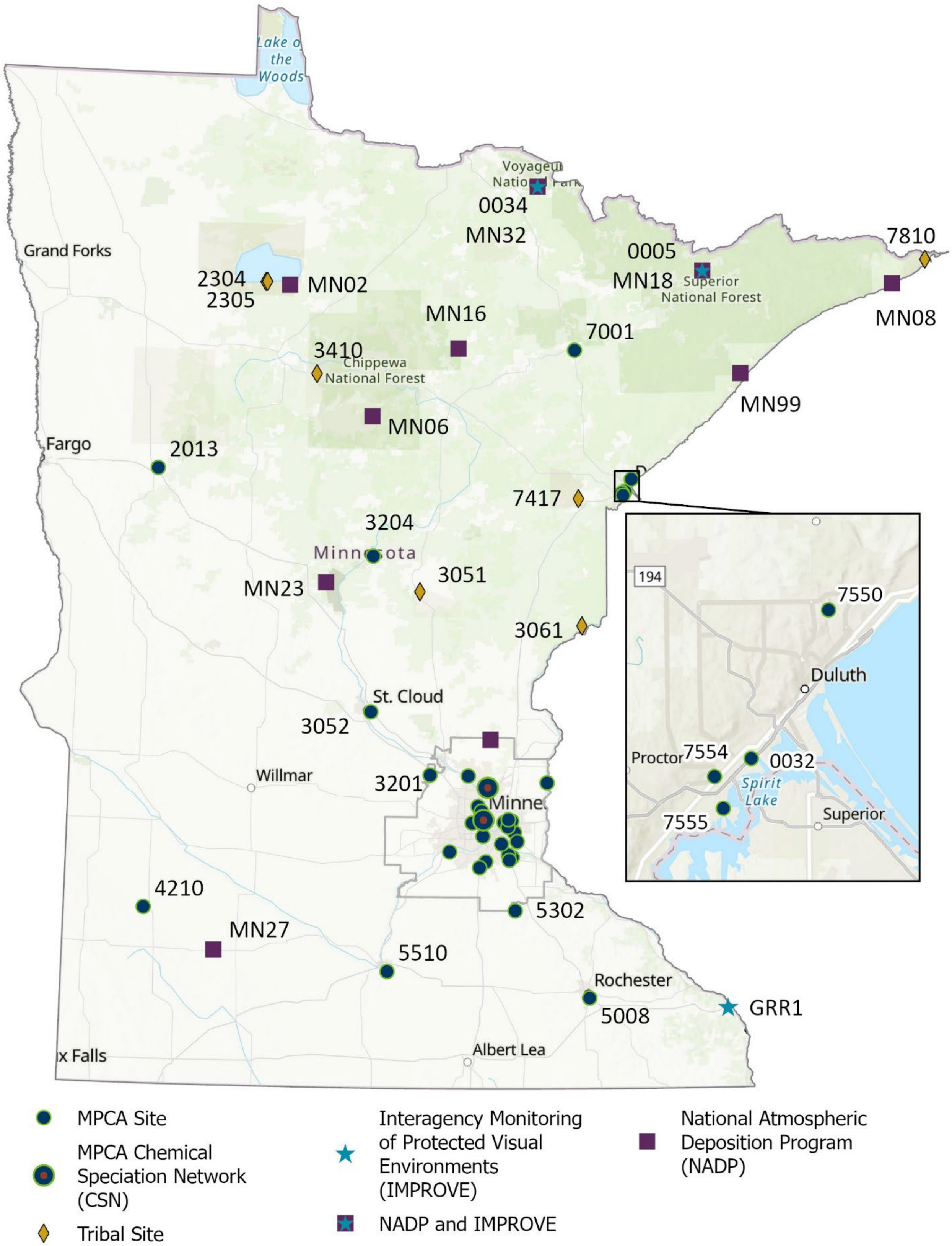
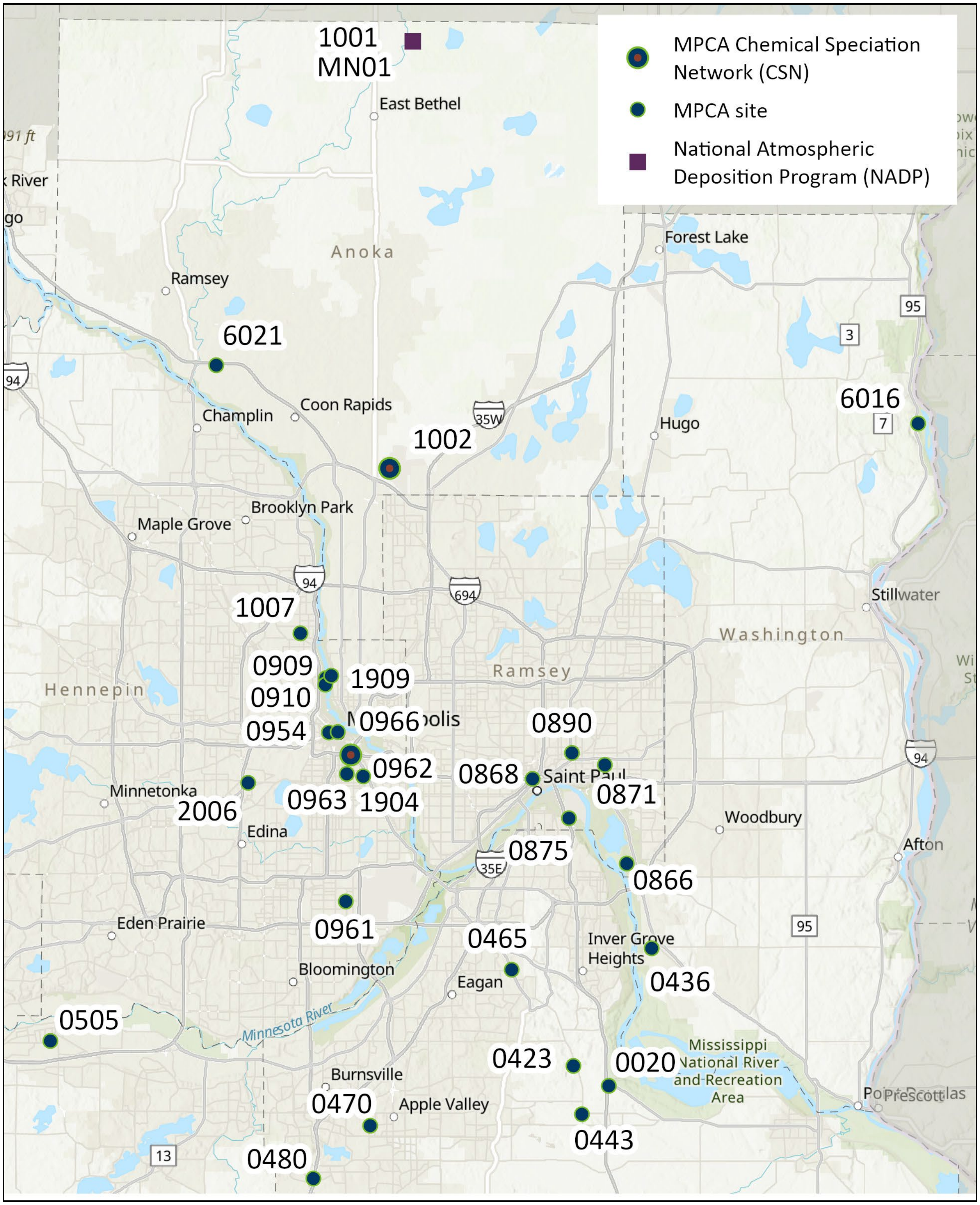


Table 2. Site information for Twin Cities metropolitan area sites active in 2025

Site ID	City	Site name	Address	LAT	LONG	Year started
27-003-1001 MN01*	East Bethel	U of M - Cedar Creek	2660 Fawn Lake Drive NE	45.4018	-93.2031	1979
27-003-1002**	Blaine	Anoka County Airport	South End of Lima St.	45.1407	-93.2220	1979
27-003-6021	Anoka	Federal Ammunition 6021	900 Bob Ehlen Dr	45.2035	-93.3723	2022
27-037-0020	Rosemount	Flint Hills Refinery 420	12821 Pine Bend Tr	44.7632	-93.0325	1972
27-037-0423	Rosemount	Flint Hills Refinery 423	2142 120th St E	44.7730	-93.0627	1990
27-037-0443	Rosemount	Flint Hills Refinery 443	14035 Blaine Ave E	44.7459	-93.0554	2008
27-037-0465	Eagan	Gopher Resources	Hwy 149 & Yankee Doodle Rd	44.8343	-93.1163	2006
27-037-0470	Apple Valley	Westview School	225 Garden View Dr	44.7387	-93.2373	2000
27-037-0480	Lakeville	Near Road I-35	16750 Kenyon Ave	44.7061	-93.2858	2015
27-053-0909	Minneapolis	Lowry Avenue	3104 N Pacific St	45.0121	-93.2767	2013
27-053-0910	Minneapolis	Pacific Street	2710 N Pacific St	45.0083	-93.2770	2015
27-053-xxxx	Minneapolis	Minneapolis Public School Maintenance	1225 N 7th St	TBD	TBD	2025
27-053-0954	Minneapolis	Arts Center	528 Hennepin Ave	44.9790	-93.2737	1989
27-053-0961	Richfield	Richfield Intermediate School	7020 12th Ave S	44.8756	-93.2588	1999
27-053-0962	Minneapolis	Near Road I-35/I-94	1444 18th St E	44.9652	-93.2548	2013
27-053-0963	Minneapolis	Andersen School	2727 10th Ave S	44.9535	-93.2583	2001
27-053-0966	Minneapolis	City of Lakes Building	309 2nd Ave S	44.9793	-93.2611	2002
27-053-1007	Minneapolis	Humboldt Avenue	4646 N Humboldt Ave	45.0397	-93.2987	1966
27-053-1904	Minneapolis	East Phillips Community	1860 E 28th St.	45.9521	-93.2443	2024
27-053-1909	Minneapolis	Bottineau / Marshall Terrace	2522 Marshall St NE	45.0136	-93.2721	2017
27-053-2006	St Louis Park	St. Louis Park City Hall	5005 Minnetonka Blvd	44.9481	-93.3429	1972
27-123-0866	St. Paul	Red Rock Road	1450 Red Rock Rd	44.8994	-93.0171	1997
27-123-0868	St. Paul	Ramsey Health Center	555 Cedar St	44.9507	-93.0985	1998
27-123-0871	St. Paul	Harding High School	1540 East 6th St	44.9593	-93.0359	1998
27-123-0875	St. Paul	West Side	515 Concord St	44.9271	-93.0671	2020
27-123-0890	St. Paul	Northern Iron	842 Mendota St.	44.9667	-93.0642	2024
27-123-xxxx	St. Paul	St. Paul Brass	911 Lafond Ave	TBD	TBD	2025
27-139-0505	Shakopee	B.F. Pearson School	917 Dakota St	44.7894	-93.5125	2000
27-163-xxxx	Newport	City of Newport	2060 1st Ave	TBD	TBD	2025
27-163-0436	St. Paul Park	St. Paul Park Refinery 436	649 5th St	44.8473	-92.9956	1989
27-163-6016	Marine on St. Croix	St. Croix Watershed Research Station	St. Croix Trail N	45.1680	-92.7651	2012

*NADP Site ID ** NCore site

Figure 2. 2025 air quality monitoring sites in the Twin Cities metropolitan area



1.1 Minimum monitoring requirements

The EPA establishes the minimum number of monitoring sites required to meet national ambient monitoring objectives. The minimum monitoring requirements are codified in Appendix D of 40 CFR Part 58. Minimum monitoring requirements are specific to each individual pollutant (e.g. ozone, $PM_{2.5}$) or are objective-based monitoring networks (e.g. NCore, PAMs). Minimum monitoring requirements typically rely on population and/or air pollution emissions data. Minnesota currently meets all minimum air monitoring requirements. Appendix B provides a detailed description of these requirements.

