Annual Air Monitoring Network Plan for Minnesota

2017

Minnesota Pollution Control Agency

August 2016

Federal Regulation

40 CFR § 58.10(a) (1) Annual monitoring network plan and periodic network assessment
Beginning July 1, 2007, the State, or where applicable local, agency shall adopt and submit to the Regional Administrator an annual monitoring network plan which shall provide for the establishment and maintenance of an air quality surveillance system that consists of a network of SLAMS monitoring stations including FRM, FEM, and ARM monitors that are part of SLAMS, NCore stations, STN stations, State speciation stations, SPM stations, and/or, in serious, severe and extreme ozone nonattainment areas, PAMS stations, and SPM monitoring stations. The plan shall include a statement of purposes for each monitor and evidence that siting and operation of each monitor meets the requirements of appendices A, C, D, and E of this part, where applicable. The annual monitoring network plan must be made available for public inspection for at least 30 days prior to submission to EPA.

Authors

Kurt Anderson
Kristie Ellickson
Dennis Fenlon
Kellie Gavin
Margaret McCourtney
Cassie McMahon
Rick Strassman
Mary Williams

Contributors / acknowledgements

Shawn Nelson
Mark Schifsky

Editing and Graphic Design

Cover photos: Image from Midwest Hazecam in Grand Portage, MN

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Minnesota Pollution Control Agency

520 Lafayette Road North | Saint Paul, MN 55155-4194 |

651-296-6300 | 800-657-3864 | Or use your preferred relay service. | Info.pca@state.mn.us

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Acronyms, Abbreviations, and Definitions

AADT – Annual Average Daily Traffic
AIRMoN – Atmospheric Integrated Research Monitoring Network
AIRNow- air quality forecasting program
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
BAM – Beta Attenuation Mass
BWCAW – Boundary Waters Canoe Area Wilderness
CAA – Clean Air Act
CAS – Chemical Abstracts Service
CASTNET – Clean Air Status and Trends Network
CBSA – Core Base Statistical Area
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
EPA – Environmental Protection Agency
FE-AADT – Fleet Equivalent Annual Average Daily Traffic
FEM – Federal Equivalent Method
FRM – Federal Reference Method
GC/MS – Gas Chromatography/Mass Spectrometry
H_2S – hydrogen sulfide
HAP – Hazardous Air Pollutant
Hg – mercury
HPLC – High Pressure Liquid Chromatography
HRV – Health Risk Value
ICAP-AES – Inductively Coupled Plasma Atomic Emission Spectrometry: a technique used for metals analysis
IMPROVE – Interagency Monitoring of Protected Visual Environments
IO-3.1 – EPA method for extracting metals from TSP filters
IO-3.4 – EPA method for analyzing metals utilizing ICAP
LADCO – Lake Michigan Air Directors Consortium
MAAQS – Minnesota Ambient Air Quality Standard
MDH – Minnesota Department of Health
MDN – Mercury Deposition Network
MnDOT – Minnesota Department of Transportation
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
NH_3 – ammonia
NO – nitric oxide
NO_2 – nitrogen dioxide
NO_x – oxides of nitrogen
NO_y – total reactive nitrogen

NPAP – National Performance Audit Program
NTN – National Trends Network
O_3 – ozone
PAH – Polycyclic Aromatic Hydrocarbon
PAMS - Photochemical Assessment Monitoring Stations
Pb – lead
PEP – Performance Evaluation Program
PFC – perfluorochemical
PM_4 – particulate matter less than 4 microns in diameter
$PM_{2.5}$ – 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
ppm – parts per million
PQAO – Primary Quality Assurance Organization
QAPP – Quality Assurance Project Plans
QA/QC – Quality Assurance/Quality Control
QMP – Quality Management Plan
SIP – State Implementation Plan
SLAMS – State and Local Air Monitoring Stations
SO_2 – sulfur dioxide
SPM – special purpose monitoring
STN – speciation trends network
TEOM – Tapered Element Oscillating Microbalance
TMDL – Total Maximum Daily Load
TO-11A – EPA method for analyzing carbonyls utilizing HPLC
TO-15 – EPA method for analyzing VOCs utilizing GC/MS
tpy – tons per year
TRS – total reduced sulfur
TSP – total suspended particulate matter
U of M – University of Minnesota
UFP – ultrafine particles (particulate matter less than 0.1 microns in diameter)
USDA – United States Department of Agriculture
USG – unhealthy for sensitive groups
USGS – United States Geological Survey
VOC – Volatile Organic Compound

Introduction

The Minnesota Air Monitoring Network Plan is an annual report required under the Code of Federal Regulations (40 CFR 58 § 58010(a)(1)). The purpose of this plan is to provide evidence that the Minnesota Pollution Control Agency (MPCA) air monitoring network meets current federal monitoring requirements, to detail any changes proposed for the 18 months following publication, to provide specific information on each of the MPCA's existing and proposed monitoring sites, and to provide the opportunity for the public to comment on air monitoring activities conducted by the MPCA. The plan also includes information on known industrial monitoring activities and special air monitoring projects occurring in the state.

The Minnesota Pollution Control Agency (MPCA) monitors outdoor air quality throughout Minnesota. The data collected by the MPCA helps determine major sources of ambient air pollution in Minnesota and whether we are protecting the public from its harmful health effects. Data are also used to address ways to reduce pollution levels and track concentrations of pollutants over time.

The MPCA's air quality data are used to determine compliance with National Ambient Air Quality Standards (NAAQS) and Minnesota Ambient Air Quality Standards (MAAQS). In 1970, the Clean Air Act (CAA) established NAAQS for six pollutants known to cause harm to human health and the environment. The CAA requires the MPCA to monitor these pollutants, called criteria pollutants, and report the findings to the U. S. Environmental Protection Agency (EPA). The criteria pollutants are particulate matter, lead, ozone, nitrogen dioxide, sulfur dioxide, and carbon monoxide. The MPCA monitors criteria pollutants to comply with the CAA.

The MPCA also monitors Minnesota's air for other pollutants called air toxics. Air toxics include a wide range of chemicals that are known or suspected to affect human health. These pollutants do not have federal standards; however, levels found in Minnesota are compared to health benchmarks established by the Minnesota Department of Health (MDH), the EPA, and the State of California.

Network overview

The MPCA monitors ambient air quality at 53 sites throughout Minnesota. This includes monitoring at four tribal sites, three Interagency Monitoring of Protected Visual Environments (IMPROVE) sites, two Chemical Speciation Network (CSN) sites, and nine National Atmospheric Deposition Program (NADP) sites. Figure 1 shows all of these sites. Tin addition to these sites, there is a network of industrial air quality monitors that must conform to EPA standards but are owned and operated by the specific industrial facility.

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

The maps on the following pages show sites labeled according to their MPCA, NADP, or IMPROVE site identification numbers. Figure 1 shows the Greater Minnesota sites and Figure 2 shows the Twin Cities metropolitan area sites.

Throughout the report, sites are referred to using the site name or the city where the site is located and the MPCA, NADP, or IMPROVE site identification number.

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 objective based (e.g. NCore, PAMs) monitoring network. 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.

Monitoring objectives

Since it is not possible to monitor everywhere in the state, the concept of spatial scales is used to clarify the link between monitoring objectives and the physical location of the monitor. When designing an air monitoring network one of the following six objectives should be determined:

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

Site selection

The selection of air monitoring sites is usually based on at least one of these basic monitoring objectives:

- Determine representative concentrations and exposure in areas of high population density
- Determine the highest concentrations of pollutants in an area based on topography and/or wind patterns
- Judge compliance with and/or progress made towards meeting the NAAQS and MAAQS
- Track pollution trends
- Determine the highest concentrations of pollutants within the state based on the known atmospheric chemistry of specific pollutants and wind patterns
- Determine the extent of regional pollutant transport to and from populated areas
- Determine how much major sources impact ambient pollution levels
- Validate control strategies designed to prevent or alleviate air pollution
- Provide a data base for research and evaluation of air pollution effects
- Determine 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.

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 1). 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 four to 50 kilometers. This scale represents conditions over an entire metropolitan area and is useful in assessing city-wide trends in air quality.
- **Regional Scale/ Background (50-1,000 km)** – usually 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 1: Network 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

Regional network assessment

In addition to this air monitoring network plan, the EPA requires states to complete a network assessment every five years. Under the direction of the Lake Michigan Air Directors Consortium (LADCO), Minnesota collaborated with other states in our region for the first network assessment which was completed in 2010, http://www.ladco.org/reports/general/Regional_Network_Assessment/index.html. The network assessment provides a detailed evaluation of the regional air monitoring network. It contains a network history, a re-evaluation of the types of pollutants monitored, and an evaluation of the network's objectives and costs. It also includes spatial analysis of ambient air monitoring data and a reconsideration of monitor placement based on changes in land use and population.

For the 2015 Network Assessment, the MPCA again collaborated with other EPA Region 5 states. The results of the 2015 Regional Network Assessment can be found on LADCO's website at http://www.ladco.org/reports/general/Regional_Network_Assessment/RNA15.html.

Key findings of the 2015 Network Assessment:

- Criteria pollutant monitoring networks are adequate to meet EPA's minimum monitoring criteria.
- Monitoring equipment is aging and will require replacement in the coming years. The $PM_{2.5}$ filter-based monitoring network in Minnesota was replaced in 2008, but is no longer being supported by vendors. Inability to access parts for instrument repairs may require instrument replacement sooner than anticipated.
- Disinvestment or relocation of existing $PM_{2.5}$ and ozone monitoring sites is very difficult due to stringent EPA criteria for shutdown.
- Using these criteria, amongst all ozone and $PM_{2.5}$ monitors in the state, only three $PM_{2.5}$ monitors are eligible for disinvestment. These include monitors in Duluth, Virginia, and St. Cloud. While these monitors are eligible for disinvestment, we feel these monitors are valuable for spatial and temporal coverage and we do not intend to shut down these monitors at this time.

Table 2: Site information – Greater Minnesota sites active in 2016

MPCA Site ID	City	Site name	AQS Site ID	Address	LAT	LONG	Year Started
MN08*	Hovland	Hovland	(none)	(open field)	47.8472	-89.9625	1996
MN16*	Balsam Lake	Marcell Experimental Forest	(none)	Marcell Experimental Forest	47.5311	-93.4686	1978
MN23*	Pillager	Camp Ripley	(none)	(open field)	46.2494	-94.4972	1983
MN27*	Lamberton	Lamberton	(none)	U of M SW Agricultural Research and Outreach Center	44.2369	-95.3010	1979
MN28*	Sandstone	Grindstone Lake	(none)	Audubon Center of the North Woods	46.1208	-93.0042	1996
MN32* VOYA2**	International Falls	Voyageurs NP	27-137-0034	Voyageurs National Park - Sullivan Bay	48.4128	-92.8292	2000
MN99*	Finland	Wolf Ridge	(none)	6282 Cranberry Rd	47.3875	-91.1958	1996
1300	Virginia	Virginia	27-137-7001	327 First St S	47.5212	-92.5393	1968
2013	Detroit Lakes	FWS Wetland Management District	27-005-2013	26624 N Tower Rd	46.8499	-95.8463	2004
2304***	Red Lake	Red Lake Nation	27-007-2304	24760 Hospital Drive	47.8782	-95.0292	2014
3051***	Onamia	Mille Lacs Band	27-095-3051	16687 Shaw Bosh Kung Dr	46.2052	-93.7594	1997
3052	Saint Cloud	Talahi School	27-145-3052	1321 Michigan Ave SE	45.5497	-94.1335	1998
3204	Brainerd	Brainerd Lakes Regional Airport	27-035-3204	16384 Airport Rd	46.3921	-94.1444	2004
4210	Marshall	Southwest Minnesota Regional Airport	27-083-4210	West Highway 19	44.4559	-95.8363	2004
5008	Rochester	Ben Franklin School	27-109-5008	1801 9th Ave SE	43.9949	-92.4504	1997
5302	Stanton	Stanton Air Field	27-049-5302	1235 Highway 17	44.4719	-93.0126	2003
7001 MN18* BOWA1**	Ely	Fernberg	27-075-0005	Fernberg Rd	47.9466	-91.4956	1977
7417***	Cloquet	Fond du Lac	27-017-7416	28 University Rd	46.7137	-92.5117	2015
7545	Duluth	Oneota Street	27-137-0032	37th Ave W & Oneota St	46.7516	-92.1413	1985
7549	Duluth	Michigan Street	27-137-7549	1532 W Michigan St	46.7694	-92.1194	1994
7550	Duluth	WDSE	27-137-7550	1202 East University Circle	46.8182	-92.0894	1998
7554	Duluth	Laura MacArthur School	27-137-7554	720 N Central Ave	46.7437	-92.1660	2012
7555	Duluth	Waseca Road	27-137-7555	Waseca Industrial Rd	46.7306	-92.1634	2001
7810***	Grand Portage	Grand Portage	27-031-7810	27 Store Rd	47.9701	-89.6910	2005
GRRI1**	Winona	Great River Bluffs	27-169-9000	43605 Kipp Dr	43.9373	-91.4052	2002

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

Figure 1: 2016 Air quality monitoring sites in Greater Minnesota

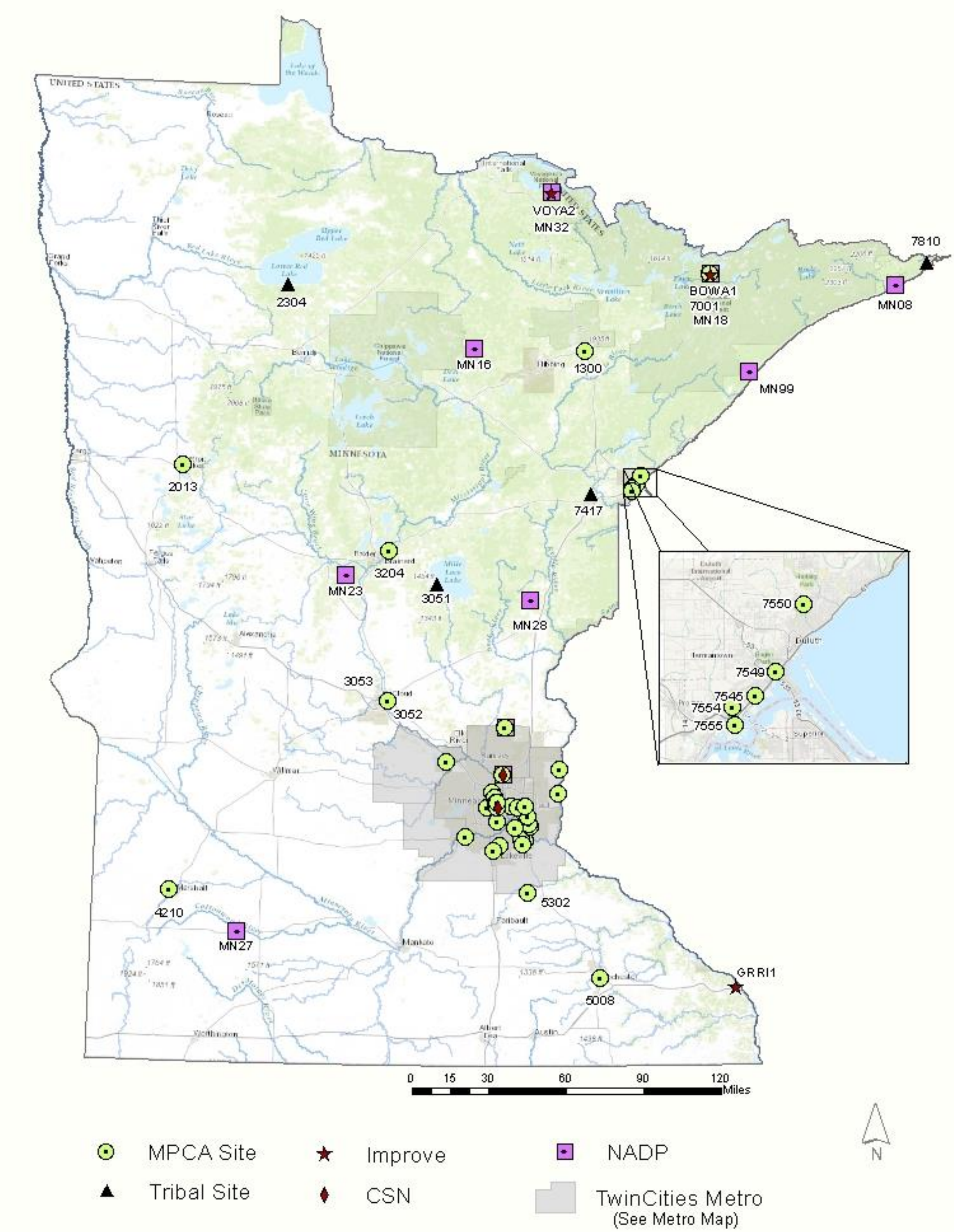
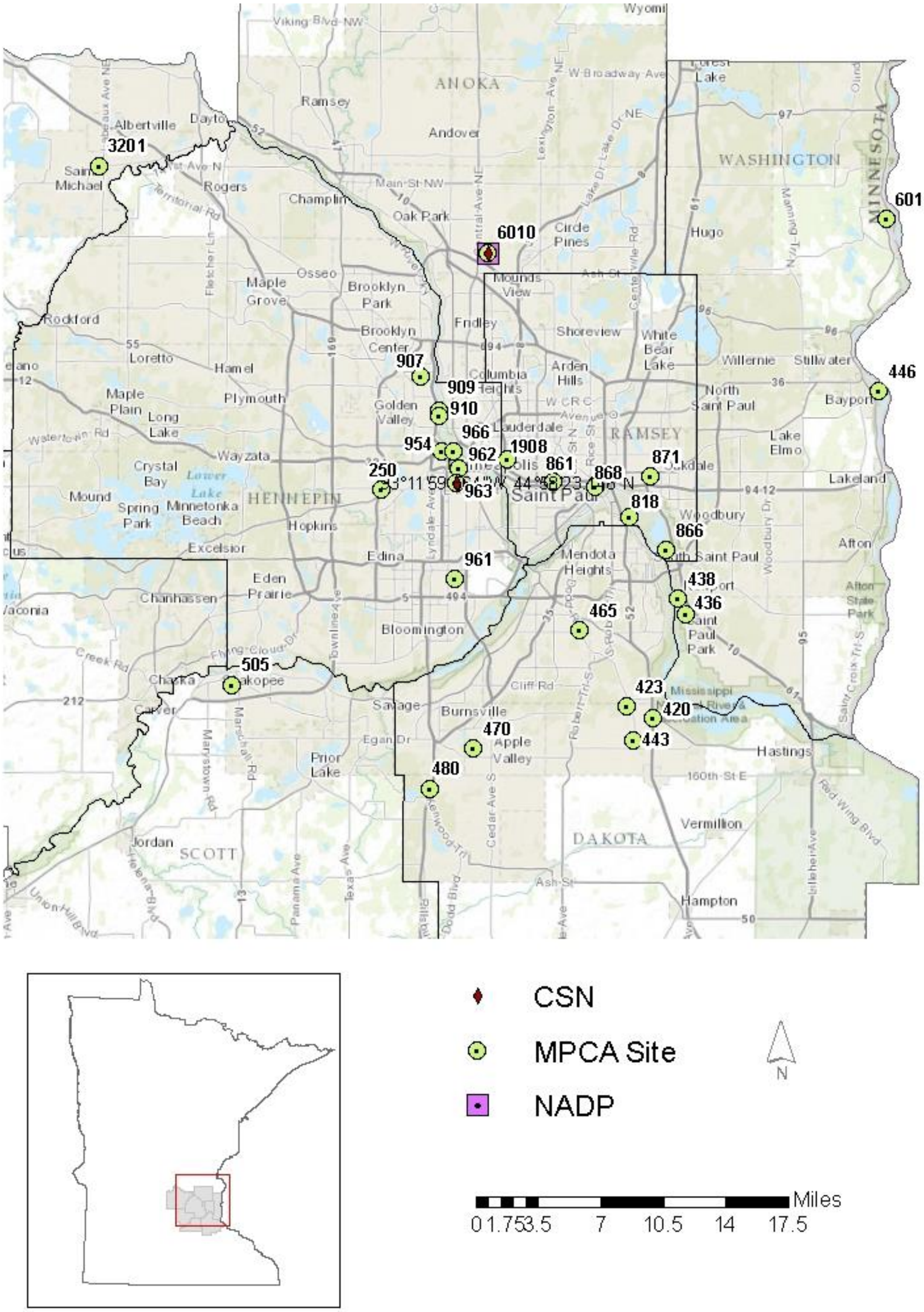


Table 3: Site information – Twin Cities metropolitan area sites active in 2016

MPCA Site ID	City	Site name	AQS Site ID	Address	LAT	LONG	Year Started
250	St Louis Park	St. Louis Park	27-053-2006	5005 Minnetonka Blvd	44.9481	-93.3429	1972
420	Rosemount	Flint Hills Refinery 420	27-037-0020	12821 Pine Bend Tr	44.7632	-93.0325	1972
423	Rosemount	Flint Hills Refinery 423	27-037-0423	2142 120th St E	44.7730	-93.0627	1990
436	St. Paul Park	St. Paul Park Refinery 436	27-163-0436	649 5th St	44.8473	-92.9956	1989
438	Newport	St. Paul Park Refinery 438	27-163-0438	4th Ave & 2nd St	44.8599	-93.0035	1995
443	Rosemount	Flint Hills Refinery 443	27-037-0443	14035 Blaine Ave E	44.7457	-93.0554	2008
446	Bayport	Point Road	27-163-0446	22 Point Rd	45.0280	-92.7738	2007
465	Eagan	Gopher Resources	27-037-0465	Hwy 149 & Yankee Doodle Rd	44.8343	-93.1163	2006
470	Apple Valley	Apple Valley	27-037-0470	225 Garden View Dr	44.7387	-93.2373	2000
480	Lakeville	Near Road I-35	27-037-0480	16750 Kenyon Ave	44.7061	-93.2858	2015
505	Shakopee	B.F. Pearson School	27-139-0505	917 Dakota St	44.7894	-93.5125	2000
818	St. Paul	St. Paul Downtown Airport	27-123-0818	719 Eaton St	44.926753	-93.0593	2016
861	St. Paul	Lexington Avenue	27-123-0050	1088 W University Ave	44.9556	-93.1459	1987
866	St. Paul	Red Rock Road	27-123-0866	1450 Red Rock Rd	44.8994	-93.0171	1997
868	St. Paul	Ramsey Health Center	27-123-0868	555 Cedar St	44.9507	-93.0985	1998
871	St. Paul	Harding High School	27-123-0871	1540 East 6th St	44.9593	-93.0359	1998
907	Minneapolis	Humboldt Avenue	27-053-1007	4646 N Humboldt Ave	45.0397	-93.2987	1966
909	Minneapolis	Lowry Ave	27-053-0909	3104 N Pacific St	45.0121	-93.2767	2013
910	Minneapolis	Pacific Street	27-053-0910	2710 N Pacific St	45.0083	-93.2770	2015
954	Minneapolis	Arts Center	27-053-0954	528 Hennepin Ave	44.9790	-93.2737	1989
961	Richfield	Richfield Intermediate School	27-053-0961	7020 12th Ave S	44.8756	-93.2588	1999
962	Minneapolis	Near Road I-35/I-94	27-053-0962	1444 18th St E	44.9652	-93.2548	2013
963	Minneapolis	H.C. Andersen School	27-053-0963	2727 10th Ave S	44.9535	-93.2583	2001
966	Minneapolis	City of Lakes	27-053-0966	309 2nd Ave S	44.9793	-93.2611	2002
1908	St. Paul	South St. Anthony Park	27-123-1908	2237 Robbins St	44.9731	-93.1999	2016
3201	St. Michael	St. Michael	27-171-3201	101 Central Ave W	45.2092	-93.6690	2003
6010 MN98*	Blaine	Anoka Airport	27-003-1002	2289 CO Rd J	45.1407	-93.2220	1979
6012 MN01*	East Bethel	Cedar Creek	27-003-1001	2660 Fawn Lake Drive NE	45.4018	-93.2031	1979
6016	Marine on St. Croix	Marine on St. Croix	27-163-6016	St. Croix Trail N	45.1680	-92.7651	2012

*NADP Site ID

Figure 2: 2016 Air quality monitoring sites in the Twin Cities metropolitan area



Quality Assurance/Quality Control (QA/QC) Program

The purpose of the QA/QC program is to assure the quality of data obtained from the MPCA air monitoring networks. The MPCA meets or exceeds the QA requirements defined in 40 CFR 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
- Bias determinations
- Flow rate audits
- Leak checks
- Data validation

For independent quality assurance activities, the MPCA participates in the National Performance Audit Program and the Performance Evaluation Program for criteria pollutant monitoring. Additional inter-laboratory comparisons 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 to be applied 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.

Types of 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.

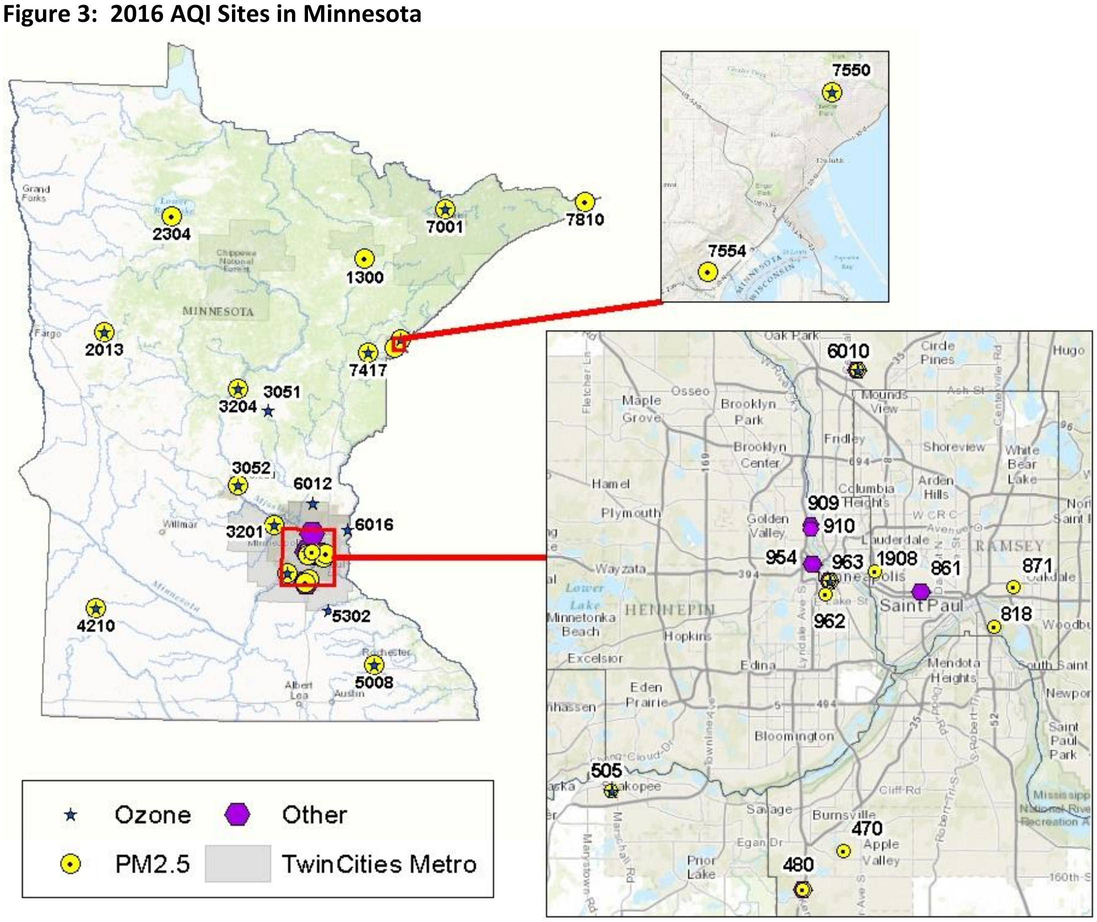
State and Local Air Monitoring Stations (SLAMS)

This network consists of about 3,500 monitoring sites across the United States. The 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 Minnesota monitoring sites are part of the SLAMS network. Sites in the SLAMS network may also belong to monitoring networks described below.

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 hourly measurements of six pollutants: $PM_{2.5}$, PM_{10}, ground-level O_3, sulfur dioxide (SO_2), nitrogen dioxide (NO_2), and carbon monoxide (CO). The most common pollutants to drive the AQI are $PM_{2.5}$ and O_3. AQI values are updated hourly and posted on the MPCA's website at www.pca.state.mn.us/aqi. There are currently 30 sites in the AQI network in Minnesota (Figure 3).