1.2 Monitoring objectives

When designing an air monitoring network, one of the following six objectives should be considered:

1. Highest concentrations expected to occur in the area covered by the network
2. Representative concentrations in areas of high population density
3. Impact of specific sources on ambient pollutant concentrations
4. General background concentration levels
5. Extent of regional transport among populated areas and in support of secondary standards
6. Welfare-related impacts in the more rural and remote areas

1.3 Site selection

The selection of air monitoring sites is usually based on at least one of the following objectives:

- Determining representative concentrations and exposure in areas of high population density
- Determining highest concentrations in an area based on topography and/or wind patterns
- Judging compliance with and/or progress made towards meeting the NAAQS and MAAQS
- Tracking pollution trends
- Determining the highest concentrations of pollutants within the state based on the known atmospheric chemistry of specific pollutants and wind patterns
- Determining the extent of regional pollutant transport to and from populated areas
- Determining to what extent major sources impact ambient pollution levels
- Validating control strategies designed to prevent or alleviate air pollution
- Providing a database for research and evaluation of air pollution effects
- Determining general background concentration levels

The exact location of a site is most often dependent on the logistics of the area chosen for monitoring, such as site access, security, and power availability.

1.4 Network scales

The EPA developed a system which specifies an exclusive area, or spatial scale, that an air monitor represents. The goal in establishing air monitoring sites is to correctly match the spatial scale that is most appropriate for the monitoring objective of the site (Table 3). The representative measurement scales are:

- **Micro Scale (10-100 m)** – defines the concentrations in air volumes associated with area dimensions ranging from several meters up to about 100 meters. Measurements on the micro scale typically include concentrations in street canyons, intersections, and in areas next to major emission sources.

- **Middle Scale (100-1,000 m)** – defines the concentration typical of areas up to several city blocks in size, with dimensions ranging from about 100 to 1,000 meters.
- **Neighborhood Scale (1-4 km)** – defines concentrations within some extended area of the city that has relatively uniform land use with dimensions in the one to four kilometers range. Generally, these stations represent areas with moderate to high population densities.
- **Urban Scale (4-50 km)** – defines the overall, citywide conditions with dimensions on the order of 4 to 50 kilometers. This scale represents conditions over an entire metropolitan area, and is useful in assessing citywide trends in air quality.
- **Regional Scale/Background (50-1,000 km)** – usually represents a rural area of reasonably homogeneous geography and extends from tens to hundreds of kilometers.
- **National/Global** – concentrations characterizing the nation and the globe as a whole.

Table 3. Monitoring objectives and appropriate siting scales.

Monitoring objective	Appropriate siting scales
Highest concentration	Micro, Middle, Neighborhood (sometimes Urban)
Population exposure	Neighborhood, Urban
Source impact	Micro, Middle, Neighborhood
General/Background	Urban, Regional (sometimes Neighborhood)
Regional transport	Urban, Regional
Welfare – related	Urban, Regional

2. Quality Assurance/Quality Control program

The purpose of the Quality Assurance/Quality Control (QA/QC) program is to assure the quality of data obtained from the MPCA air monitoring network. The MPCA meets or exceeds the QA requirements defined in 40 CFR Part 58 and all applicable appendices.

The QA/QC program includes, but is not limited to, the following activities:

- Instrument performance audits
- Monitor siting evaluations
- Precision and span checks
- Flow rate audits
- Leak checks
- Data validation
- Bias determinations

For independent quality assurance activities, the MPCA participates in the National Performance Audit Program and the Performance Evaluation Program for criteria pollutant monitoring. Additional proficiency tests are performed periodically for air toxics monitoring.

As the Primary Quality Assurance Organization (PQAO) for ambient air monitoring activities in Minnesota, the MPCA operates under an EPA-approved Quality Management Plan (QMP) and utilizes Quality Assurance Project Plans (QAPP) for each statewide monitoring network. The primary purpose of the QAPP is to provide an overview of the project, describe the need for the measurements, and define

QA/QC activities that apply to the project. All other ambient air monitoring initiatives including state, tribal, and industrial projects must have an MPCA-approved monitoring plan for each specific project.

As part of the instrument performance audit, each monitoring site is assessed to ensure that all applicable EPA siting requirements are fully met. This also includes a safety inspection to assure a safe work environment for site operators and staff.

To meet the minimum monitoring requirements for the Minneapolis-St. Paul MN-WI Metropolitan Statistical Area (MSA) and the Lacrosse-Onalaska MN-WI MSA, the MPCA and Wisconsin Department of Natural Resources (DNR) Bureau of Air Management entered into a Memorandum of Agreement (MOA) in January 2011. The MOA formalized the collective agreement between the two States per requirements of 40 CFR Part 58 Appendix D, Section 2(e). The MPCA worked with Wisconsin DNR to update the MOA in 2020. The MPCA reconfirmed with the Wisconsin DNR that all monitoring requirements are currently being met. An updated MOA is included with this Network Plan.

3. National air monitoring networks

Air monitoring networks are designed to satisfy a variety of purposes, including monitoring compliance with the NAAQS, public reporting of the Air Quality Index (AQI), assessing population exposure and risk from air toxics, determining pollution trends, monitoring specific emissions sources, investigating background conditions, and evaluating computer models. Below are descriptions of the existing monitoring networks in Minnesota.

3.1 State and Local Air Monitoring Stations (SLAMS)

The SLAMS network consists of about 3,500 monitoring sites across the United States. Size and distribution of the sites are largely determined by the needs of state and local air pollution control agencies to meet their respective State Implementation Plan (SIP) requirements and monitoring objectives. Most monitoring sites in Minnesota are part of the SLAMS network. Sites in the SLAMS network may also belong to other monitoring networks, as described below.

3.2 Chemical Speciation Network (CSN)

The CSN network is an EPA effort to gather data on the chemical composition of urban $PM_{2.5}$ and to provide a basic, long-term record of the concentration levels of selected ions, metals, carbon species, and organic compounds found in $PM_{2.5}$. The EPA established this network, which consists of approximately 150 monitoring sites nationwide. CSN data can be useful for assessing trends and developing mitigation strategies to reduce emissions and ambient pollutant concentrations.

The programmatic objectives of the CSN network are:

- Temporal and spatial characterization of aerosols
- Air quality trends analysis and tracking progress of control programs
- Comparison of the urban chemical speciation data set to the rural data collected from the IMPROVE network
- Development of emission control strategies

There are currently two CSN sites in Minnesota, located at the Andersen School (0963) in Minneapolis and at the NCore site in Blaine (1002).

3.3 Interagency Monitoring of Protected Visual Environments (IMPROVE)

The IMPROVE Aerosol Network is a cooperative air quality monitoring effort managed by the IMPROVE Steering Committee with representation from EPA, the National Park Service, U.S. Forest Service, U.S. Fish and Wildlife Service, Bureau of Land Management, the National Oceanic and Atmospheric Administration, several Multi-Jurisdictional Organizations that represent US States, and Arizona DEQ. This program was established in 1985 in response to the 1977 CAA Amendments to aid in developing Federal and State implementation plans for the protection of visibility in Class I areas. Class I areas are national parks overseen by the U.S. Department of the Interior (USDOI) and national forests and wilderness areas overseen by the U.S. Department of Agriculture (USDA). The IMPROVE network comprises 158 monitoring sites network-wide, 110 of which represent visibility conditions in 155 Mandatory Class I areas in the U.S. and Virgin Islands. The remaining monitors, separately sponsored by state, regional, tribal and national organizations, do not represent Mandatory Class I areas but expand the spatial coverage for the network.

The objectives of the IMPROVE network are:

- To establish current visibility and aerosol conditions in Class I areas
- To identify chemical species and emission sources responsible for existing man-made visibility impairment
- To document long-term trends for assessing progress towards the national visibility goal
- To, in conjunction with the enactment of the Regional Haze Rule, provide regional haze monitoring that is representative of all visibility-protected Class I areas (where practical)

The IMPROVE monitors collect $PM_{2.5}$ speciation data. They are a key component of the EPA's national fine particle monitoring network and are critical to tracking progress related to the Regional Haze Regulations. Minnesota has three IMPROVE Aerosol Network sites shown in Figure 1. The sites are located at Voyageurs National Park (0034/VOYA2, USDOI), the Boundary Waters Canoe Area Wilderness near Ely (0005/BOWA1, USDA), and Great River Bluffs State Park (9000/GRRI1, Minnesota Department of Natural Resources).

3.4 National Air Toxics Trends Stations (NATTS)

The purpose of EPA's National Air Toxics Trends Stations (NATTS) network is to track trends in ambient air toxics levels to facilitate measuring progress toward emission and risk reduction goals. It consists of 27 sites across the U.S. that were established between 2003 and 2008.

There are no NATTS sites in Minnesota; however, we refer to EPA's guidance for the NATTS program for our air toxics sampling, laboratory analyses, data validation, and AQS submittals. To find more information on the NATTS program, visit the EPA's Air Toxics Ambient Monitoring webpage (https://www.epa.gov/amtic/air-toxics-ambient-monitoring#natts).

3.5 National Core monitoring (NCore)

In October 2006, the EPA established the National Core (NCore) multi-pollutant monitoring network in its final amendments to the ambient air monitoring regulations for criteria pollutants (codified in 40 CFR Parts 53 and 58). EPA requires each state to have at least one NCore site; there are approximately 75 sites nationwide, mostly in urban areas.

Each site in the NCore monitoring network addresses the following monitoring objectives:

- Report data on a timely schedule to the public through [the AIRNow data reporting website (https://www.airnow.gov/)](https://www.airnow.gov/)
- Air quality forecasting
- Other public reporting mechanisms
- Support the development of emission strategies through air quality model evaluation and other observational methods
- Track long-term trends of criteria and non-criteria pollutants and their precursors for the accountability of emission strategy progress
- Establish nonattainment/attainment areas via comparison and compliance with the NAAQS
- Support scientific studies ranging across technological, health, and atmospheric process disciplines; support long-term health assessments that contribute to ongoing reviews of the NAAQS
- Support ecosystem assessments, recognizing that national air quality networks benefit ecosystem assessments and, in turn, benefit from data specifically designed to address ecosystem analysis

Each NCore site must measure a minimum number of parameters (Table 4).

Table 4. NCore monitoring network site parameters.

Parameter	Comments
$PM_{2.5}$ speciation	Organic and elemental carbon, major ions and trace metals (24 hour average; every 3rd day)
$PM_{2.5}$ FRM mass	24 hr. average at least every 3rd day
Continuous $PM_{2.5}$ mass	1 hour reporting interval; FEM or pre-FEM monitors
$PM_{(10-2.5)}$ mass	Filter-based or continuous
Ozone (O_3)	All gases through continuous monitors
Carbon monoxide (CO)	Capable of trace levels (low ppm and below) where needed
Sulfur dioxide (SO_2)	Capable of trace levels (low ppm and below) where needed
Nitrogen Oxide (NO)	Capable of trace levels (low ppb and below) where needed
Total reactive nitrogen (NO/NO_y)	Capable of trace levels (low ppb and below) where needed
Surface meteorology	Wind speed and direction (reported as "Resultant"), temperature, RH

NCore sites monitor data for multiple parameters because numerous chemical and physical interactions among other pollutants underlie the formation of particulates and ozone, and the formation and destruction of one can influence the creation of the others. Multi-pollutant monitoring benefits health studies, long-term epidemiological studies, source apportionment studies, and air quality modeling.

The MPCA has an NCore site at the Anoka County Airport in Blaine (1002). The Anoka County Airport monitoring station is located approximately 11 miles north of downtown Minneapolis and approximately 15 miles northwest of downtown St. Paul. The site includes monitors for trace-level CO, SO_2, nitrogen oxide (NO), and total reactive nitrogen (NO_y). These pollutants are the predominant inorganic products of combustion, and are the most abundant inorganic elements in the atmosphere. Emissions reductions, mainly from power plants and motor vehicles, have lowered the concentrations of these pollutants in most urban and rural areas; they are precursor gases, however, and they continue to play an important role in the formation of ozone, particulate matter, and air toxics at both local and regional scales. The trace-level data that this site provides helps us understand the role of these pollutants in the environment at levels far below the NAAQS.

3.6 National Atmospheric Deposition Program (NADP)

Atmospheric deposition is monitored through the NADP Program at about 300 sites, spanning the continental United States, Alaska, Hawaii, Puerto Rico, and the Virgin Islands. More information can be found at the [National Atmospheric Deposition Program website (http://nadp.slh.wisc.edu/).](http://nadp.slh.wisc.edu/) There are five sub-networks in Minnesota: the National Trends Network (NTN), the Mercury Deposition Network (MDN), Mercury Litterfall Network (MLN), Ammonia Monitoring Network (AMoN) and an NTN sub-network for per- and polyfluorinated compounds (PFN) that began in 2024. Each site contains one to several networks (Table 5). See Section 9 for more information on each network in Minnesota.

Table 5. NADP site networks

NADP Site ID	County name	Site name	NTN	MDN	MLN	AMoN	PFN
MN01	Anoka	Cedar Creek	X				
MN02	Beltrami	Red Lake			X	X	
MN06	Cass	Leech Lake		X			
MN08	Cook	Hovland	X				X
MN16	Itasca	Marcell Experimental Forest	X	X	X		X
MN18	Lake	Fernberg	X	X		X	X
MN23	Morrison	Camp Ripley	X	X			X
MN27	Redwood	Lamberton	X	X			
MN32	St Louis	Voyageurs	X				
MN99	Lake	Wolf Ridge	X				X

3.7 Near road monitoring

Air pollution can be higher close to roadways. The purpose of the near-road network is to measure air pollution levels near heavily trafficked roadways. Near-road air monitoring sites are required to be located within 150 feet of the busiest roadways across the country. At a minimum, near-road monitoring sites are required to measure hourly levels of nitrogen dioxide (NO_2), carbon monoxide (CO), and fine particles ($PM_{2.5}$).

There are two near-road monitoring sites in Minnesota. Minneapolis (0962) is along the I-94 and I-35W freeway commons near downtown Minneapolis. Lakeville (0480) is along I-35, about 20 miles south of the downtowns of Minneapolis and St. Paul. Various parameters are being measured at each of the near-road sites (Table 6).

Table 6. Near-road monitoring parameters.

MPCA Site ID	City name	Site name				$PM_{2.5}$ FEM	TSP and Metals		O_3	NO_x	CO	VOCs	Carbonyls	Other parameters
0962	Minneapolis	Near Road I35/I94	X	X	X	X	X	X	X	Meteorological Data				
0480	Lakeville	Near Road I35	X			X	X			Meteorological Data				

3.8 Photochemical Assessment Monitoring Stations (PAMS)

The PAMS network provides enhanced monitoring of ozone, NO_2, volatile organic compounds (VOCs), and selected carbonyl compounds in ambient air along with monitoring of various meteorological parameters. This is done in order to obtain more comprehensive and representative data on ozone and its precursors. The primary data objectives of the PAMS network include:

- Providing a speciated ambient air database that is both representative and useful in evaluating control strategies and understanding the mechanisms of pollutant transport by ascertaining ambient profiles and distinguishing among various individual VOCs.
- Providing local, current meteorological and ambient data to serve as initial and boundary condition information for photochemical grid models.
- Providing a representative, speciated ambient air database that is characteristic of source emission impacts to be used in analyzing emissions inventory issues and corroborating progress toward attainment.
- Providing ambient data measurements that would allow later preparation of unadjusted and adjusted pollutant trends reports.
- Providing additional measurements of selected criteria pollutants for attainment/nonattainment decisions and to construct NAAQS maintenance plans.
- Providing additional measurements of selected criteria and non-criteria pollutants to be used for evaluating population exposure to air toxics as well as criteria pollutants.

MPCA started taking PAMS measurements at the Blaine NCore location (27-003-1002) on June 1, 2021. Table 7 includes sampling schedules and instruments for each PAMS parameter.

Table 7: PAMS sampling schedules and instrumentation.

Parameter	Duration/Frequency	Sampling schedule	Instrument
Ozone	hourly averages	Year-round	Teledyne T400 series
Wind direction	hourly averages	Year-round	RM Young 200-05103-45 Alpine Wind Monitor
Wind speed	hourly averages	Year-round	RM Young 200-05103-45 Alpine Wind Monitor
Ambient temperature	hourly averages	Year-round	R.M. Young 41382 Temp/RH sensor
Atmospheric pressure	hourly averages	Year-round	R.M. Young 61402 BP sensor
Relative humidity (RH)	hourly averages	Year-round	R.M. Young 41382 Temp/RH sensor
Speciated VOCs	hourly averages	May 1 – August 31	CAS/Chromatatec Auto GC
Carbonyls	three sequential 8-hour samples on a 1-in-3 day schedule	June 1 – August 31	ATEC 8000 cartridge sampler
"True" nitrogen dioxide (NO_2)	hourly averages	June 1 – August 31	Teledyne T500U
Precipitation amount	hourly averages	June 1 – August 31	MetOne 370D
Mixing layer height (MLH)	hourly averages	June 1 – August 31	Vaisala CL51
Intensity of solar radiation	hourly averages	June 1 – August 31	Kipp & Zonen SMP10 pyranometer
Intensity of ultraviolet (UV) radiation	hourly averages	June 1 – August 31	Kipp & Zonen SUV5 UV Radiometer

3.9 Clean Air Status and Trends Network (CASTNET)

CASTNET provides long-term monitoring of air quality in rural areas to determine trends in regional atmospheric nitrogen, sulfur, and ozone concentrations, and deposition fluxes of sulfur and nitrogen pollutants. The objective of the CASTNET network is to evaluate the effectiveness of national and regional air pollution control programs. CASTNET began collecting measurements in 1991 with the incorporation of 50 sites from the National Dry Deposition Network (NDDN), which had been in operation since 1987. CASTNET operates more than 80 regional sites throughout the contiguous United States, Alaska, and Canada. Sites are located in areas where urban influences are minimal. To learn more about CASTNET, visit the [EPA's CASTNET webpage (https://www.epa.gov/castnet).](https://www.epa.gov/castnet)

There are two CASTNET sites in Minnesota. One site, located at Voyageurs National Park (VOYA2), is operated by the National Park Service. The other, in Red Lake (2304), is operated by the Red Lake Nation (Figure 1). The MPCA does not have any role in these CASTNET sites.

4. Air Quality Standards

The Clean Air Act (CAA), last amended in 1990, requires EPA to set National Ambient Air Quality Standards (NAAQS) for six principal pollutants that are harmful to public health and the environment. These pollutants are called criteria pollutants because there are specific criteria for collecting and analyzing data laid out in the Code of Federal Regulations (CFR). The criteria pollutants are particulate matter (currently $PM_{2.5}$ and PM_{10}), lead (Pb), ozone (O_3), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and carbon monoxide (CO).

The CAA identifies two types of NAAQS. Primary standards provide public health protection, including protecting the health of "sensitive" populations such as asthmatics, children, and the elderly. Secondary standards provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings. Periodically, the standards are reviewed and sometimes may be revised, establishing new standards. The 2024 Ambient Air Monitoring Data Report contains details about current NAAQS and shows how Minnesota monitoring data compare to them.

Minnesota has also established standards for ambient air quality, called Minnesota Ambient Air Quality Standards (MAAQS). There are MAAQS for all criteria pollutants as well as additional pollutants that are not covered by NAAQS. Table 8 shows the number of primary and secondary NAAQS and MAAQS there are for each pollutant.

Table 8: Number of national and state standards for monitored pollutants

Pollutant	NAAQS Primary	NAAQS Secondary	MAAQS Primary	MAAQS Secondary
PM_{10}	1	1	1	1
$PM_{2.5}$	2	2	2	2
Lead	1	1	1	1
Ozone	1	1	1	1
Nitrogen Dioxide	2	1	2	1
Sulfur Dioxide	1	1	3	1
Carbon Monoxide	2	0	2	0
TSP	0	0	2	2
H_2S	0	0	2	0

Other pollutants, such as air toxics, do not have national or state standards but have been shown to cause adverse health or environmental effects. Measured concentrations of these pollutants are compared to health benchmarks established by various organizations such as the Minnesota Department of Health and the US EPA.

5. Criteria Pollutants

Criteria pollutants include particulate matter (currently $PM_{2.5}$ and PM_{10}), lead (Pb), ozone (O_3), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and carbon monoxide (CO). Figures 3 and 4 show criteria pollutant monitoring locations in Minnesota in 2025.