Figure 3: 2016 AQI Sites in Minnesota

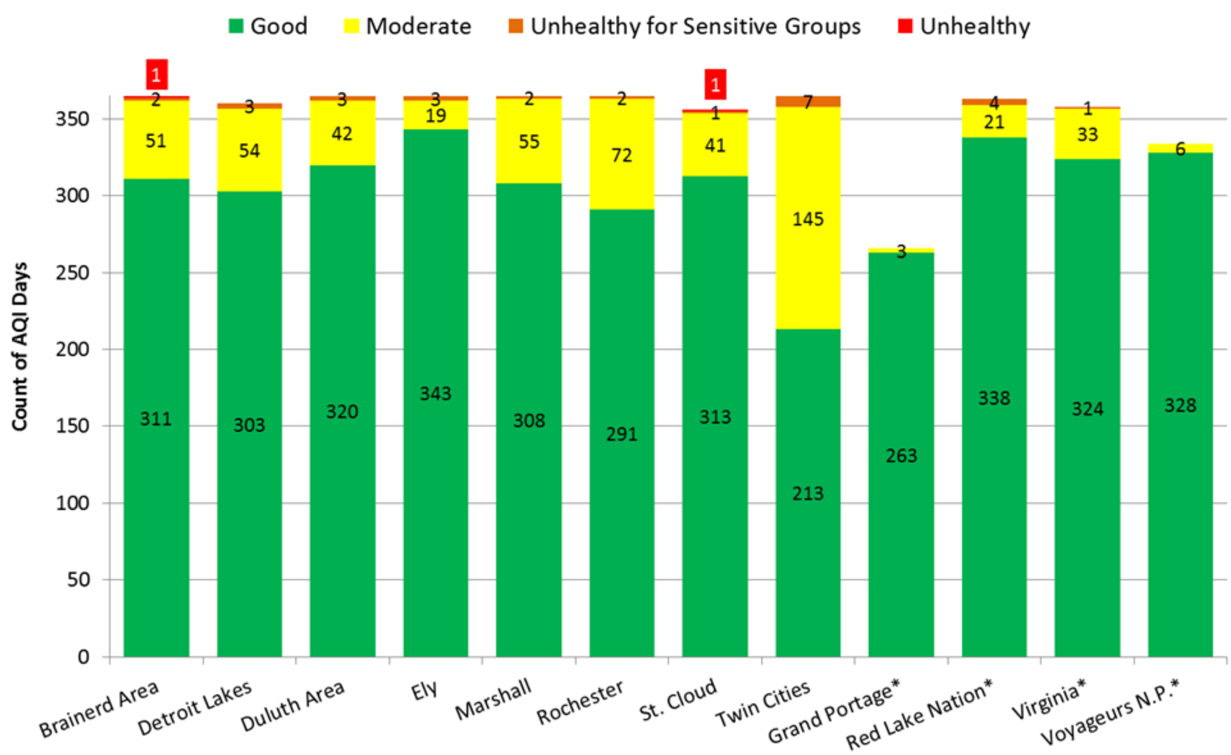


Air quality is ranked as good, moderate, unhealthy for sensitive groups (USG), unhealthy, or very unhealthy (Figure 4). If it is suspected through forecasting or monitoring that one of the six pollutants may be unhealthy for sensitive groups or higher, the MPCA issues an Air Pollution Health Alert to the media and to individuals who have signed up to receive e-mail alerts. Alerts allow the public to be proactive about protecting their health and reducing their own contributions to emissions and exposure to pollution. To receive e-mail alerts and air quality forecasts, sign up at http://mn.enviroflash.info

Figure 4: AQI categories

In 2015, across all areas of the state, the majority of days were rated good for air quality. Ely experienced the highest number of good air quality days (343) compared to the Twin Cities metropolitan area which experienced lowest number of good air quality days (213). The lower number of good AQI days in the Twin Cities compared to other areas of the state is an expected result, as the AQI is based on pollutants which are most abundant in urban areas. Statewide the number of good AQI days has been increasing over time. This suggests that overall air quality is improving.

Figure 5: 2015 AQI days in Minnesota cities



*Grand Portage, Red Lake Nation, and Virginia are based on $PM_{2.5}$ monitoring results only. Voyageurs N.P. results are based on ozone monitoring results only.

In 2015, across Minnesota, the AQI reached the unhealthy for sensitive groups or unhealthy categories on eleven days (Table 4). Fine particle pollution ($PM_{2.5}$) was the driver for eight of these days. Ozone was the driver for three of these days. On one day, both ozone and fine particle pollution reached the "unhealthy for sensitive groups" category. The majority of the high AQI days in 2015 were associated with the transport of wildfire smoke into Minnesota from Canada and the Western United States. In recent years, transported wildfire smoke has become a leading contributor to high AQI days in Minnesota (Table 4).

Table 4: 2015 days with AQI greater than 100

Event Date	Brainerd Area	Detroit Lakes	Duluth Area	Ely	Marshall	Red Lake Nation	Rochester	St. Cloud	Twin Cities	Event Description
2/7/2015									108	Local winter time stagnation event.
2/8/2015									114	
5/27/2015					113					Warm temperatures and evidence of transported wildfire smoke contributed to elevated ozone. Monitors in Sioux Falls and Brookings South Dakota also impacted.
6/9/2015				114					107	Heavy smoke from fires in Canada contributed to elevated $PM_{2.5}$ and ozone. Mostly sunny skies and afternoon temperatures near 90°F contributed to elevated ozone.
6/10/2015				108						
7/3/2015	115	130				106				Heavy smoke from fires in Canada contributed to elevated PM2.5. Independence Day fireworks displays also contributed to elevated $PM_{2.5}$.
7/4/2015	152	148	102			131		159	147	
7/5/2015	136	124				132		145	132	
7/6/2015			112	105		111	118		113	
7/7/2015			105				114		105	
8/28/2015					119					Presence of wildfire smoke may have contributed to elevated ozone concentration.

Note: Values in the table reflect the maximum AQI result for that date.

Ozone

Fine Particles ($PM_{2.5}$)

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 consisting of approximately 300 monitoring sites. CSN data can be useful for assessing trends and developing mitigation strategies to reduce emissions and ambient 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; and development of emission control strategies.

There are currently two CSN sites in Minnesota. They are located in Minneapolis at Andersen School (963) and at the NCore site in Blaine (6010). Figure 1 shows the locations of these sites.

Interagency Monitoring of Protected Visual Environments (IMPROVE)

The IMPROVE Aerosol Network is a cooperative rural air quality monitoring effort between federal land managers; regional, state, and tribal air agencies; and the EPA. 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 and forests and wilderness areas overseen by the United States Department of Agriculture (USDA). The IMPROVE network presently comprises 175 monitoring sites nationally.

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; and
- with the enactment of the Regional Haze Rule, to provide regional haze monitoring representing all visibility-protected federal class I areas where practical.

The IMPROVE sites also provide $PM_{2.5}$ speciation data; therefore, they are a key component of the EPA's national fine particle monitoring and are critical to tracking progress related to the Regional Haze Regulations. Minnesota has three IMPROVE Aerosol Network sites. They are located at Voyageurs National Park (VOYA2), near the Boundary Waters Canoe Area Wilderness at Ely (BOWA1), and Great River Bluffs State Park (GRRI1). Figure 1 shows the locations of these sites.

In 2015, the EPA completed an assessment of the National IMPROVE Protocol Network. As a result of this assessment, EPA has defunded the IMPROVE site at Blue Mounds. The Blue Mounds IMPROVE site ceased operations in January 2016. No changes are planned for the IMPROVE network in 2017.

National Atmospheric Deposition Program (NADP)

Atmospheric deposition is monitored through the NADP program with over 250 sites spanning the continental United States, Alaska, Puerto Rico, and the Virgin Islands (http://nadp.sws.uiuc.edu/). There are two sub-networks in Minnesota: the National Trends Network (NTN) and the Mercury Deposition Network (MDN) with nine NTN and five MDN sites in Minnesota (Figure 1).

The NTN network collects weekly precipitation samples for pH, sulfate, nitrate, ammonium, chloride, and base cations (such as calcium and magnesium). This network provides long-term, high-quality data for determining spatial and temporal trends in the chemical composition of precipitation.

The MDN network collects precipitation samples for analysis of total mercury and methylmercury concentrations. The objective is to develop a national database of the weekly concentrations of total mercury in precipitation along with the seasonal and annual flux of total mercury in wet deposition. Samples are collected weekly and sent to Frontier Geosciences, Inc. for analysis.

No changes are planned for the sites in the MN NADP network in 2017.

Near-road Air Quality Monitoring

Air pollution can be higher close to roadways. In 2010, the EPA introduced a new air monitoring network 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. As a minimum, near-road monitoring sites are required to measure hourly levels of nitrogen dioxide (NO_2), carbon monoxide (CO), and fine particles ($PM_{2.5}$).

In Minnesota, the MPCA has installed two near-road monitoring sites. The first near-road monitoring site (962) began operating along the I-94 & I-35W freeway commons near downtown Minneapolis on January 1, 2013. The second near-road monitoring site (480) began operating along I-35 in Lakeville on January 1, 2015. Various parameters are being measured at each of the near-road sites (Table 5).

Table 5: Near-road parameters

MPCA Site ID	City Name	Site Name	$PM_{2.5}$ FEM	TSP and Metals	O_3	NO_x	CO	VOCs	Carbonyls	Other Parameters
962	Minneapolis	Near Road I35/I94	X	X	X	X	X	X	X	Meteorological Data, Ultrafine Particle Counter, Black Carbon
480	Lakeville	Near Road I35	X			X	X			Meteorological Data

The MPCA near-road air quality monitoring is described in more detail on the MPCA Near-road website at https://www.pca.state.mn.us/air/near-road-monitoring.

National Core Monitoring (NCore)

In October 2006, the United States 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. Nationwide, there are approximately 75 sites, mostly in urban areas.

Each NCore site must measure a minimum number of parameters (Table 6).

Table 6: NCore 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 hour average every third day
continuous $PM_{2.5}$ mass	one hour reporting interval
continuous $PM_{(10-2.5)}$ mass	in anticipation of a $PM_{(10-2.5)}$ standard
ozone (O_3)	continuous monitor consistent with other O_3 sites
carbon monoxide (CO) trace level	continuous monitor capable of trace levels (low ppb and below)
sulfur dioxide (SO_2) trace level	continuous monitor capable of trace levels (low ppb and below)
total reactive nitrogen (NO/NO_y)	continuous monitor capable of trace levels (low ppb and below)
surface meteorology	wind speed and direction, temperature, barometric pressure, and relative humidity

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

- Report data on a timely schedule to the public through: a) the AIRNow data reporting website (https://www.airnow.gov/), b) air quality forecasting, and c) 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 by 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

In 2011, the MPCA began operating the full suite of NCore parameters at the Anoka County Airport in Blaine (6010). The Anoka County Airport monitoring station is located approximately 11 miles north of downtown Minneapolis and approximately 15 miles northwest of downtown St. Paul. A detailed report about Minnesota's NCore site in Blaine can be found in Appendix B of the 2010 Annual Air Monitoring Network Plan, https://www.pca.state.mn.us/sites/default/files/aq10-03b.pdf.

Minnesota's NCore site focuses on providing monitoring data for multiple parameters (Table 6). Numerous chemical and physical interactions between pollutants underlie the formation of particulates and ozone and the presence of other pollutants. In addition, emission sources tend to simultaneously release multiple pollutants or pollutant precursors. Multi-pollutant monitoring will benefit health studies, long-term epidemiological studies, source apportionment studies, and air quality models.

Another focus of the NCore site in Blaine is trace level monitoring of CO, SO_2, oxides of nitrogen (NO_x), and total reactive nitrogen. These pollutants are dominant inorganic combustion products, as well as the most abundant inorganic elements in the atmosphere. Emissions reductions have reduced the concentrations of these pollutants in most urban and rural areas; however, they are precursor gases that continue to play an important role in the formation of O_3, particulate matter, and air toxics on both local and regional scales.

The trace level data that this site provides will help us understand the role of these pollutants in the environment at levels far below the NAAQS. Trace level monitors have been operating at the NCore site in Blaine (6010) since 2009; however, due to performance issues with the monitoring equipment, trace level monitoring results were unreliable. The MPCA replaced the trace level monitoring instruments in 2014.

Industrial networks

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 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 to monitor ambient air quality near their facility receive assistance from MPCA through siting evaluations, instrument performance audits, data review and submission of data to the EPA's Air Quality System (AQS) database. The facilities are responsible for their own data validation and for other QA/QC activities.

The MPCA is currently assisting the following facilities:

- American Crystal Sugar Company in Moorhead, Crookston, and East Grand Forks
- Andersen Corporation in Bayport, MN
- Northshore Mining Company in Silver Bay, MN
- Southern Minnesota Beet Sugar Cooperative in Renville, MN
- 3M in Maplewood, MN

Photochemical Assessment Monitoring Stations (PAMS)

The PAMS network provides enhanced monitoring of ozone, NOx, and VOCs to obtain more comprehensive and representative data on ozone air pollution. 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 volatile organic compounds (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; and
- 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.

In October 2015, the EPA revised the PAMs monitoring network requirements in 40 CFR part 58. Beginning on June 1, 2019, state and local monitoring agencies are required to collect and report PAMS measurements at each NCore site located in a CBSA with a population of one million or more. The revised PAMS requirements will result in PAMS measurements at the NCore site in Blaine. Further details on Minnesota's implementation of the PAMS monitoring requirement will be included in the 2019 Annual Network Plan, which is due on July 1, 2018.

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, 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 (http://epa.gov/castnet).

There are two CASTNET sites in Minnesota (Figure 1). One site is located at Voyageurs National Park (VOYA2) and operated by the National Park Service. The other is in Red Lake (2304) and operated by the Red Lake Band of Chippewa Indians. The MPCA does not have any role in this monitoring.

Parameter networks

The MPCA monitors different types of measurable properties called parameters. The group of sites where a parameter is monitored is referred to as a parameter network. Generally, parameters are pollutants such as fine particles or air toxics. However, parameters also include non-concentration data such as wind speed and temperature.

The MPCA monitors the six criteria pollutants established by the 1970 CAA to show compliance with the NAAQS. The criteria pollutants are particulate matter ($PM_{2.5}$ and PM_{10}), lead (Pb), ozone (O_3), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and carbon monoxide (CO).

Other types of particulate matter are also collected in Minnesota. Total suspended particulate matter (TSP) is monitored to show compliance with Minnesota Ambient Air Quality Standards (MAAQS). Chemical speciation of $PM_{2.5}$ is currently monitored at five sites in Minnesota through the IMPROVE network and CSN. Speciation data are used for trends analysis and to better understand the sources of fine particles. In 2014, the MPCA began monitoring ultrafine particles (UFP) and black carbon at the near-road monitoring site (962) in Minneapolis.

The MPCA also monitors pollutants that pose a potential risk to human health and the environment, but are not regulated by standards including air toxics, acid rain, and mercury (Hg). Air toxics include volatile organic compounds (VOCs), carbonyls, and metals. Acid rain and mercury are monitored through the NADP network across Minnesota.

Compounds containing sulfur are also monitored since they may cause irritation to the eyes, nose, and throat. Hydrogen sulfide (H_2S) is monitored to show compliance with the MAAQS. Total reduced sulfur (TRS) contains H_2S; it is monitored around industrial sources and used as conservative measure to compare to the H_2S MAAQS.

Temperature, wind speed, wind direction, barometric pressure, and relative humidity strongly influence the concentrations and transport of pollutants. Meteorological data are collected at five sites in the Twin Cities metropolitan area. Meteorological data from other sources near air monitoring stations can also be used to help interpret air quality monitoring data.

Generally, parameters are monitored continuously or as integrated data. Continuous data gives readings on a real time basis, in short increments such as every 5 or 15 minutes or every hour. Integrated samples are usually 24-hour averages. Integrated samples are collected midnight to midnight once every three days or once every six days. Continuous data are collected and analyzed at the site. For integrated data, samples are collected at sites and then transported to the MPCA lab for further analysis.

Tables 7 and 8 list all of the air quality monitoring sites in Minnesota and the parameters monitored at each. Table 9 lists the types of parameters monitored by the MPCA along with the methods and equipment used.

Table 7: 2016 Site parameters - Greater Minnesota

MPCA Site ID	City Name	Site Name	$PM_{2.5}$ FRM	$PM_{2.5}$ FEM	$PM_{2.5}$ Speciation	PM_{10}	TSP and Metals	Ozone	Oxides of Nitrogen	Sulfur Dioxide	Carbon Monoxide	VOCs	Carbonyls	Other Parameters
MN08*	Hovland	Hovland												Acid Deposition
MN16*	Balsam Lake	Marcell												Acid and Hg Deposition
MN23*	Pillager	Camp Ripley												Acid and Hg Deposition
MN27*	Lamberton	Lamberton												Acid and Hg Deposition
MN28*	Sandstone	Grindstone Lake												Acid Deposition
MN32* VOYA1**	International Falls	Voyageurs			IMP			X						Acid Deposition
MN99*	Finland	Wolf Ridge												Acid Deposition
1300	Virginia	Virginia		X		X	X							
2013	Detroit Lakes	Detroit Lakes		X				X						
2304***	Red Lake	Red Lake Nation		X										
3051***	Mille Lacs	Mille Lacs						X						
3052	Saint Cloud	Talahi School		X				X						
3204	Brainerd	Brainerd Airport		X				X						
4210	Marshall	Marshall Airport		X				X						
5008	Rochester	Ben Franklin School	X	X				X		X				
5302	Stanton	Stanton Air Field						X						
7001 MN18* BOWA1**	Ely	Fernberg Road		X	IMP			X						Acid and Hg Deposition
7417***	Cloquet	Cloquet		X				X						
7545	Duluth	Oneota Street				X								Collocated PM_{10}
7549	Duluth	Michigan Street					X					X	X	
7550	Duluth	WDSE	X					X						Collocated $PM_{2.5}$ FRM
7554	Duluth	Laura MacArthur School	X	X										
7555	Duluth	Waseca Road					X							Collocated TSP and metals
7810***	Grand Portage	Grand Portage		X										
GRRI1**	Winona	Great River Bluffs			IMP									

*NADP Site ID (no MPCA site ID exists)
**IMPROVE Site ID (no MPCA site ID exists and not an NADP site)
*** Tribal monitor

Table 8: 2016 Site parameters - Twin Cities metropolitan area

MPCA Site ID	City Name	Site Name	$PM_{2.5}$ FRM	$PM_{2.5}$ FEM	$PM_{2.5}$ Speciation	PM_{10}	TSP and Metals	Ozone	Oxides of Nitrogen	Sulfur Dioxide	Carbon Monoxide	VOCs	Carbonyls	Other Parameters
250	St. Louis Park	St. Louis Park	X									X	X	
420	Rosemount	Flint Hills Refinery 420					X		X	X	X	X	X	Collocated TSP and Metals, TRS, PAH, Meteorological Data
423	Rosemount	Flint Hills Refinery 423					X		X	X	X	X	X	TRS, Meteorological Data
436	St. Paul Park	St. Paul Park Refinery 436								X		X	X	TRS, Collocated VOCs and Carbonyls
438	Newport	St. Paul Park Refinery 438					X					X	X	
443	Rosemount	Flint Hills Refinery 443								X		X	X	
446	Bayport	Point Road					X					X	X	
465	Eagan	Gopher Resources					X[L]							Collocated TSP and Metals
470	Apple Valley	Apple Valley	X	X			X					X	X	
480	Lakeville	Near Road I35		X					X		X			Meteorological Data
505	Shakopee	Shakopee	X					X						
818	St. Paul	St. Paul Downtown Airport					X							
861	St. Paul	Lexington Avenue									X			
866	St. Paul	Red Rock Road				X								Collocated PM_{10}
868	St. Paul	Ramsey Health Center	X			X[C]						X	X	[C]PM_{10} Continuous, Fibers
871	St. Paul	Harding High School	X	X			X					X	X	Collocated $PM_{2.5}$ FRM and $PM_{2.5}$ FEM
907	Minneapolis	Humboldt Avenue					X					X	X	PAH
909	Minneapolis	Lowry Ave				X[C]	X					X	X	Meteorological Data
910	Minneapolis	Pacific Street				X[C]	X							
954	Minneapolis	Arts Center								X	X			
961	Richfield	Richfield Intermediate School										X	X	
962	Minneapolis	Near Road I35/I94		X			X	X	X		X	X	X	Meteorological Data, Ultrafine Particle Counter, Black Carbon
963	Minneapolis	H.C. Andersen School	X	X	CSN		X					X	X	PAH
966	Minneapolis	City of Lakes				X	X					X	X	Collocated VOCs and Carbonyls
1908	St. Paul	South St. Anthony Park		X			X					X	X	
3201	Saint Michael	Saint Michael		X				X						
6010	Blaine	Anoka Airport	X	X	CSN	X[C]	X[PL]	X	X[T]	X[T]	X[T]	X	X	[C]PM_{10} Continuous, [T]NCore trace level gases, Hg Deposition, $PM_{10-2.5}$, and Meteorological Data
6012	East Bethel	Cedar Creek						X						Acid Deposition
6016	Marine on St. Croix	Marine on St. Croix						X						

[L]Source-oriented Lead [PL]Population-oriented Lead

Table 9: Methods and equipment

Monitoring parameter	Methods and equipment	Analyzing agency
Acid Deposition	Wet-only precipitation collection, Chromatography analysis	NADP
Black Carbon	Teledyne API Model 633	MPCA
Carbonyls	Liquid Chromatography – ATEC Model 2200 sampler	MPCA
CO	Infrared Absorption – Teledyne API Models 300E/T300	MPCA
CO trace level	Infrared Absorption – Teledyne API Model T300U	MPCA
Fibers	MDH Method 852 – TE-2000 TSP sampler	MDH
H_2S	Honeywell Analytics MDA Model SPM Chemcassette	MPCA
Mercury Deposition	Wet-only precipitation collection, Inductively Coupled Argon Plasma analysis	NADP
Metals	Inductively Coupled Argon Plasma (ICP-OES) from TSP filters	MPCA
Meteorological Data	Various meteorological sensors	MPCA
NO/NO_y trace level	Chemiluminescence – Teledyne API Model T200U	MPCA
NO_X	Chemiluminescence – Teledyne API Models 200A/T200	MPCA
O_3	Ultraviolet Absorption – Teledyne API Models 400E/ T400	MPCA
PM_{10}	Gravimetric – Andersen Hi-Vol samplers	MPCA
PM_{10} Continuous	Beta Attenuation – MetOne Instruments BAM-1020	MPCA
$PM_{10-2.5}$	Beta Attenuation – MetOne Instruments BAM-1020	MPCA
$PM_{2.5}$ Continuous	Beta Attenuation – MetOne Instruments BAM-1020	MPCA
$PM_{2.5}$ FEM	Beta Attenuation – MetOne Instruments BAM-1020 FEM	MPCA
$PM_{2.5}$ FRM	Gravimetric – Thermo Partisol-Plus Model 2025 $PM_{2.5}$ Sequential Air Sampler	MPCA
$PM_{2.5}$ Speciation - CSN	Gravimetric, GC/MS, Ion Chromatography – MetOne Instruments SAAS Speciation Sampler; URG3000N Carbon Samplers	US EPA
$PM_{2.5}$ Speciation - IMPROVE	Gravimetric, GC/MS, Ion Chromatography – IMPROVE Speciation Sampler	IMPROVE
SO_2	Pulsed Fluorescence – Teledyne API Models 100E/T100	MPCA
SO_2 trace level	Pulsed Fluorescence – Teledyne API Model T100U	MPCA
TRS	SO_2 analyzer (pulsed fluorescence) with thermal oxidizer	MPCA
TSP	Gravimetric – Andersen Hi-Volume samplers	MPCA
Ultrafine Particles	TSI Model 3031 Ultrafine Particle Monitor	MPCA
VOCs	Gas Chromatography and Mass Spectrometry – ATEC Model 2200 sampler	MPCA

Criteria pollutants

In 1970, the CAA authorized the EPA to establish standards for six pollutants known to cause harm to human health and the environment. The CAA requires states, so subsequently the MPCA, to monitor these pollutants called criteria pollutants, and report the findings to the EPA. The criteria pollutants are particulate matter ($PM_{2.5}$ and PM_{10}), lead (Pb), ozone (O_3), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and carbon monoxide (CO).

For each of these pollutants the EPA has developed national primary and secondary ambient air monitoring concentration standards (NAAQS). Primary standards are set to protect public health, while the secondary standard is set to protect the environment and public welfare (i.e. visibility, crops, animals, vegetation, and buildings).

The CAA requires the EPA to review the scientific basis of these standards every five years to ensure they are protective of public health and the environment. Table 10, found on the EPA website at https://www.epa.gov/criteria-air-pollutants/naaqs-table, describes the NAAQS standards (as of June 2016).

Table 10: National Ambient Air Quality Standards (NAAQS)

Pollutant [final rule cite]		Primary/ Secondary	Averaging Time	Level	Form
Carbon Monoxide [76 FR 54294, Aug 31, 2011]		primary	8-hour	9 ppm	Not to be exceeded more than once per year
			1-hour	35 ppm	
Lead [73 FR 66964, Nov 12, 2008]		primary and secondary	Rolling 3 month average	0.15 μg/m³ (1)	Not to be exceeded
Nitrogen Dioxide [75 FR 6474, Feb 9, 2010] [61 FR 52852, Oct 8, 1996]		primary	1-hour	100 ppb	98th percentile, averaged over 3 years
		primary and secondary	Annual	53 ppb (2)	Annual Mean
Ozone [80 FR 65292, Oct 26, 2015]		primary and secondary	8-hour	0.070 ppm (3)	Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years
Particle Pollution 78 FR 3086, Jan 15, 2013	$PM_{2.5}$	primary	Annual	12 μg/m³	annual mean, averaged over 3 years
		secondary	Annual	15 μg/m³	annual mean, averaged over 3 years
		primary and secondary	24-hour	35 μg/m³	98th percentile, averaged over 3 years
	PM_{10}	primary and secondary	24-hour	150 μg/m³	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide [75 FR 35520, Jun 22, 2010] [38 FR 25678, Sept 14, 1973]		primary	1-hour	75 ppb (4)	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		secondary	3-hour	0.5 ppm	Not to be exceeded more than once per year

(1) Final rule signed October 15, 2008. The 1978 lead standard (1.5 µg/m3 as a quarterly average) remains in effect until one year after an area is designated for the 2008 standard, except that in areas designated nonattainment for the 1978, the 1978 standard remains in effect until implementation plans to attain or maintain the 2008 standard are approved.

(2) The official level of the annual NO2 standard is 0.053 ppm, equal to 53 ppb, which is shown here for the purpose of clearer comparison to the 1-hour standard.

(3) Final rule signed October 1, 2015, and effective December 28, 2015. The previous (2008) O3 standards additionally remain in effect in some areas. Revocation of the previous (2008) O3 standards and transitioning to the current (2015) standards will be addressed in the implementation rule for the current standards.

(4) Final rule signed June 2, 2010. The 1971 annual and 24-hour SO2 standards were revoked in that same rulemaking. However, these standards remain in effect until one year after an area is designated for the 2010 standard, except in areas designated nonattainment for the 1971 standards, where the 1971 standards remain in effect until implementation plans to attain or maintain the 2010 standard are approved.

Particulate matter

The MPCA monitors five different particle fractions: ultrafine particulate matter (UFP) which has an aerodynamic diameter of less than 0.1 microns, fine particulate matter ($PM_{2.5}$), coarse particulate matter ($PM_{10-2.5}$) which has an aerodynamic diameter ranging from 2.5 to 10 microns, PM_{10}, and total suspended particulate matter (TSP) which includes the total mass of particles found in a sample of ambient air. $PM_{2.5}$ and PM_{10} are regulated by the NAAQS and TSP is regulated by the MAAQS. There are currently no air quality standards for UFP or $PM_{10-2.5}$.

Ultrafine Particulate (UFP)

UFPs are particulate matter with an aerodynamic diameter less than 0.1 microns. UFPs are released directly into the air through combustion and are also formed in the environment when other pollutant gases react in the air. Motor vehicles are a significant source of UFPs with the highest levels found along roadways. Similar to $PM_{2.5}$, UFPs can be inhaled deeply into the lungs and may enter the blood stream, impacting respiratory and cardiovascular health. However, due to their small size and unique physical characteristics, emerging health research suggests that exposure to UFPs may be a more significant driver of health effects than exposure to $PM_{2.5}$. To date, the EPA has found insufficient health evidence to support the creation of a distinct UFP standard but continues to examine the evidence

In 2014, the MPCA installed an UFP monitor at the near-road monitoring site (962) along I-94 and I-35W in Downtown Minneapolis. In contrast to particulate monitors for $PM_{2.5}$, $PM_{10-2.5}$, PM_{10}, and TSP, which measure the total mass of particles in a sample of air, the UFP monitor counts the number of particles contained in the sample across six distinct size fractions (20–30 nm, 30–50 nm, 50–70 nm, 70–100 nm, 100–200 nm, and 200-1000 nm).

The addition of an UFP monitor in Minnesota's particulate monitoring network should support future research activities ranging across technological, health, and atmospheric process disciplines and should help inform future long-term health assessments that contribute to ongoing reviews of the NAAQS.

Fine particulate matter ($PM_{2.5}$)

$PM_{2.5}$ is a chemically and physically diverse mixture of different sizes of very small particles smaller than 2.5 microns in diameter. It is comprised of a complex mixture of chemicals including ammonium sulfate, ammonium nitrate, particle-bound water, elemental carbon, hundreds or thousands of organic compounds, and inorganic material including soil and metals.

$PM_{2.5}$ can be inhaled deeply into the lungs. 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.