Figure 3. Statewide criteria pollutant map

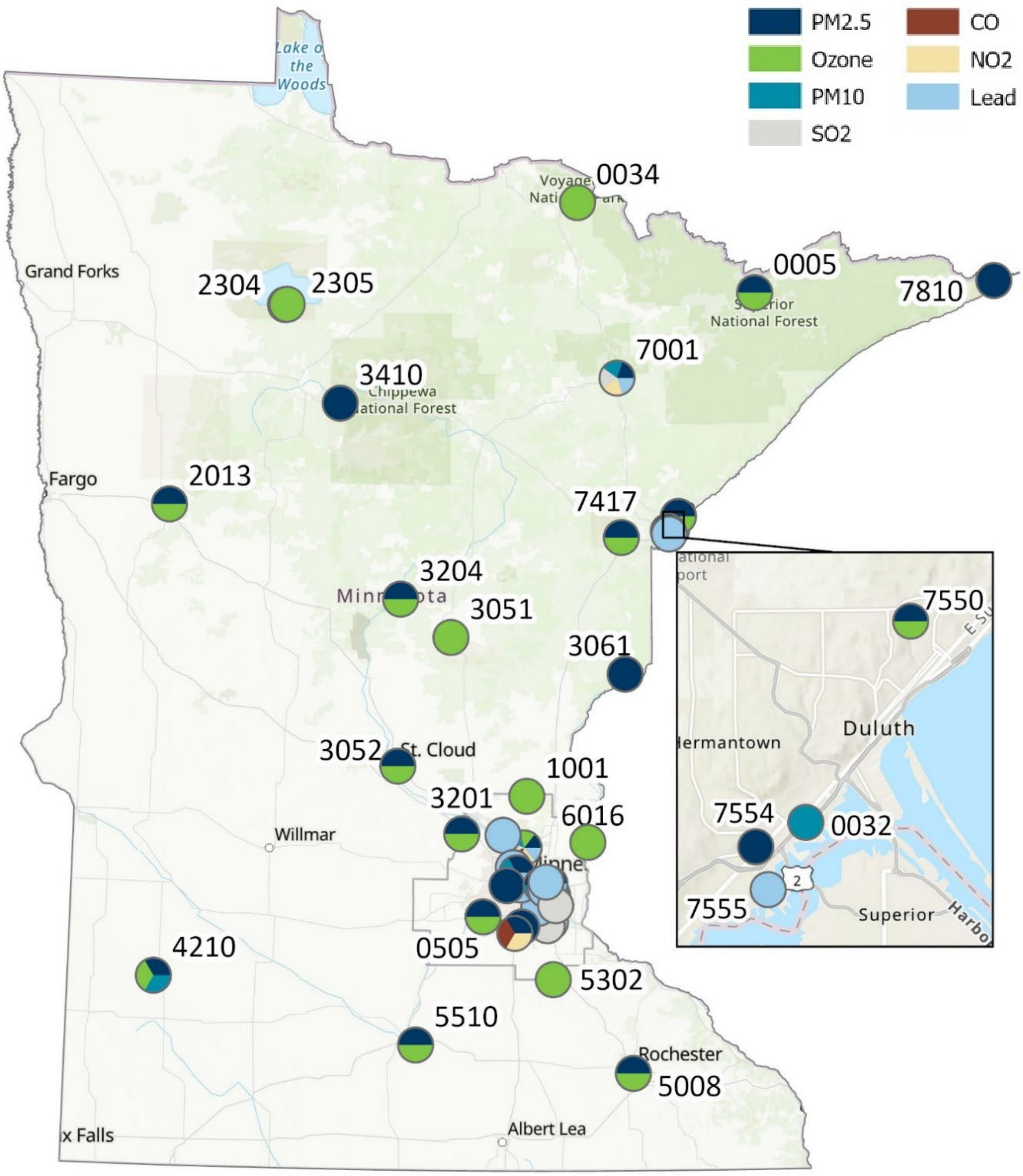
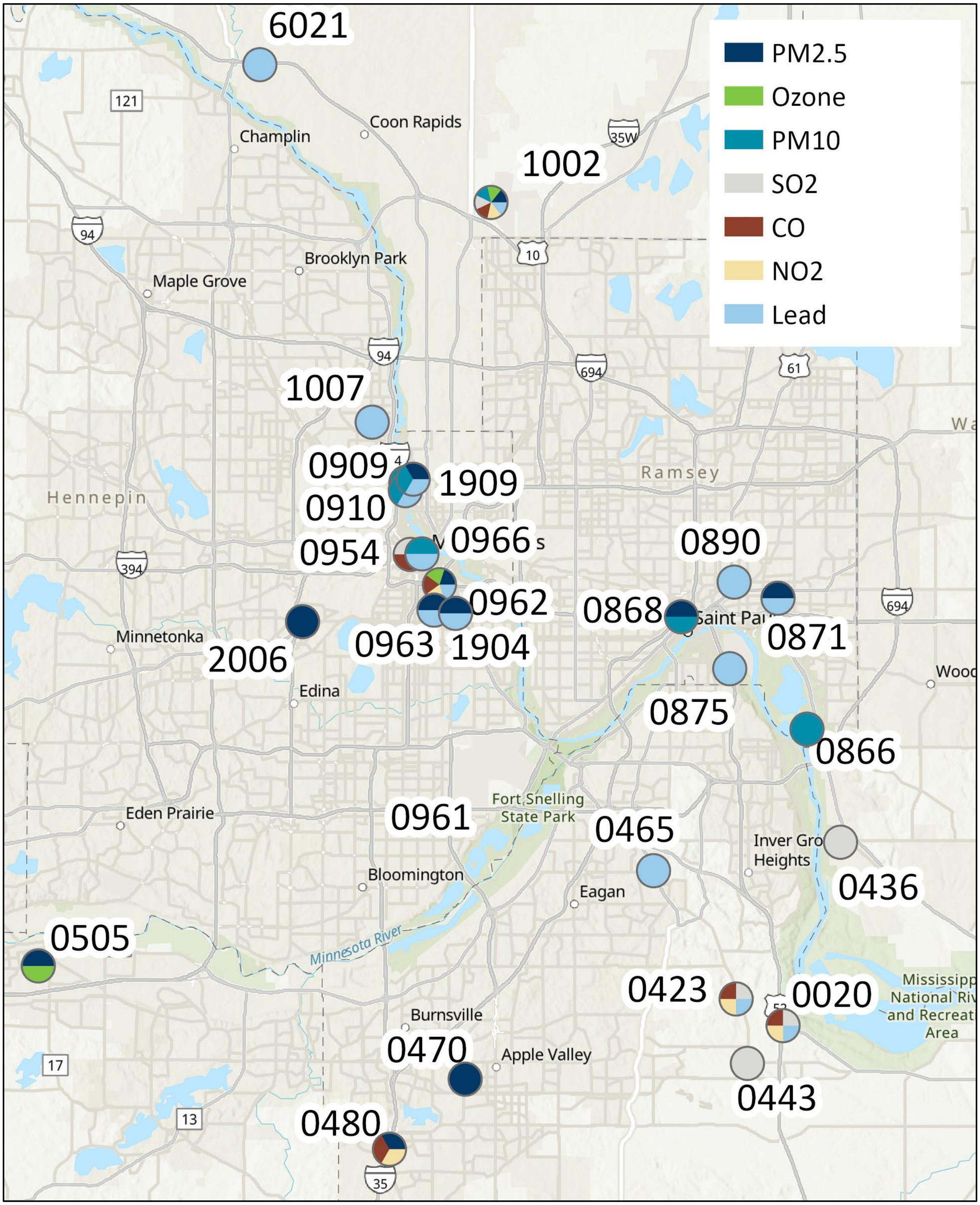


Figure 4. Twin cities metropolitan area criteria pollutant map



5.1 PM_{10}

PM_{10} includes all particulate matter with an aerodynamic diameter equal to or less than 10 microns. Most particles form in the atmosphere as a result of complex reactions of chemicals such as sulfur dioxide and nitrogen oxides, which are pollutants emitted from power plants, industries, and automobiles. These particles can be made up of hundreds of different chemicals. Some are emitted directly from a source, such as construction sites, unpaved roads, fields, smokestacks or fires.

Particulate matter contains microscopic solids or liquid droplets that are so small that they can be inhaled and cause serious health problems. Particles less than 10 micrometers in diameter can get deep into your lungs and some may even get into your bloodstream. Short-term exposure to PM_{10} is linked to hospitalization, even premature death, in people with heart or lung disease. Decreased lung function and increased respiratory symptoms in children are also associated with PM_{10} exposure.

5.2 $PM_{2.5}$

$PM_{2.5}$, also referred to as fine particles, is the fraction of particles with an aerodynamic diameter less than or equal to 2.5 microns. Of all particle sizes, fine particles pose the greatest risk to health. They are a chemically and physically diverse mixture of very small particles that can be inhaled deeply into the lungs. They are comprised of a complex blend of chemicals including ammonium sulfate, ammonium nitrate, particle-bound water, elemental carbon, organic compounds, and inorganic material, including soil and metals.

Elevated concentrations of $PM_{2.5}$ are associated with a rise in heart attacks, acute and chronic bronchitis, asthma attacks, and respiratory symptoms. In children, reduced lung function, growth, and increased respiratory illness are also associated with elevated $PM_{2.5}$ concentrations. Two types of $PM_{2.5}$ monitors are operated in Minnesota: filter-based Federal Reference Method (FRM) and Continuous Federal Equivalent Method (FEM). Monitors classified as FRM or FEM are regulatory-grade monitors that collect total $PM_{2.5}$ and can be used to demonstrate compliance with the $PM_{2.5}$ NAAQS.

The FRM $PM_{2.5}$ monitors collect a 24-hour mass sample of $PM_{2.5}$ once every three days. The FEM $PM_{2.5}$ monitors are continuous mass monitors that collect and report hourly $PM_{2.5}$ concentrations. Hourly $PM_{2.5}$ data are also used to calculate the AQI and develop AQI forecasts for Minnesota. Continuous data are reported to the MPCA's [AQI website (www.pca.state.mn.us/aqi)](www.pca.state.mn.us/aqi) and the EPA's [AIRNow website (https://www.airnow.gov/)](https://www.airnow.gov/), as well as the Air Quality System (AQS).

Total suspended particulate (TSP), coarse particulate matter ($PM_{10} – PM_{2.5}$) and $PM_{2.5}$ speciated data are also collected in Minnesota. They are described in Sections 7.1, 7.2 and 7.3 of this document, respectively.

5.3 Lead (Pb)

Lead (Pb) is a metal that is found naturally in the environment, as well as in manufactured products. Lead emitted into the air can be inhaled directly or can be ingested after it settles onto surfaces or soils.

Scientific evidence about the health effects of lead has expanded significantly in the last 40 years. Once taken into the body, lead distributes throughout the body in the blood and is accumulated in the bones. Depending on the level of exposure, lead can adversely affect the nervous system, kidney function, immune system, reproductive and developmental systems and the cardiovascular system. Lead exposure also affects the oxygen carrying capacity of the blood. The lead effects most likely to be encountered in current populations are neurological effects in children. Infants and young children are especially sensitive to lead exposures, which my contribute to behavioral problems, learning deficits and lowered IQ. Elevated levels are also detrimental to animals and to the environment. Ecosystems near sources show many adverse effects including losses in biodiversity, changes in community composition, decreased growth and reproductive rates in plants and animals, and neurological effects in animals. After lead was removed from gasoline, air emissions and ambient air concentrations decreased dramatically. Today, sources of lead emissions vary from one area to another. At the national level, major sources of lead in the air are ore and metals processing and piston-engine aircraft operating on leaded aviation fuel. The highest air concentrations of lead are usually found near lead smelters. Other sources are waste incinerators, utilities, and lead-acid battery manufacturers.

5.4 Ozone (O_3)

Ozone is an odorless, colorless gas composed of three oxygen atoms. Ground-level ozone is not emitted directly into the air but is created through a reaction of NOx and VOCs in the presence of sunlight. Ground-level ozone is a secondary pollutant formed through chemical reactions between nitrogen oxides and volatile organic compounds, and a criteria pollutant regulated under the federal Clean Air Act. Ozone in the air we breathe can harm our health, especially on hot sunny days when ozone can reach unhealthy levels. People at greatest risk of harm from breathing air containing ozone include people with asthma.

As ozone formation requires high temperatures and sunny conditions, the EPA only requires Minnesota to monitor ozone seasonally. The ozone monitoring season runs from March 1 through October 31 each year. The NCore site in Blaine (1002), at which ozone is monitored year-round, is the only exception to the seasonal monitoring schedule in Minnesota. Additional ozone monitors may periodically operate year-round to support modeling or research. The data collected from ozone monitors are used to determine compliance with the NAAQS and are reported as part of the AQI.

Breathing air containing ozone can reduce lung function and inflame airways, which may, in turn, increase respiratory symptoms and aggravate asthma or other lung diseases. Ozone exposure has also been associated with increased susceptibility to respiratory infections, medication use, doctor and emergency department visits, and hospital admissions for individuals with lung disease. Exposure increases the risk of premature death from heart and lung disease. Children are at increased risk because their lungs are still developing and they are more likely to have increased exposure since they are often active outdoors.

In addition, cumulative ozone exposure can lead to reduced tree growth, visibly injured leaves, increased susceptibility to disease and damage from insects, and harsher weather. These effects can have adverse impacts on ecosystems, including loss of species and changes to habitat quality and water and nutrient cycles.

5.5 Nitrogen dioxide (NO_2)

NO_x is the generic term for a group of highly reactive gases, all of which contain nitrogen and oxygen in varying amounts. The two primary components are nitric oxide (NO) and nitrogen dioxide (NO_2), the sum usually designated as NO_x. NO_2 is the federally regulated pollutant. NO_2 primarily gets in the air from the burning of fuel. It forms from emissions from cars, trucks and buses, power plants, and off-road equipment.

Trace-levels of NO and NO_y are monitored at the NCore site in Blaine (1002). NO_y, referred to as total reactive nitrogen, consists of NO_x and all compounds that are products of the atmospheric oxidation of NO_x. This trace-level data will help us understand the role of these pollutants at levels far below the NAAQS.

NO_x contributes to a wide range of health and environmental effects. NO_2 itself can irritate the lungs and lower resistance to respiratory infections. More importantly, NO_x reacts to form ground-level ozone, $PM_{2.5}$, acid rain, and other toxic chemicals that are harmful when inhaled.

NO_2 can irritate airways in the human respiratory system. Exposures over short periods can aggravate respiratory diseases, particularly asthma, leading to respiratory symptoms (such as coughing, wheezing or difficulty breathing), hospital admissions and visits to emergency rooms. Longer exposures to elevated concentrations of NO_2 may contribute to the development of asthma and potentially increase susceptibility to respiratory infections. People with asthma, as well as children and the elderly are generally at greater risk for the health effects of NO_2.

At high levels, NO_2 can be seen as a reddish-brown layer in the air over urban areas. It can also lead to visibility impairment and to water quality impairment due to increased nitrogen loading in water bodies.

5.6 Carbon monoxide (CO)

CO is a colorless, odorless gas that can be harmful when inhaled in large amounts. It is formed when carbon in fuels such as gasoline, diesel fuel, crude oil, wood, and other natural and synthetic products, is not burned completely. The greatest sources of CO to outdoor air are cars, trucks and other vehicles or machinery that burn fossil fuels. A variety of items in your home such as unvented kerosene and gas space heaters, leaking chimneys and furnaces, and gas stoves also release CO and can affect air quality indoors.

At very high levels, which are possible indoors or in other enclosed environments, CO can cause dizziness, confusion, unconsciousness and death. CO enters the bloodstream and reduces the delivery of oxygen to the body's organs and tissues. Exposure to elevated CO concentrations is associated with vision problems, reduced ability to work or learn, reduced manual dexterity, and difficulty performing complex tasks. Prolonged exposure to high levels can lead to death.

Very high levels of CO are not likely to occur outdoors. However, when CO levels are elevated outdoors, they can be of particular concern for people with some types of heart disease. These people already have a reduced ability for getting oxygenated blood to their hearts in situations where the heart needs more oxygen than usual. They are especially vulnerable to the effects of CO when exercising or under increased stress. In these situations, short-term exposure to elevated CO may result in reduced oxygen to the heart accompanied by chest pain also known as angina. Carbon monoxide is also oxidized to form carbon dioxide (CO_2), which contributes to climate change.

5.7 Sulfur dioxide (SO_2)

SO_2 is a bad-smelling toxic gas that belongs to the family of sulfur oxide (SO_x) gases. These gases, especially SO_2, are emitted by the burning of fossil fuels or other materials that contain sulfur. The largest source of SO_2 in the atmosphere is the burning of fossil fuels by power plants and other industrial facilities. Smaller sources of SO_2 emissions include industrial processes such as extracting metal from ore; natural sources such as volcanoes; and locomotives, ships and other vehicles and heavy equipment that burn fuel with a high sulfur content. SO_2 also reacts with other chemicals in the air to form sulfate particles. SO_2 data are used to determine compliance with the NAAQS and are reported as part of the AQI.

Exposure to SO_2 and sulfate aerosols in $PM_{2.5}$ contribute to respiratory illness, and aggravate existing heart and lung diseases. People with asthma, particularly children, are especially sensitive to these effects of SO_2. High levels of SO_2 emitted over a short period, such as throughout the course of a day, can be particularly problematic for people with asthma. SO_2 also contributes to visibility impairment.

At high concentrations, SO_X can harm trees and plants by damaging foliage and decreasing growth. When SO_X react to form fine particles, it can produce haze and reduce visibility in parts of the United States, including many of our treasured national parks and wilderness areas.

In addition to reporting hourly SO_2 concentrations to EPA, MPCA also reports 5-minute averages from all SO_2 monitoring sites. Current scientific evidence links health effects with short-term exposure to SO_2 ranging from 5-minutes to 24-hours. Adverse respiratory effects include narrowing of the airways which can cause difficulty breathing (bronchoconstriction) and increased asthma symptoms. These effects are particularly important for asthmatics during periods of faster or deeper breathing (e.g., while exercising or playing).

Studies also show an association between short-term SO_2 exposure and increased visits to emergency departments and hospital admissions for respiratory illnesses; particularly in at risk populations including children, the elderly, and asthmatics.

6. 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 numbers are determined by measurements of six pollutants: fine particles ($PM_{2.5}$), particulate matter (PM_{10}), ground-level ozone (O_3), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), and carbon monoxide (CO). The AQI values for each pollutant are calculated daily and apply to the respective averaging period. The EPA's NowCast AQI values are updated hourly, and posted on the MPCA's to help inform the public of current air quality conditions and trends.

The MPCA creates daily forecasts in AQI units for $PM_{2.5}$ and ozone, centered at monitoring locations across the state (Figure 5). There are currently 28 sites in the full AQI network in Minnesota. The Twin Cities monitors are grouped into three forecast locations: Minneapolis-St. Paul, North Metro, and South Metro. There are 18 forecast locations across the state (Table 6). Daily AQI values are generally the highest for these two pollutants and are responsible for most poor air quality events in Minnesota. In 2025. the PCA will begin issuing air quality alerts for coarse particulate (PM_{10}) caused by windblown dust events.

Figure 5. 2024 fine particle ($PM_{2.5}$) and ozone-monitoring network which serves the AQI forecast program.