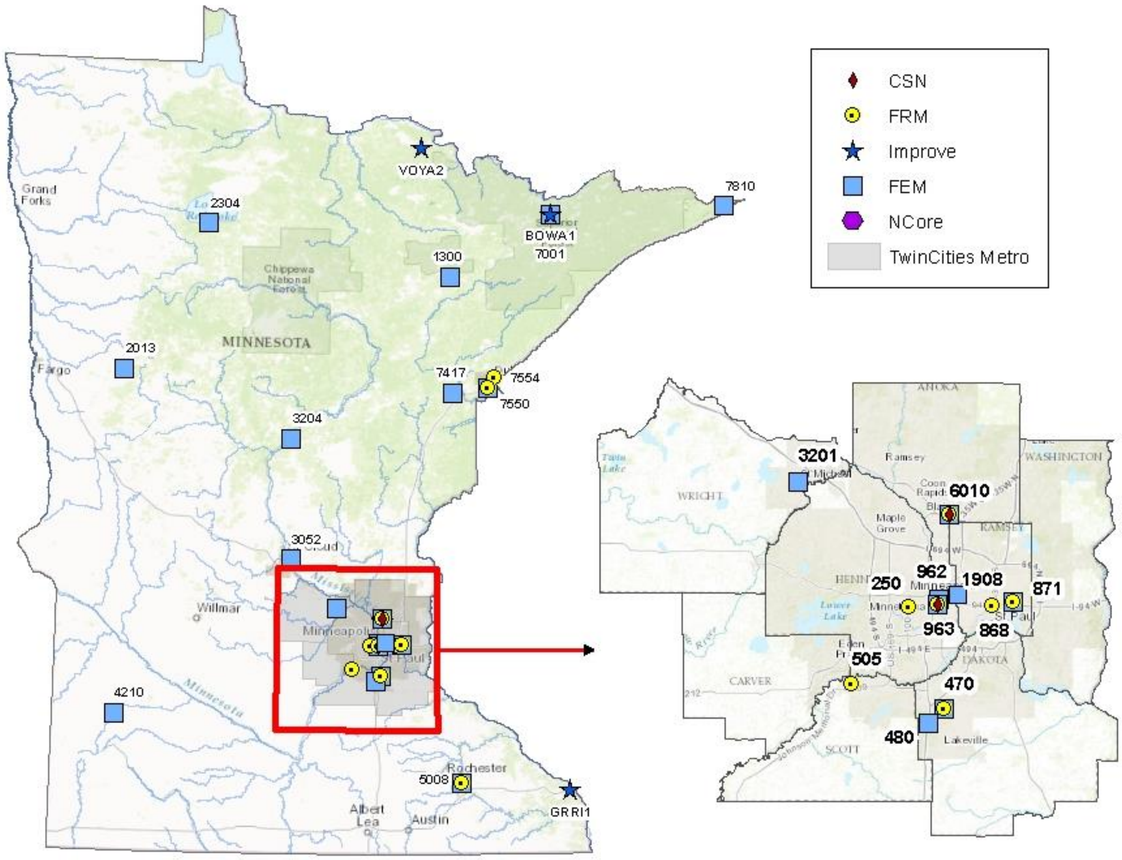
There are currently 25 $PM_{2.5}$ sites in Minnesota, 11 of which are in the Twin Cities metropolitan area (Figure 6). Five types of $PM_{2.5}$ monitors operate in Minnesota: Federal Reference Method (FRM), Federal Equivalent Method (FEM), monitors in the Chemical Speciation Network (CSN), and monitors in the IMPROVE network. Monitors classified as FRM or FEM are regulatory grade monitors and can be used to demonstrate compliance with the $PM_{2.5}$ NAAQS. Monitors in the CSN and IMPROVE networks are not eligible for regulatory comparisons.

The FRM monitors collect a 24-hour mass sample of $PM_{2.5}$ on Teflon filters. All FRM sites in Minnesota run once every three days. $PM_{2.5}$ data collected using this method are compared to the NAAQS to demonstrate compliance.

The FEM $PM_{2.5}$ monitors are Met One Instruments BAM-1020 (BAM) continuous mass monitors that collect and report hourly $PM_{2.5}$ concentrations. All BAM monitors operating in Minnesota are designated as FEM and can be used to demonstrate compliance with the $PM_{2.5}$ NAAQS. 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) and the EPA's AIRNow website (http://airnow.gov/) as well as the Air Quality System (AQS).

CSN and IMPROVE monitors collect 24-hour samples once every three days and are analyzed for chemical composition. Data from the $PM_{2.5}$ speciation networks are used for trends analysis and to better understand sources and health effects.

Figure 6: 2016 $PM_{2.5}$ monitoring sites in Minnesota



$PM_{2.5}$ regulatory network

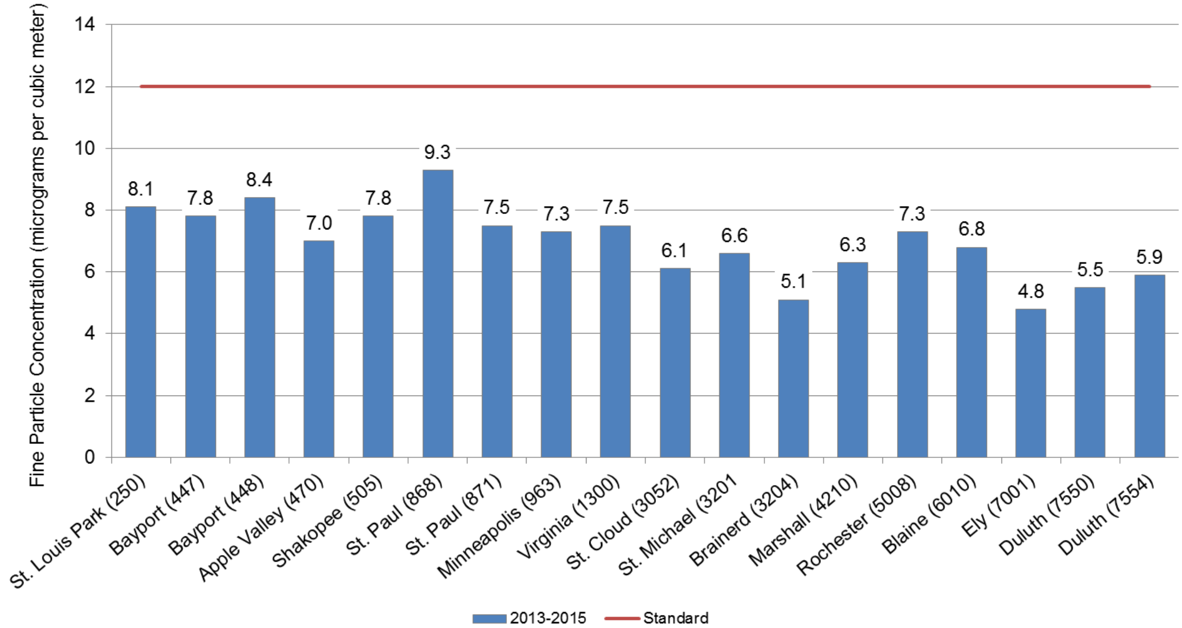
The $PM_{2.5}$ regulatory network includes FRM and FEM monitors. Currently the MPCA operates FRM monitors at 10 sites and FEM monitors at 19 sites (Figure 6).

In 2016 a $PM_{2.5}$ FEM monitor was added to Grand Portage (7810). In addition, a special purpose $PM_{2.5}$ FEM monitor was added to a short term site (1908) as part of the Community Air Monitoring Project. This project will continue at a different site in 2017; more information can be found on the Community Air Monitoring Project website (http://www.pca.state.mn.us/9xc4ahc). No other changes are expected to the $PM_{2.5}$ regulatory network in 2017.

If a $PM_{2.5}$ FRM monitoring site were lost due to circumstances beyond the MPCA's control, a replacement site would be established if the lost site exceeded the NAAQS or if it is the "design value site" for a particular metropolitan statistical area (MSA). In this case, all possible efforts would be made to find a new site that is physically close to the lost site and has a similar scale and monitoring objective. However, if the "design value site" for that MSA is still operational, the MPCA would not establish a replacement site because the "design value site" would be used to determine compliance with the $PM_{2.5}$ NAAQS.

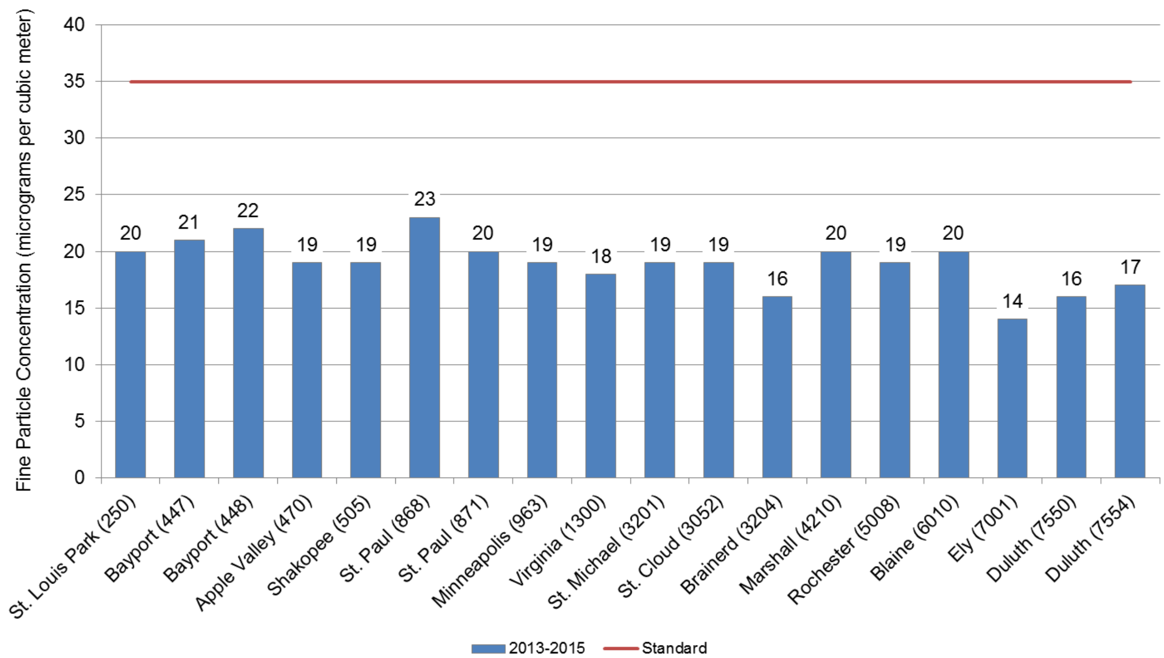
A monitoring site meets the annual $PM_{2.5}$ NAAQS if the three-year average of the annual average $PM_{2.5}$ concentration is less than or equal to 12 $\mu g/m^3$. Figure 7 shows the average of the 2013 through 2015 annual average $PM_{2.5}$ concentrations at Minnesota sites and compares them to the standard. Minnesota averages ranged from 4.8 μg/m^3 in Ely (7001) to 9.3 μg/m^3 in St. Paul (868); therefore, all sites were below the annual standard.

Figure 7: Annual $PM_{2.5}$ concentrations compared to the NAAQS



A site meets the 24-hour NAAQS if the 98th percentile of the 24-hour $PM_{2.5}$ concentrations in a year, averaged over three years, is less than or equal to 35 μg/m^3. Figure 8 shows the average of 2013 through 2015 98th percentile of the daily $PM_{2.5}$ averages at Minnesota sites and compares them to the standard. Minnesota averages ranged from 14 μg/m^3 in Ely (7001) to 23 μg/m^3 in St. Paul (868); therefore, all sites were below the 24-hour standard.

Figure 8: 24-hour $PM_{2.5}$ concentrations compared to the NAAQS



$PM_{2.5}$ continuous network

The MPCA currently operates 19 FEM $PM_{2.5}$ sites in Minnesota. This includes an FEM $PM_{2.5}$ monitor at Grand Portage (7810) which is owned and operated by the Grand Portage Band of Lake Superior Chippewa. A special purpose monitor will be removed from a Community Air Monitoring Project site in 2016 and moved to a new location in 2017.

The $PM_{2.5}$ continuous data provides two key types of information that are not available from the FRM network. Continuous data capture high concentration days that might be missed in the one in three day FRM sampling schedule. Daily monitoring also allows for temporal comparisons between sites on an ongoing basis, providing better comparisons. In addition, continuous $PM_{2.5}$ monitoring provides hourly data that assists in understanding how concentrations vary throughout the day. Understanding these daily fluctuations helps determine sources of $PM_{2.5}$ and when health risks from fine particles are greatest. This increased understanding of concentrations and risks aids in prioritizing emission reduction efforts.

Figure 9 shows daily average $PM_{2.5}$ concentrations from six FEM monitors across Minnesota. This chart illustrates how continuous data show the variability between sites. $PM_{2.5}$ is a regional pollutant with some addition from local sources; therefore, concentrations tend to rise and fall in unison across the state. The differences in concentrations between sites tend to be driven by local sources and closer proximity to large urban areas to the south. The difference between urban and rural areas demonstrates the effect of man-made sources on fine particulate concentrations.

Figure 9: $PM_{2.5}$ daily average concentrations at several Minnesota sites in August 2015

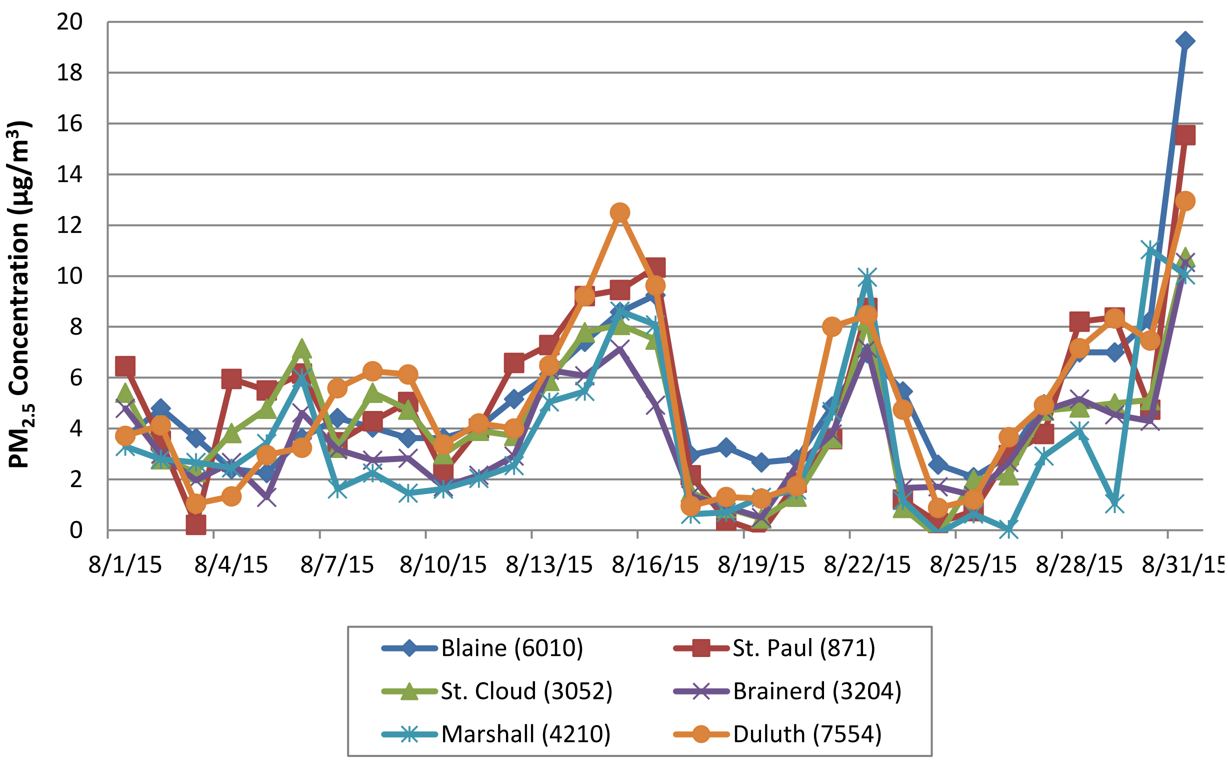
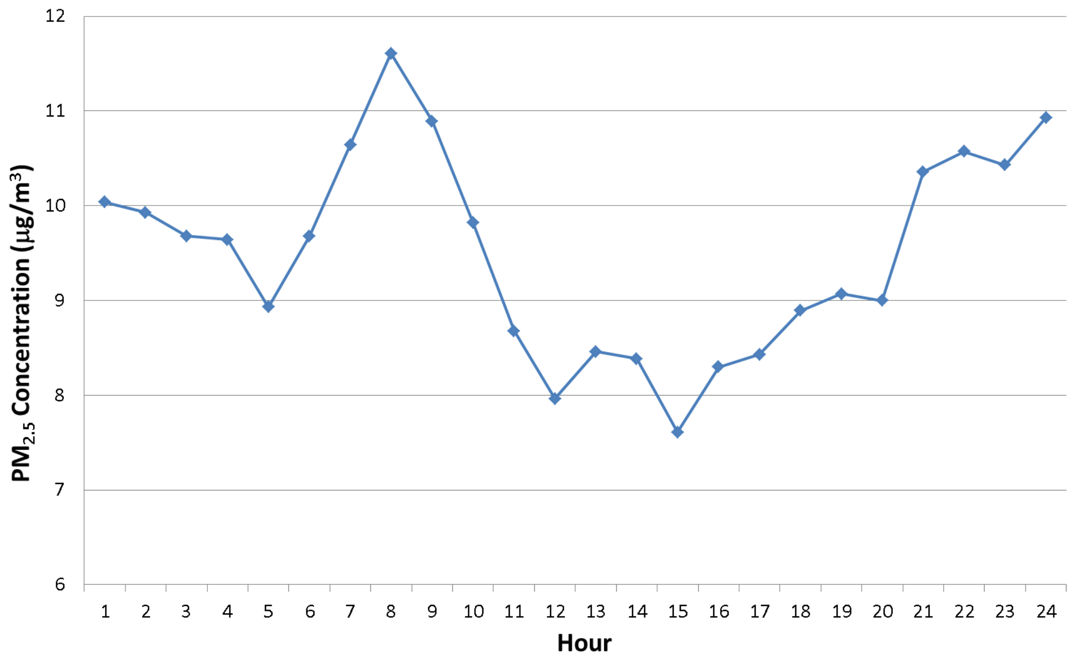


Figure 10 shows the average hourly concentrations in February 2015 in St. Paul (871). It shows a classic traffic pattern in an urban area. The mid-morning peak concentration results from traffic. As temperatures rise in the day, the atmospheric mixing height increases. This allows for dilution of fine particle concentrations and lowered concentrations throughout the afternoon. Temperatures fall in the evening, lowering the mixing height and trapping the particles, including those emitted during evening rush hour. This results in elevated concentrations throughout the night.

Figure 10: $PM_{2.5}$ average hourly concentrations at Harding High School (871) in February 2015



$PM_{2.5}$ speciation

Currently, five monitors measure $PM_{2.5}$ chemical speciation in Minnesota. Figure 1 shows the locations of the sites in Minnesota. The monitors in Minneapolis (963) and Blaine (6010) are part of the EPA's CSN (http://www.epa.gov/ttn/amtic/speciepg.html) which focuses on urban locations. The monitors at Voyageurs (VOYA2), Ely (BOWA1), and Great River Bluffs (GRRI1) are part of the IMPROVE network (http://vista.cira.colostate.edu/IMPROVE/) which focuses on visibility issues primarily in rural locations. Sampling frequency for these sites is once every three days. Samples are analyzed at contract labs selected by the EPA and the IMPROVE program.

The particulate monitoring portion of the IMPROVE program measures $PM_{2.5}$ for optical absorption, major and trace elements, organic and elemental carbon, and nitrate. CSN monitoring is similar except that it also includes analysis for ammonium and does not include optical absorption.

Coarse particulate matter ($PM_{10-2.5}$)

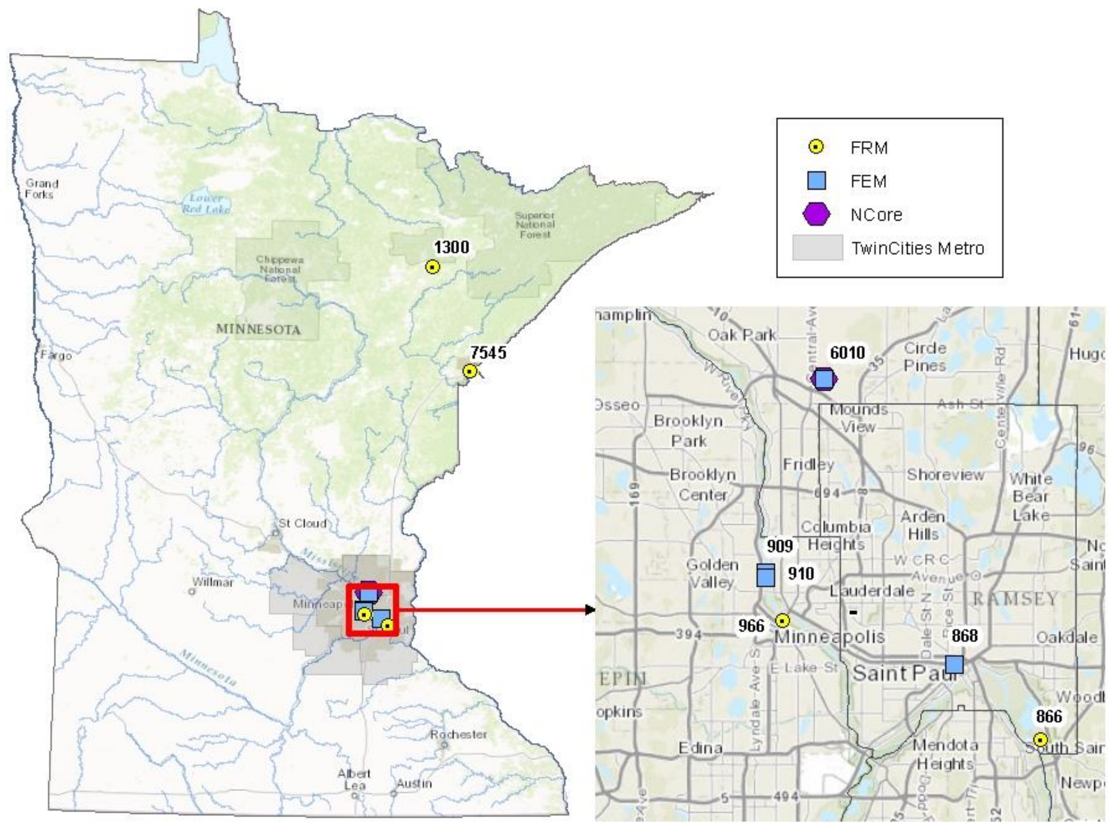
The national monitoring requirements defined in Appendix D of 40 CFR Part 58 contain a requirement for $PM_{10-2.5}$ mass monitoring to be conducted at NCore multipollutant monitoring sites. The MPCA started monitoring $PM_{10-2.5}$ at the NCore site in Blaine (6010) in 2011. No additional sites are expected at this time.

PM_{10}

PM_{10} includes all particles with an aerodynamic diameter less than 10 microns. Short-term exposure to PM_{10} is linked to hospitalization and 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.

The MPCA currently operates four PM_{10} FRM monitors. This method collects mass samples of PM_{10} over a 24-hour period once every six days. There are also continuous PM_{10} FEM monitors that measure hourly PM_{10} concentrations at four sites: St. Paul (868), Minneapolis (909), Minneapolis (910), and Blaine (6010). Figure 11 shows the locations of the PM_{10} monitors in Minnesota in 2016. The majority of the PM_{10} monitors are located in the Twin Cities metropolitan area with additional monitors in Duluth (7545) and Virginia (1300). No changes to the PM_{10} network are expected in 2017.

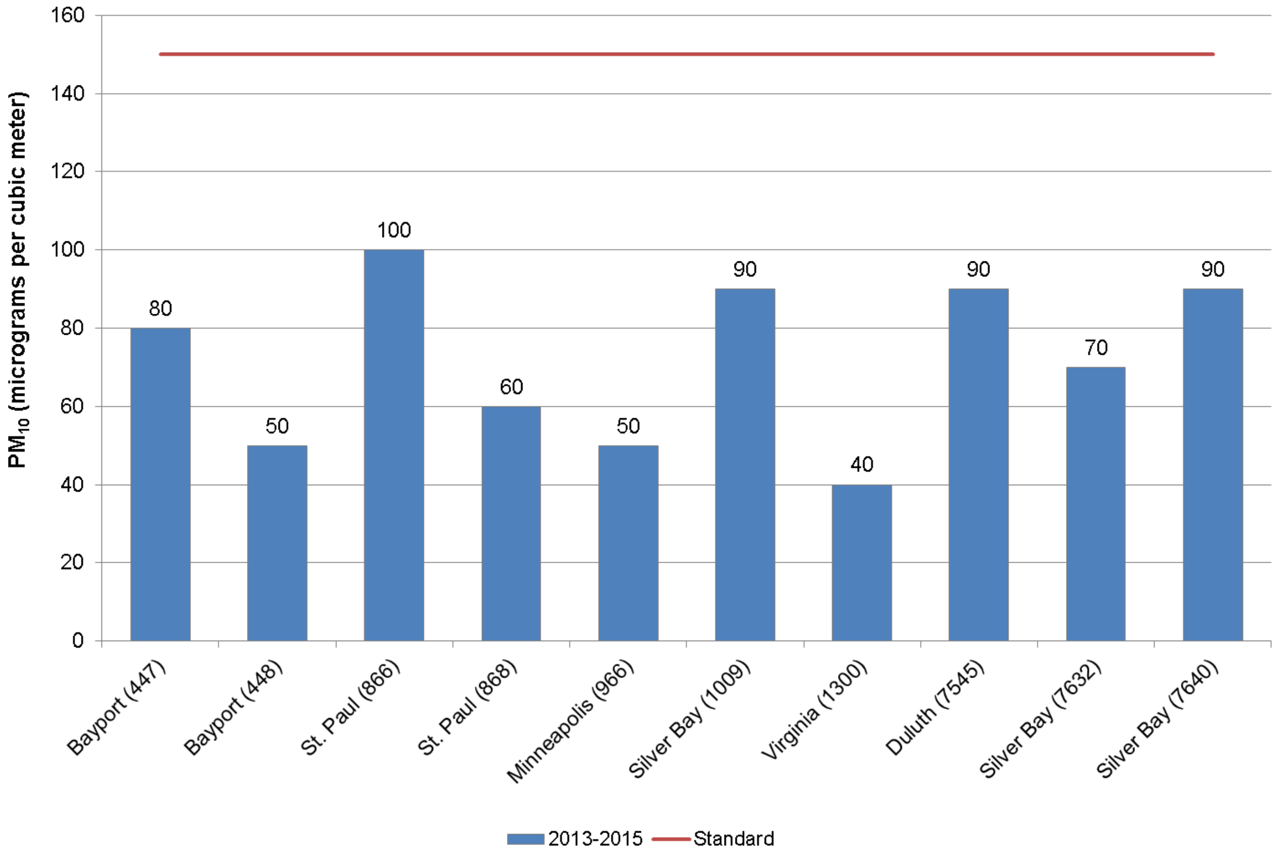
Figure 11: 2016 PM_{10} monitoring sites in Minnesota



Minnesota currently meets applicable NAAQS for PM_{10} at sites with three years of complete data. A monitoring site meets the 24-hour PM_{10} NAAQS when the level of 150 µg/m^3 is not exceeded more than once per year on average over 3-years.

To describe the magnitude of daily PM_{10} measurements, the MPCA reports the daily PM_{10} background concentration, which is calculated following the methodology established in EPA's "PM_{10} SIP Development Guidance" (EPA-450/2-86-001, June 1987, Table 6-1). Depending on the total number of samples collected over a three-year period, the daily PM_{10} background concentration is calculated as the 1st, 2nd, 3rd or 4th highest daily PM_{10} concentration measured over three-years. Figure 12 shows the 2013-2015 daily PM_{10} background concentration at Minnesota sites. The Minnesota values ranged from 40 µg/m^3 in Virginia (1300) to 100 µg/m^3 in St. Paul (866). While there is no annual NAAQS for PM_{10}, there is a Minnesota Ambient Air Quality Standard (MAAQS). All PM_{10} monitoring sites with three-years of data meet the annual PM_{10} MAAQS of 50 µg/m^3.

Figure 12: 24-hour PM_{10} concentrations compared to the NAAQS



Total suspended particulate matter (TSP)

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. TSP was one of the original NAAQS; however, it was replaced in 1987 by the PM_{10} standard at the national level. Generally, more health effects are expected from smaller particles such as PM_{10} and $PM_{2.5}$. Today, TSP levels are regulated by the MAAQS in Minnesota. The MAAQS includes four distinct standards for TSP. These standards include:

Table 11: Minnesota Ambient Air Quality Standards for TSP

Standard Type	Time Interval	Level of Standard	A monitoring site meets the standard if…
Primary[1]	Daily (24-hour)	260 micrograms per cubic meter	...the annual 2nd highest daily TSP concentration is less than or equal to 260 µg/m³
	Annual	75 micrograms per cubic meter	...the annual geometric mean is less than or equal to 75 µg/m³
Secondary[2]	Daily (24-hour)	150 micrograms per cubic meter	...the annual 2nd highest daily TSP concentration is less than or equal to 150 µg/m³
	Annual	60 micrograms per cubic meter	...the annual geometric mean is less than or equal to 60 µg/m³

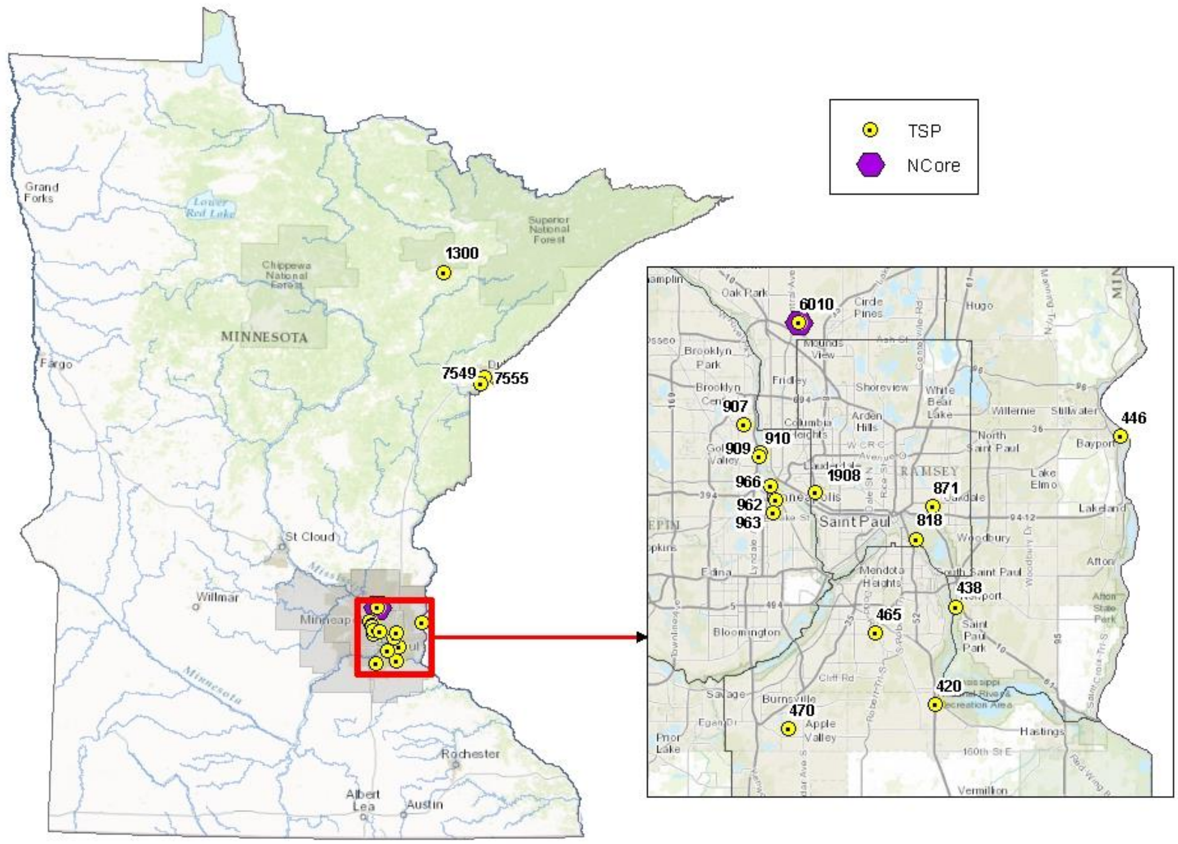
[1]A primary standard is set to protect against human health effects associated with exposure to an air pollutant.
[2]A secondary standard is set to protect against environmental or public welfare effects associated with exposure to an air pollutant.