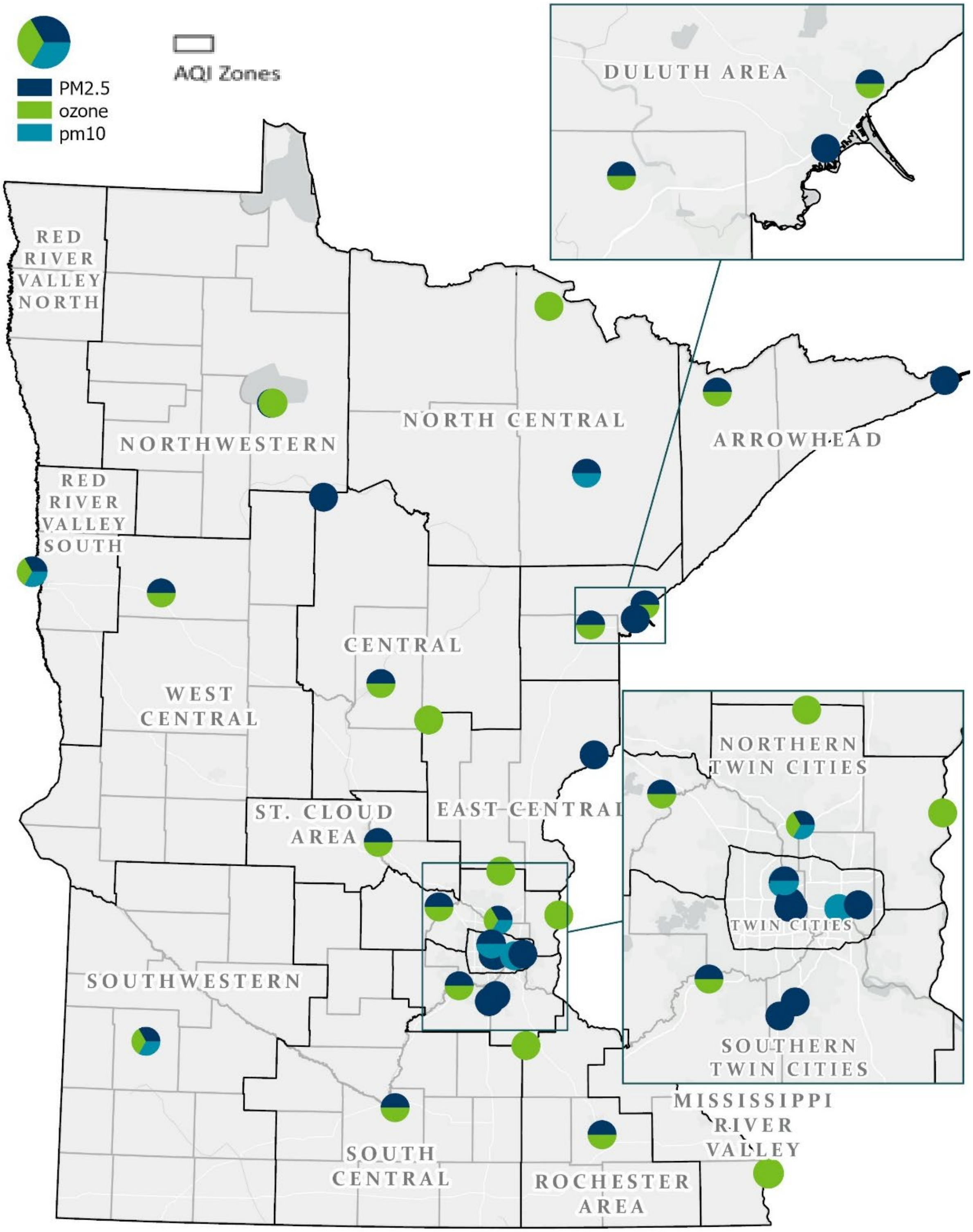


Table 9. Forecast locations and monitors utilized

AQI Zone	AQ Site ID	City	Site Name	AQI Pollutant(s)
Arrowhead	27-031-7810	Grand Portage	Grand Portage Band	$PM_{2.5}$
	27-075-0005	Ely	Boundary Waters	$PM_{2.5}$, Ozone
Central	27-021-3410	Cass Lake	Leech Lake Nation	$PM_{2.5}$
	27-035-3204	Brainerd	Brainerd Lakes Regional	$PM_{2.5}$, Ozone
	27-095-3051	Mille Lacs	Mille Lacs Band	Ozone
Duluth Area	27-017-7417	Cloquet	Fond du Lac Band	$PM_{2.5}$, Ozone
	27-137-7550	Duluth	U of M Duluth	$PM_{2.5}$, Ozone
	27-137-7554	Duluth	Laura MacArthur School	$PM_{2.5}$
	27-115-3061	Hinckley	Lake Lena	$PM_{2.5}$
Mississippi River Valley	55-063-0012***	La Crosse, WI	La Crosse DOT building	$PM_{2.5}$, Ozone
North Central	27-134-0034	International Falls	Voyageurs NP – Sullivan	Ozone
	27-137-7001	Virginia	Virginia City Hall	$PM_{2.5}$
Northern Twin Cities	27-003-1001	East Bethel	Cedar Creek	Ozone
	27-003-1002	Blaine	Anoka Airport	$PM_{2.5}$, Ozone
	27-163-6016	Marine on St. Croix	Marine on St. Croix	Ozone
	27-171-3201	St. Michael	St. Michael	$PM_{2.5}$, Ozone
Northwestern	27-007-2304	Red Lake	Red Lake Nation- Hospital	$PM_{2.5}$
	27-007-2305	Red Lake	Red Lake Nation- DNR	Ozone
Red River Valley North	None*			
Red River Valley South	38-017-1004**	Fargo, ND	Fargo NW	$PM_{2.5}$, Ozone
Rochester Area	27-109-5008	Rochester	Ben Franklin School	$PM_{2.5}$, Ozone
South Central	27-013-5510	Mankato	Rosa Parks Elementary	$PM_{2.5}$, Ozone
Southern Twin Cities	27-037-0470	Apple Valley	Apple Valley	$PM_{2.5}$
	27-037-0480	Lakeville	Near Road I35	$PM_{2.5}$, Ozone
	27-049-5302	Stanton	Stanton Air Field	Ozone
	27-139-0505	Shakopee	Shakopee	$PM_{2.5}$, Ozone
Southwestern	27-083-4210	Marshall	Southwest Minnesota Regional Airport	$PM_{2.5}$, Ozone
St. Cloud Area	27-145-3052	St. Cloud	Talahi School	$PM_{2.5}$, Ozone
Twin Cities	27-053-0909	Minneapolis	Lowry Avenue	$PM_{2.5}$, Ozone
	27-053-0910	Minneapolis	Pacific Street	$PM_{2.5}$, Ozone
	27-053-0962	Minneapolis	Near Road	$PM_{2.5}$, Ozone
	27-053-0963	Minneapolis	Andersen School	$PM_{2.5}$
	27-053-1904	Minneapolis	East Phillips Community	$PM_{2.5}$
	27-053-1909	Minneapolis	Near Road	$PM_{2.5}$, Ozone
	27-053-2006	St. Louis Park	St. Louis Park City Hall	$PM_{2.5}$
	27-123-0866	St. Paul	Red Rock Road	PM_{10}
	27-123-0868	St. Paul	Ramsey Health Center	$PM_{2.5}$
	27-123-0871	St. Paul	Harding High School	$PM_{2.5}$
West Central	27-005-2013	Detroit Lakes	FWS Wetland Management District	$PM_{2.5}$, Ozone

*For all forecast zones, the MPCA also uses Purple Air sensors for particulate forecasting
**38-017-1004 is maintained and operated by the North Dakota Department of Environmental Quality
***55-063-0012 is maintained and operated by the Wisconsin Department of Natural Resources

7. Other ambient air monitoring

7.1 Total Suspended Particulates (TSP)

Total Suspended Particulates (TSP) includes the total mass of particles of solid or liquid matter—such as soot, dust, aerosols, fumes, and mist—found in a sample of ambient air. In Minnesota, TSP samples are also analyzed for metals as part of our air toxics program.

TSP was one of the original criteria pollutants but was replaced by the PM_{10} standard in 1987. Generally, smaller particles, such as PM_{10} and $PM_{2.5}$, are expected to have greater health impacts than TSP. Today, TSP levels are regulated at the state level by the Minnesota Ambient Air Quality Standards (MAAQS).

While primary standards focus on a pollutant's effect on human health, secondary standards are put in place to protect public welfare. In the case of TSP, the secondary standard was reviewed for effects like low visibility, climate change, structural damage, and soiling.

- Low visibility may adversely affect public welfare though either the enjoyment of the environment and transportation operations, particularly pertaining to maintaining good visibility around airports. However, while TSP may be related to low visibility, visibility is directly measured and managed through a regional haze program in the Boundary Water Canoe Area Wilderness and Voyageurs National Park.
- Suspended particulates in the atmosphere may also play a role in affecting the climate of a region. Suspended particles will absorb and scatter light, resulting in less solar radiation to the surface of the Earth, which could reduce the temperature at the surface.
- The deposition of airborne particles may impact public welfare as well. Structural damage from corrosion or erosion may occur with TSP; sea salt and road salt are the main causes of corrosive TSP.
- Soiling, of "dirtying" of horizontal surfaces is a buildup of sediment on horizontal surfaces. It can result in the degradation of aesthetic quality of an area, which is subjective and not related to the function of an object. However, soiling may affect the public perception of neighborhoods and indirectly affect the value of property and result in nuisance and decreased enjoyment of the environment.

An area experiencing the effects of TSP in excess of the secondary standard may include some or all of these impacts on public welfare.

7.2 $PM_{10-2.5}$ – Coarse particulate matter

Coarse particulate matter ($PM_{10-2.5}$) has an aerodynamic diameter ranging from 2.5 to 10 microns. $PM_{10-2.5}$ mass monitoring is required at NCore multipollutant monitoring sites. The MPCA monitors $PM_{10-2.5}$ at the NCore site in Blaine (1002).

7.3 $PM_{2.5}$ speciation

$PM_{2.5}$ is a chemically and physically diverse mixture of very small particles. $PM_{2.5}$ speciation sites collect several components of $PM_{2.5}$ to conduct trend analyses, to better understand health effects and the human and natural sources contributing $PM_{2.5}$, and to estimate visibility impairment. Measured at the three IMPROVE network sites and two CSN sites in Minnesota, the $PM_{2.5}$ measured is not eligible for regulatory comparisons to the NAAQS. The IMPROVE network sites are sited in rural areas of Minnesota and are designed for visibility analyses. CSN network sites are sited in urban areas of Minnesota and are designed to better understand the health effects.

The IMPROVE network sites, Voyageurs (0034/VOYA2), Boundary Waters (0005/BOWA1), and Great River Bluffs (9000/GRRI1), measure the $PM_{2.5}$ components sulfate, nitrate, organic and elemental carbon, major and trace elements and optical absorption. The CSN network sites, Minneapolis (0963) and Blaine (1002) collect similar components, except that they do not include optical absorption and do include analysis for ammonium.

CSN and IMPROVE samplers collect 24-hour $PM_{2.5}$ samples once every three days and are analyzed for chemical composition at contracted labs selected by the EPA and the IMPROVE program. Speciated parameters and daily $PM_{2.5}$ concentrations are available from both networks.

7.4 Hydrogen sulfide (H_2S)

H_2S is a flammable, colorless gas that smells like rotten eggs, even at low levels. H_2S occurs naturally in sources such as crude petroleum and natural gas, results from bacterial breakdown of organic matter, and is produced by human and animal wastes. Exposure to low concentrations of H_2S may cause irritation to the eyes, nose, and throat, and may also cause difficulty breathing for some asthmatics. Industrial activities such as food processing, coke ovens, kraft paper mills, petroleum refineries, and confined animal feedlots also emit H_2S.

Minnesota's state standard for H_2S is a 30-minute average of 30 ppb not to be exceeded more than twice in five days, or a 30-minute average of 50 ppb not to be exceeded more than twice per year. H_2S is primarily a concern in the summer when biological activity is at a peak. The MPCA has monitored several confined animal feedlots and municipal wastewater facilities as a result of odor complaints and health concerns. The MPCA currently oversees industrial monitoring at the Southern Minnesota Beet Sugar Cooperative processing plant in Renville and the American Crystal Sugar processing plants in Moorhead, Crookston, and East Grand Forks, and ConAgra in Waseca.

7.5 Total reduced sulfur (TRS)

TRS consists of the total sulfur from various compounds, including H_2S, methyl mercaptan, dimethyl sulfide, and dimethyl disulfide; SO_2 is not included. Since the majority of TRS is H_2S and the other components are considered to be less toxic than H_2S, TRS can be used as a conservative measure and compared to the H_2S standard. No federal or state standard for TRS is currently available. The MPCA measures TRS at Rosemount sites 0020 and 0423, near the Flint Hills Refinery, and at site 0436 near the St. Paul Park Refining Company in St. Paul Park.