The MPCA currently operates 18 TSP monitoring sites; figure 13 shows the location of the sites. Mass samples of TSP are collected over a 24-hour period once every six days. TSP filters are also analyzed using Inductively Coupled Argon Plasma (ICAP) for metals as part of the air toxics program. Metals are discussed further in the air toxics section of this report.

Following violations of the secondary daily TSP MAAQS at site in 909 in 2014 and 2015, a TSP monitor was added to a new site in Minneapolis (910) in June 2015. The violations at site 909 remain under investigation. More information is available on the MPCA's website, https://www.pca.state.mn.us/air/north-minneapolis-air-monitoring-project.

In 2016 a TSP monitor was also added to South St. Anthony Park (1908) as part of the Community Air Monitoring Project; more information can be found on the project website (https://www.pca.state.mn.us/air/community-air-monitoring-project). This project will continue in 2017. No other changes to the TSP network are expected in 2017.

Figure 13: 2016 TSP monitoring sites in Minnesota



In 2016, one site violated the annual TSP MAAQS and two sites violated the secondary daily TSP MAAQS. These violations of the TSP MAAQS have occurred at two sites in North Minneapolis (909 & 910) that bracket the Northern Metals facility. Because site 910 was not established until the summer of 2015, an annual average concentration cannot be calculated for 2015.More information about the MPCA's action to resolve the ongoing TSP exceedances at the Lowry Ave (909) and Pacific Street (910) sites is available on the MPCA's website, https://www.pca.state.mn.us/air/north-minneapolis-air-monitoring-project.

Figure 14 shows the 2015 annual average TSP concentrations at Minnesota sites and compares them to the secondary standard. Minnesota averages ranged from 14 $\mu g/m^3$ in Silver Bay (7641) to 80 $\mu g/m^3$ at the Minneapolis Lowry Avenue (909) site. The Lowry Avenue site has violated the primary and secondary annual TSP standard in 2015. All other sites meet the primary and secondary TSP standards.

Figure 14: Annual average TSP concentrations compared to the secondary MAAQS

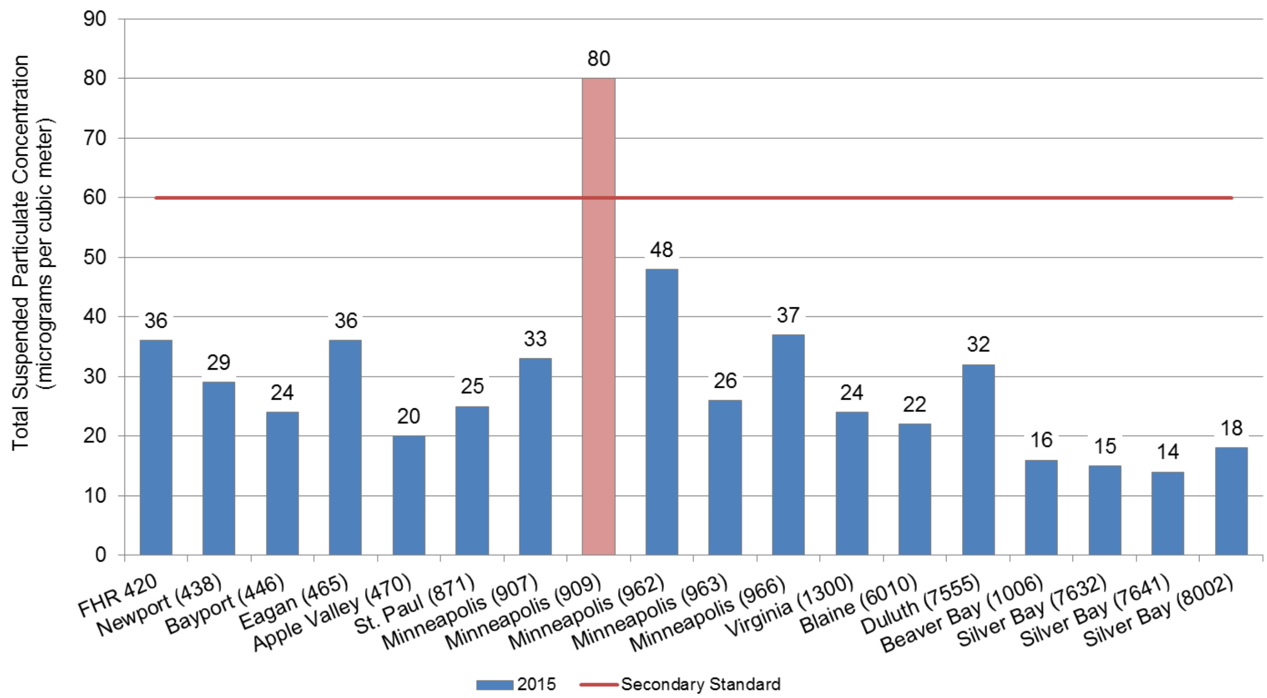
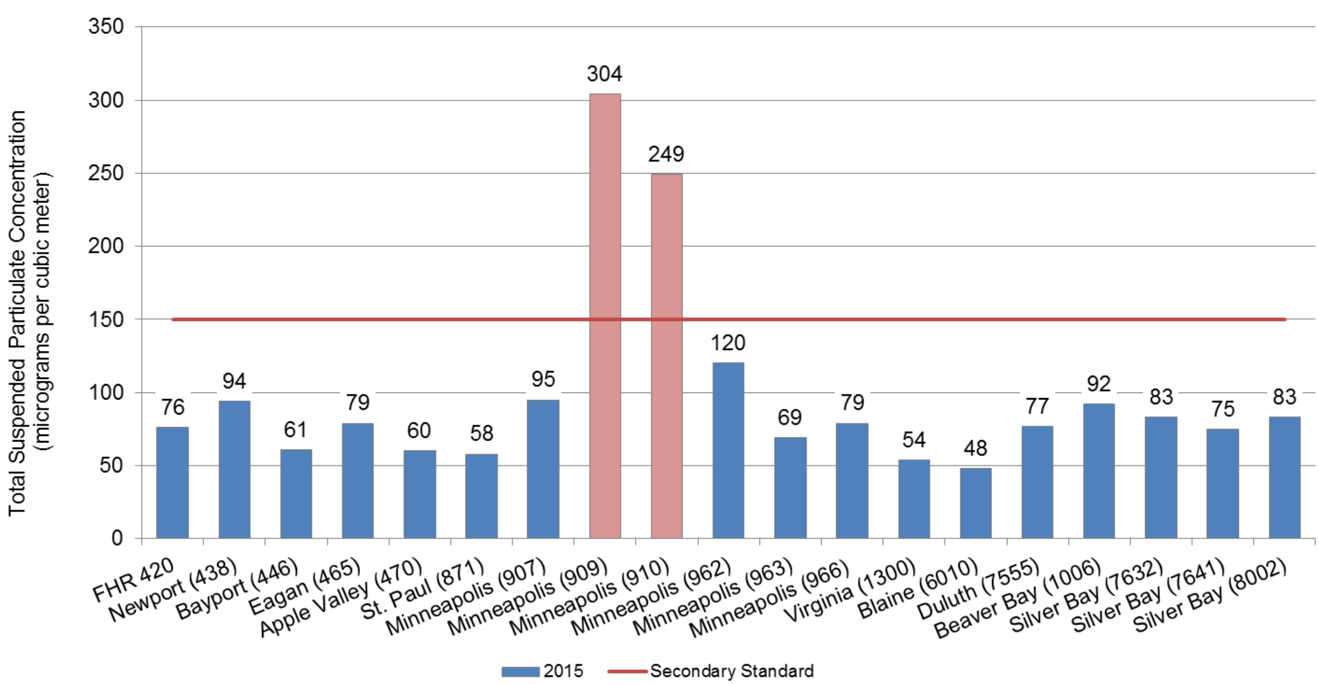


Figure 15 shows the 2015 second highest daily maximum TSP concentrations at Minnesota sites and compares them to the secondary TSP standard. Minnesota values ranged from 48 μg/m³ in Blaine (6010) to 304 μg/m³ at the Minneapolis Lowry Avenue site (909). In 2015, the TSP monitoring sites at Lowry Ave (909) and Pacific Street (910) violated the secondary daily TSP standard. The Lowry Avenue site also violated the primary daily TSP standard. All other sites met the primary and secondary daily TSP standards.

Figure 15: 24-hour TSP concentrations compared to the secondary MAAQS



Lead (Pb)

Lead (Pb) is a metal found naturally in the environment as well as in manufactured products. Since Pb was phased out of gasoline, air emissions and ambient air concentrations have decreased dramatically. Currently, metals processing facilities (Pb and other metals smelters) and leaded aviation fuel are the primary sources of Pb emissions.

Pb emitted into the air can be inhaled directly or ingested after it settles onto surfaces or soils. Scientific evidence about the health effects of Pb has expanded significantly in the last 30 years. Exposures to low levels early in life have been linked to effects on IQ, learning, memory, and behavior. There is no known safe level of Pb in the body.

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.

Figure 16 shows the locations where Pb is monitored in 2016. The MPCA monitors Pb at one source-oriented monitoring site in Eagan (465) and at one population-oriented NCore site in Blaine (6010). As part of our Air Toxics Program, the MPCA also monitors Pb and 12 other heavy metals at 10 additional TSP sites. As discussed in the TSP section, a TSP monitor will be added to a short term site as part of the Community Air Monitoring Project in 2017; more information can be found on the project website (https://www.pca.state.mn.us/air/community-air-monitoring-project).

All Pb monitoring sites in Minnesota meet the 2008 Pb NAAQS of 0.15 µg/m^3. Figure 17 shows the 3-year maximum rolling quarter average concentration at monitored sites from 2013-2015. Minnesota values range from 0.00 µg/m^3 in Bayport (446) to 0.13 µg/m^3 in Eagan (465) with the majority of sites below 0.01µg/m^3.

Figure 16: 2016 Lead monitoring sites in Minnesota

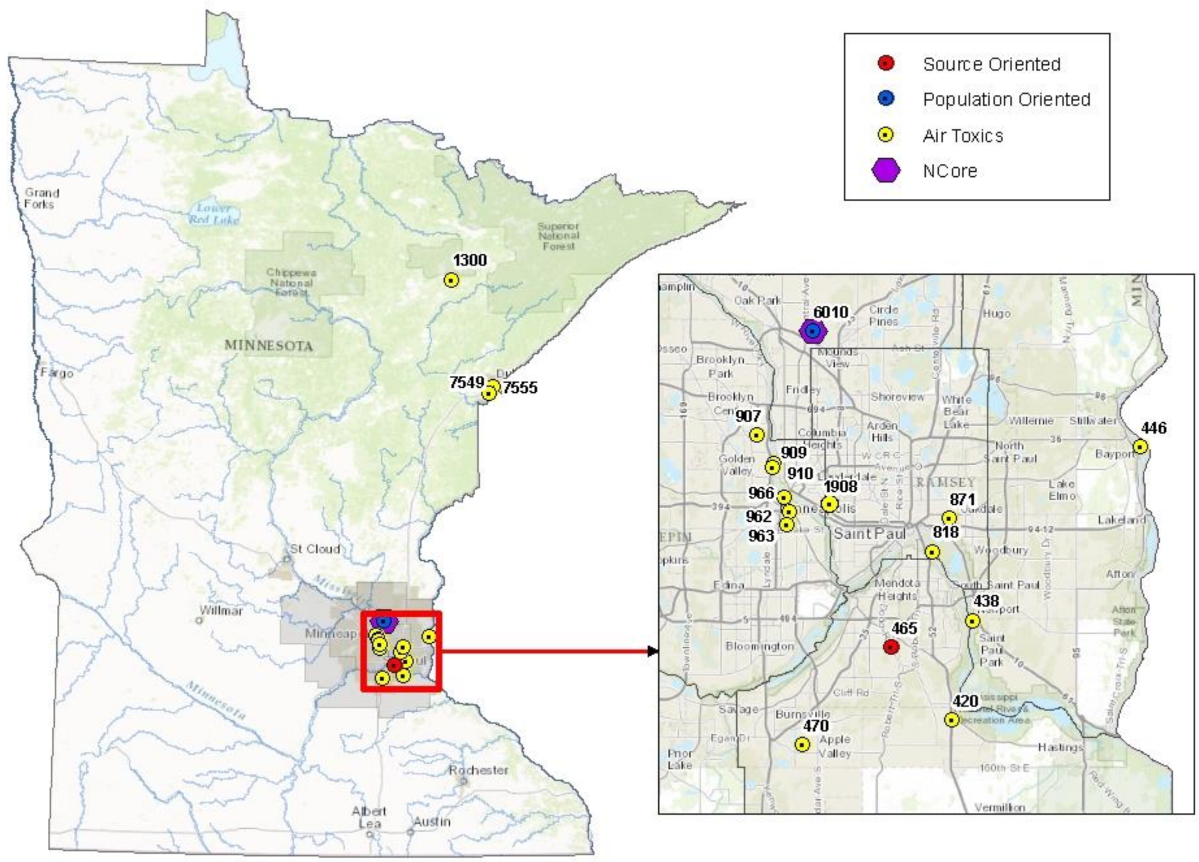
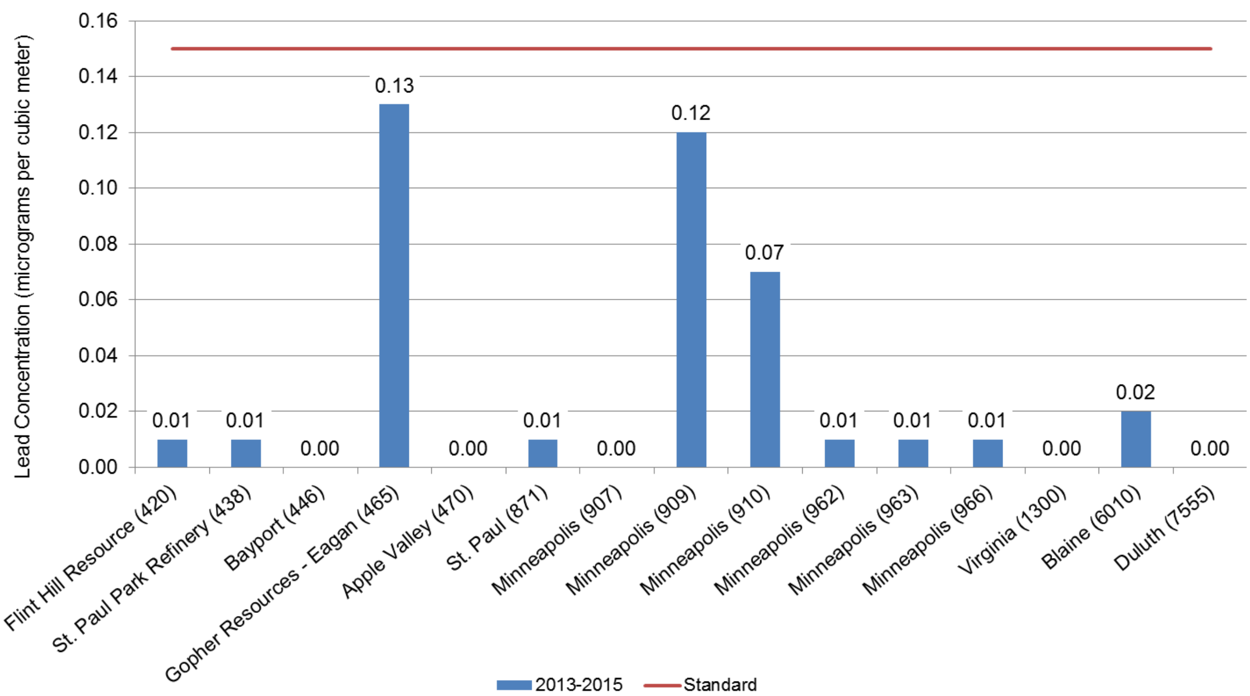