7.6 Meteorological data

Air pollution concentrations are strongly influenced by atmospheric conditions. Meteorological data can be an important tool for understanding and interpreting concentration data. The MPCA collects hourly wind speed and wind direction data at Rosemount sites 0020 and 0423, near the Flint Hills Resources refinery; site 0909 in North Minneapolis; at the near-road sites in Lakeville (0480) and Minneapolis (0962); and at the NCore site in Blaine (1002). In Blaine, temperature, relative humidity, barometric pressure, solar radiation, rainfall, and mixing layer height are also measured.

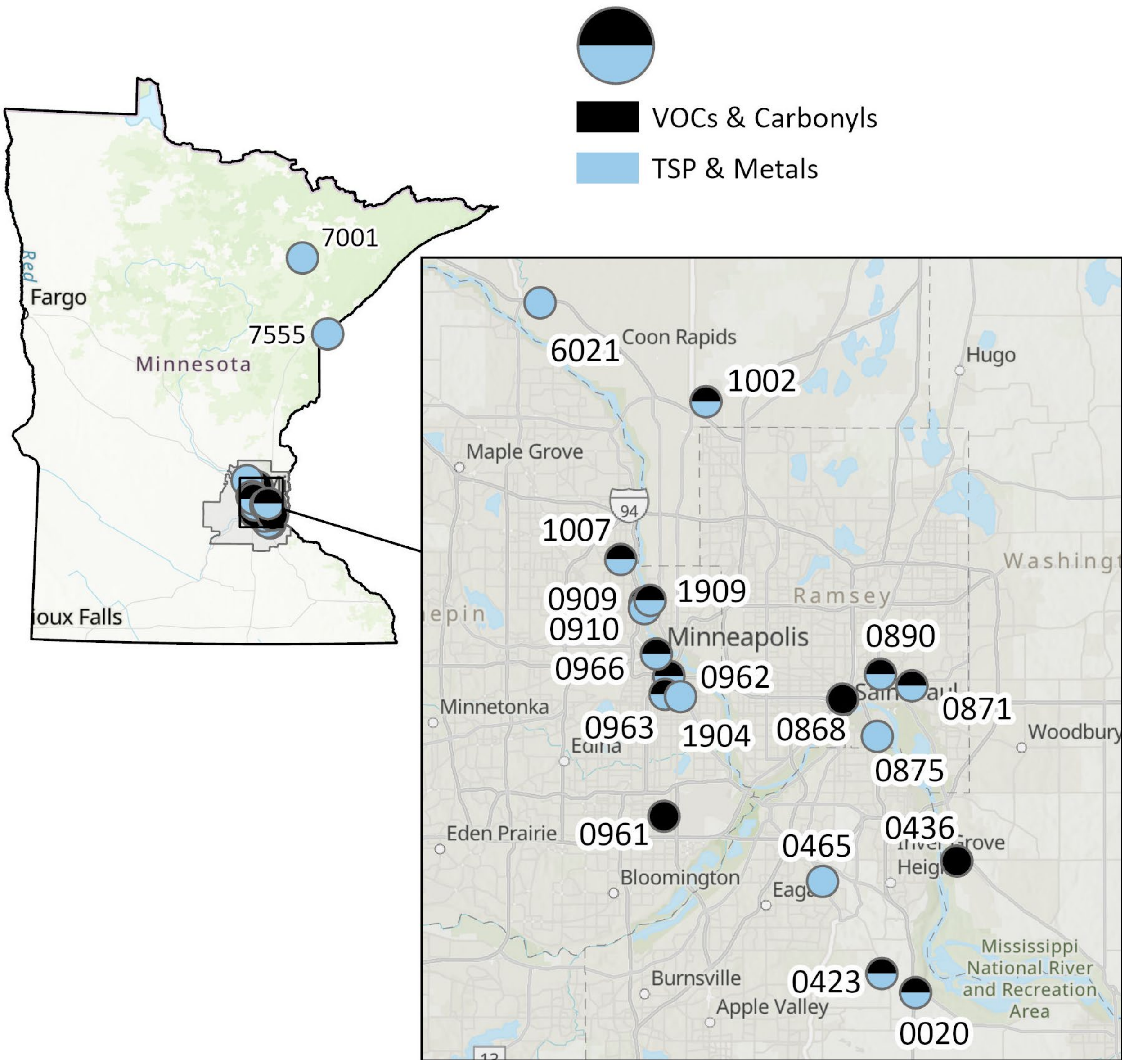
8. Air toxics

The EPA defines air toxics as those pollutants that cause or may cause cancer or other serious health effects, or adverse environmental and ecological effects. Air toxics include, but are not limited to, the 188 Hazardous Air Pollutants (HAPs) specified in the 1990 CAA Amendments. There are no federal requirements for air toxics monitoring, but the MPCA monitors many of the HAPS compounds to understand potential risks to Minnesota residents and to track reductions in emissions and concentrations.

The MPCA monitors three types of air toxics: 57 VOCs, 7 carbonyls, and 10 metals. Samples are collected once every six days, over a 24-hour period. The resulting concentration is a 24-hour average.

The MPCA monitors VOCs and carbonyls at 18 sites in Minnesota (Figure 5) at the time of this publication. For more information, see the Statewide Network Assessment section of this Network Plan.

Figure 5. 2025 Air toxics monitoring sites in Minnesota.



8.1 Metals

The MPCA monitors metals at 18 TSP monitoring sites in Minnesota (Figure 36) at the time of this publication. These sites are primarily located in the Twin Cities metropolitan area, with additional sites in Virginia (7001) and Duluth (7555 and 7549) (Figure 36).

Metals are extracted from TSP glass fiber filters and are analyzed using ICP/MS, following an EPA FEM for lead determination, eql-0710-192. MPCA monitors 10 metals in the state (Table 18).

Table 10. Metals monitored by MPCA in 2025.

Parameter	CAS #	EPA Parameter code
Arsenic (As)	7440-38-2	12103
Beryllium (Be)	7440-41-7	12105
Cadmium (Ca)	7440-43-9	12110
Chromium (Cr)	16065-83-1	12112
Cobalt (Co)	7440-48-4	12113
Iron (Fe)	15438-31-0	12126
Lead (Pb)	7439-92-1	14129
Manganese (Mn)	7439-96-5	12132
Nickel (Ni)	7440-02-0	12136
Selenium (Se)	7782-49-2	12154

8.2 Carbonyls

The MPCA analyzes samples for seven carbonyls (Table 11). Samples are analyzed using EPA Compendium TO-11A.

Table 11. Carbonyls monitored by MPCA in 2025.

Parameter	CAS #	EPA Parameter code
Acetaldehyde	75-07-0	43503
Acetone	67-64-1	43551
Benzaldehyde	100-52-7	45501
Butyraldehyde	123-72-8	43510
Crotonaldehyde	4170-30-3	43528
Formaldehyde	50-00-0	43502
Propionaldehyde	123-38-6	43504

8.3 VOCs (volatile organic compounds)

The MPCA analyzes samples for 57 VOCs (Table 12). Samples are analyzed using EPA Compendium Methods TO-15.

Table 12. VOCs monitored by MPCA

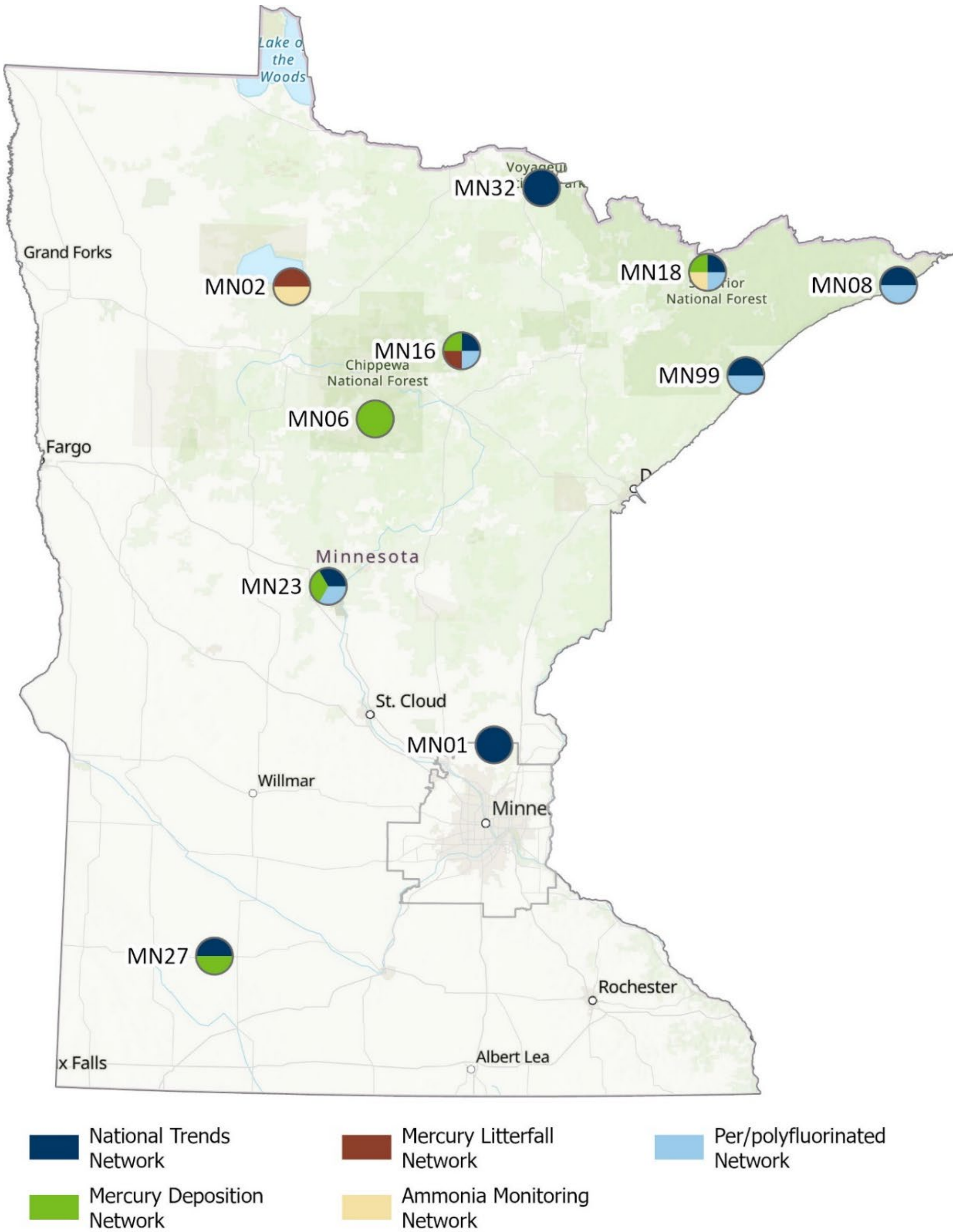
Parameter	CAS #	EPA Parameter code
1,1,2,2-tetrachloroethane	79-34-5	43818
1,1,2,3,4,4-Hexachloro-1,3-butadiene	87-68-3	43844
1,1,2-Trichloroethane	79-00-5	43820
1,1-Dichloroethane	75-34-3	43813
1,1-diChloroEthene	75-35-4	43826
1,2,4-Trichlorobenzene	120-82-1	45810
1,2,4-Trimethylbenzene	95-63-6	45208
1,2-Dichloropropane	78-87-5	43829
1,3,5-Trimethylbenzene	108-67-8	45207
1,3-Butadiene	106-99-0	43218
4-Ethyltoluene	622-96-8	45228
Acrolein	107-02-8	43505
Benzene	71-43-2	45201
Benzyl chloride	100-44-7	45809
Bromodichloromethane	75-27-4	43828
Bromoform	75-25-2	46806
Carbon tetrachloride	56-23-5	43804
Chlorobenzene	108-90-7	45801
Chloroform	67-66-3	43803
cis-1,2-Dichloroethene	156-59-2	43839
cis-1,3-Dichloropropene	10061-01-5	43831
Cyclohexane	110-82-7	43248
Dibromochloromethane	124-48-1	43832
Dichlorobenzene (m)	541-73-1	45806
Dichlorobenzene (o)	95-50-1	45805
Dichlorobenzene (p)	106-46-7	45807
Dichlorodifluoromethane (Freon 12)	75-71-8	43823
Dichloromethane	75-09-2	43802
Dichlorotetrafluoroethane (Freon 114)	76-14-2	43208
Ethyl Acetate	141-78-6	43209
Ethyl Chloride	75-00-3	43812

Ethylbenzene	100-41-4	45203
Ethylene dichloride	107-06-2	43815
Ethylene dibromide	106-93-4	43843
Heptane	142-82-5	43232
Hexane	110-54-3	43231
Methyl bromide	74-83-9	43819
Methyl butyl ketone	591-78-6	43559
Methyl chloride	74-87-3	43801
Methyl chloroform	71-55-6	43814
Methyl ethyl ketone	74-83-9	43552
Methyl isobutyl ketone	108-10-1	43560
Methyl methacrylate	80-62-6	43441
Methyl tert-butyl ether	1634-04-4	43372
Styrene	100-42-5	45220
Tetrachloroethene	127-18-4	43817
Tetrahydrofuran	109-99-9	46401
Toluene	108-88-3	45202
trans-1,2-Dichloroethene	156-60-5	43838
trans-1,3-Dichloropropene	10061-02-6	43830
Tribromomethane	75-25-2	43806
Trichloroethene	79-01-6	43824
Trichlorofluoromethane (Freon 11)	75-69-4	43811
Trichlorotrifluoroethane	76-13-1	43207
Vinyl chloride	75-01-4	43860
Xylene (m&p)	108-38-3, 106-42-3	45109
Xylene (o)	95-47-6	45204

9. Atmospheric deposition

Atmospheric deposition is monitored through the National Atmospheric Deposition Program (NADP). The NADP has five active sub-networks in Minnesota: the National Trends Network (NTN), Mercury Deposition Network (MDN), Mercury Litterfall Network (MLN), Ammonia Monitoring Network (AMoN) and a pilot NTN sub-network for per- and polyfluorinated compounds (PFN) that began in 2024. Minnesota has 10 NADP sites (Figure 9). To learn more about the National Atmospheric Deposition program, visit the [NADP website (https://nadp.slh.wisc.edu/)](https://nadp.slh.wisc.edu/).

Figure 6. Atmospheric deposition sites in Minnesota.



9.1 Acid deposition (NTN)

Acid deposition, or acid rain, is monitored as part of the National Trends Network. Acid deposition begins with the burning of fossil fuels (such as coal, gas, or oil) for energy; resulting air pollution contains SO_2 and NO_x. These gases react in the atmosphere to form various acidic compounds. These compounds may be deposited on the Earth by dry deposition, a process where acidic particles or gases settle on, or are absorbed by, plants, land, water, or building materials. The acidic compounds may also be deposited through rain, snow, and cloud water. These pathways are known as wet deposition. There are about 240 active NTN sites nationwide.

Of the eight Minnesota NADP sites with NTN, five are sponsored by MPCA. One of the remaining sites is privately sponsored, while the other two are federally sponsored. The purpose of the network is to collect data on the chemistry of precipitation for monitoring of geographical and long-term trends. The precipitation at each station is collected weekly and is sent to a national contract laboratory where it is analyzed for hydrogen (acidity as pH), sulfate, nitrate, ammonium, chloride, cations (such as calcium, magnesium, potassium and sodium) and total nitrogen.

9.2 Per- and polyfluorinated (PFAS) compounds (PFN)

As a sub-network of NTN, a pilot program sponsored by EPA-ORD was established in January 2024 to provide weekly concentrations and deposition fluxes of more than 30 PFAS compounds in precipitation from 14 active sites, currently none in Minnesota. The pilot network will operate at least one year, while NADP finalizes quality assurance documentation and standard operating procedures. The PFN leverages the existing NTN network. A USGS-funded Great Lakes PFAS precipitation project utilizes five active NTN sites in Minnesota as part of the PFN. They are Hovland (MN08), Marcell (MN16), Fernberg (MN18), Camp Ripley (MN23) and Wolf Ridge (MN99). MN08, MN18 and MN99 were sampled July 2022-July 2024. MN16 and MN23 began sampling in July 2023 and are scheduled to end July 2025.

9.3 Mercury (Hg) deposition (MDN)

Widespread mercury contamination of fish is a well-documented problem in Minnesota. The MDH advises people to restrict their consumption of large sport fish from all lakes and rivers. In 2007, the EPA accepted Minnesota's mercury total maximum daily load (TMDL) plan that concludes that atmospheric mercury deposition must be reduced by 76% to achieve compliance with aquatic mercury standards. Based on the statewide TMDL, 99% of the mercury in Minnesota surface water comes from the atmosphere.

Mercury is monitored in wet deposition in Minnesota as part of the NADP through the MDN, which began in 1996 and now consists of about 75 sites nationwide. MDN monitors collect weekly samples of precipitation, which are analyzed for total mercury. The objective of the MDN is to provide a nationally consistent survey of mercury in precipitation so that atmospheric loading to surface water can be quantified, and long-term changes can be detected.

Minnesota was on the leading edge of mercury monitoring, establishing four sites as part of the MDN in 1996, which are still operating. They are Marcell (MN16), Fernberg Road (MN18), Camp Ripley (MN23), and Lamberton (MN27). A site at Mille Lacs (MN22) operated from April 2002 to April 2007. An urban site operated in Blaine (MN98) from February 2008 through 2017. In 2014, MDN began collecting at Leech Lake (MN06) and is still active. The USDA-Forest Service sponsors MN16 and the Leech Lake Band of Ojibwe sponsors MN06. There are currently five MDN sites operating in Minnesota (Figure 37).

9.4 Mercury (Hg) Litterfall (MLN)

In 2021, NADP approved MLN, to complement MDN. This network collects dry deposition Hg in forested landscapes to examine ranges of Hg dry deposition and estimate combined wet and dry Hg deposition. Of just over 20 sites nationwide, two are active in Minnesota. They are Red Lake (MN02)—sponsored by the Red Lake Band of the Chippewa Nation—and Marcell (MN16)—sponsored by the USDA-Forest Service. In May 2025, NADP passed a motion to no longer analyze Hg litterfall samples for methylmercury beginning with samples collected in 2024.

9.5 Ammonia gas (AmoN)

In 2010, NADP approved AMoN as an official NADP network that currently consists of about 90 sites nationwide. While AMoN measures ambient ammonia gas (NH_3), among other things, it has value for assessing deposition of reduced nitrogen species and assessing changes atmospheric chemistry as a result of changes in SO_2 and NO_X. Minnesota has two active AMoN at Red Lake (MN02) and Fernberg (MN18), both sponsored by a private contractor under USEPA contract.

10. Air Sensor Program

The Air Sensor Program was implemented in early 2023 as part of the MPCA's commitment to protecting and improving the environment and human health along with improving air quality in population centers and reducing disproportionate impacts from pollution. The Air Sensor Program aims to fill data gaps where regulatory monitoring is not feasible. The program objectives will:

- support existing and new partnerships with communities, educational institutions, and educators,
- locate grants for the program and its partners,
- and store, analyze, and share sensor datasets.

Current efforts involve a partnership with the City of Minneapolis to collect and store data for the deployment of 30 of AQMesh sensors, and with the Minnesota State Mankato to help a few Minneapolis schools with air sensor projects. For more information on the Sensor Program, including grant opportunities, please visit the MPCA's [Air Quality Sensors page (https://www.pca.state.mn.us/local-sites-and-projects/statewide-air-quality-sensors).](https://www.pca.state.mn.us/local-sites-and-projects/statewide-air-quality-sensors)

11. Industrial monitoring

In Minnesota, air quality permits are required to legally operate certain industrial facilities, to begin construction on new facilities, or to modify certain facilities. Air quality permits contain state and federal requirements aiming to minimize the environmental impact of air emissions from these facilities. Some federal programs specify performance standards for certain types of facilities or processes within a facility. Others address the impact of newly constructed facilities, or modifications to existing facilities, on ambient air quality.

Facilities that are required by state permit to monitor nearby ambient air quality to demonstrate compliance with air quality standards receive assistance from MPCA. This assistance includes siting evaluations, instrument performance audits, and data verification. The facilities are responsible for their own data validation and for other QA/QC activities.

Table 13. Industrial Monitors and Locations

Parameters	City	Facility
H_2S	Crookston	American Crystal Sugar Company
	East Grand Forks	American Crystal Sugar Company
	Long Prairie (coming later in 2025)	Central Bi-Products
	Moorhead	American Crystal Sugar Company
	Renville	Southern Minnesota Beet Sugar Cooperative
	Waseca	ConAgra
$PM_{2.5}$	Hastings (coming later in 2025)	Ardent Mills
	Northfield	Malt-O-Meal
	Shakopee	CertainTeed
	St. Paul (coming later in 2025)	Northern Iron
	Warroad	Marvin Windows
$PM_{2.5}$ and PM_{10}	Bayport	Andersen Corporation
	Maplewood	3M
	Perham (coming later in 2025)	Shearer's Foods
$PM_{2.5}$, PM_{10}, and TSP	Silver Bay	Northshore Mining Company
VOCs	White Bear Lake	Otter Lake Technologies (formerly Water Gremlin)