Figure 17: Lead concentrations compared to the NAAQS



Ozone (O_3)

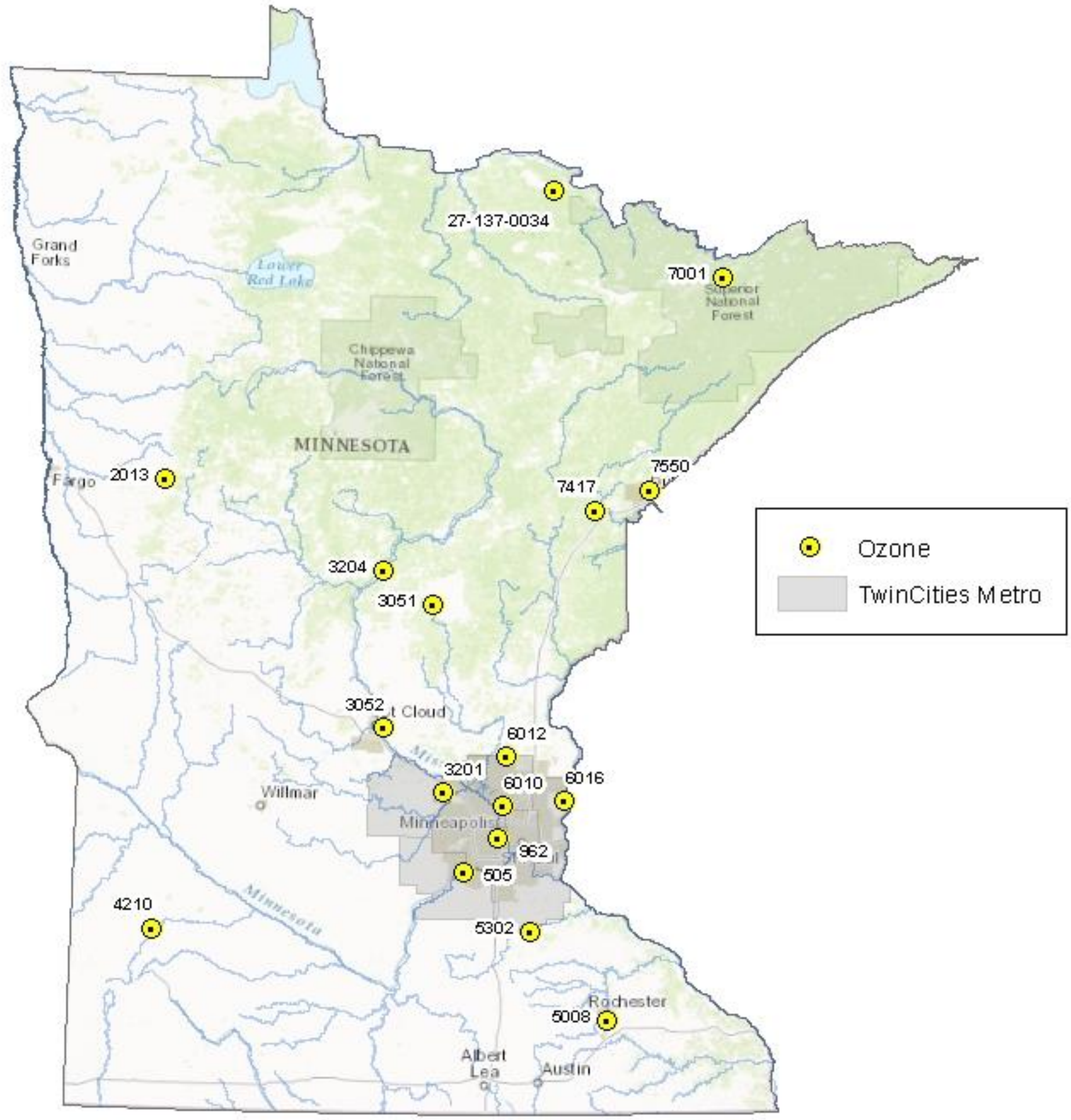
O_3 is an odorless, colorless gas composed of three atoms of oxygen. Ground-level O_3 is not emitted directly into the air, but is created through a reaction of NO_x and VOCs in the presence of sunlight.

Breathing air containing O_3 can reduce lung function and inflame airways, which can increase respiratory symptoms and aggravate asthma or other lung diseases. O_3 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 also increases the risk of premature death from heart and lung disease. Children are at increased risk because their lungs are still developing and are more likely to have increased exposure since they are often active outdoors.

In addition, cumulative O_3 exposure can lead to reduced tree growth, visibly injured leaves and increased susceptibility to disease, damage from insects and harsh weather. These effects can have adverse impacts on ecosystems, including loss of species and changes to habitat quality, and water and nutrient cycles.

MPCA monitors ozone on a continuous basis at 16 monitoring sites (figure 18). An additional monitor, located at Voyageurs National Park (AQS site 27-137-0034), is operated by the National Park Service. Since the MPCA does not have any role in this monitor, it is not included in our SLAMS or AQI monitoring networks.

Figure 18: 2016 Ozone monitoring sites in Minnesota

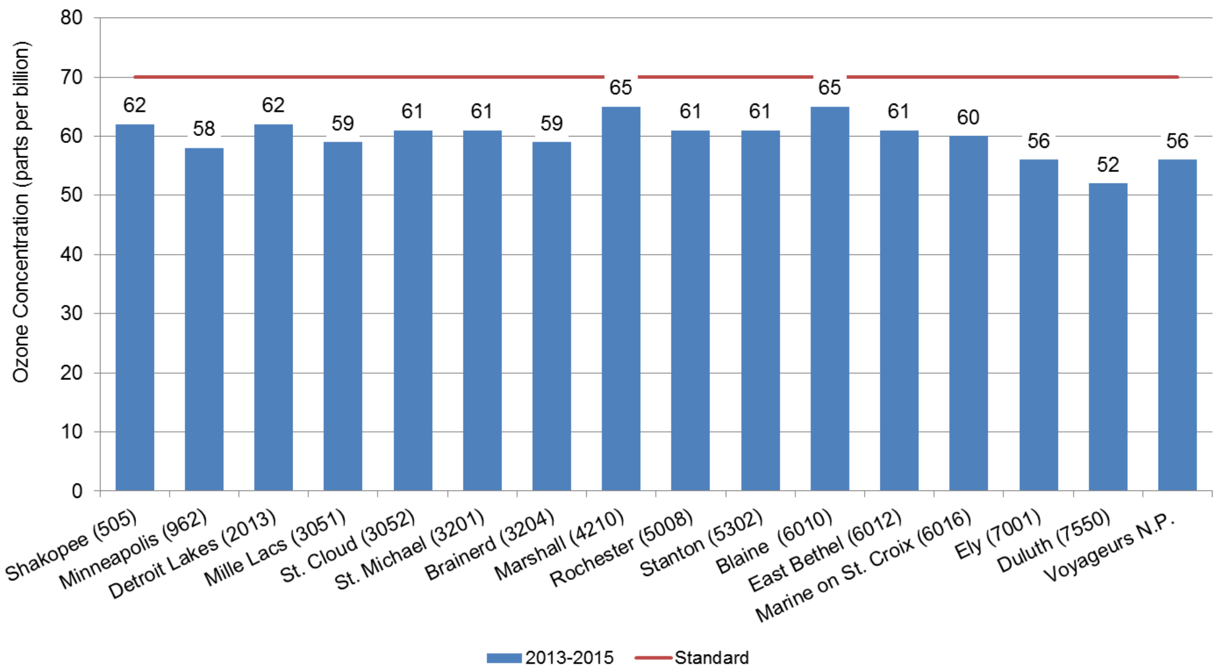


Because O_3 formation requires high temperatures and sunny conditions, the EPA only requires Minnesota to monitor O_3 seasonally. Beginning in 2017, the ozone monitoring season will run from March 1 through October 31 each year. The majority of ozone sites in Minnesota follow this monitoring season; however, ozone is measured year round at the NCore site in Blaine (6010). The data collected from these monitors are used to determine compliance with the NAAQS and are reported as part of the AQI. Figure 18 shows the monitoring locations for O_3 in Minnesota in 2016. No changes are expected in 2017.

A monitoring site meets the primary O_3 NAAQS if the three-year average of the 4th highest daily maximum 8-hour concentration is less than or equal to 70 ppb. Figure 19 shows the 2013 through 2015 8-hour averages at Minnesota sites and compares them to the standard. Minnesota averages ranged from 52 ppb in

Duluth (7550) to 65 ppb in Blaine (6010) and Marshall (4210); therefore, all sites were below the 8-hour standard.

Figure 19: 8-hour average ozone concentrations compared to the NAAQS



Oxides of nitrogen (NO_X)

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). NO_2 is the regulated pollutant; it can often be seen as a reddish-brown layer in the air over urban areas.

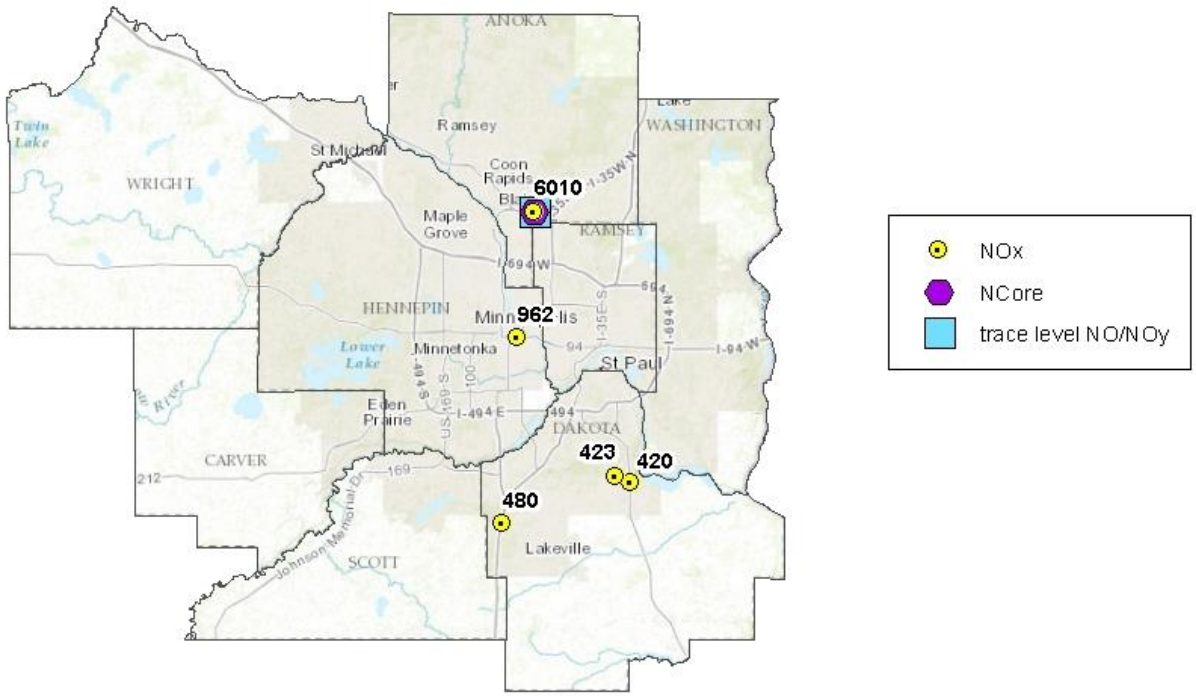
NO_X contribute to a wide range of health and environmental effects. NO_2 itself can irritate the lungs and lower resistance to respiratory infections. More importantly, NO_X react to form ground–level ozone, $PM_{2.5}$, acid rain and other toxic chemicals. They also can lead to visibility and water quality impairment due to increased nitrogen loading in water bodies. In addition, nitrous oxide, another component of NO_X, is a greenhouse gas that contributes to climate change.

Currently, the MPCA monitors NO_2 and NO at five sites in the Twin Cities metropolitan area (Figure 20). Trace level NO/NOy has been at the NCore site in Blaine (6010) since 2009. This trace level data will help us understand the role of these pollutants at levels far below the NAAQS; however, due to performance issues with the monitoring equipment, trace level monitoring results have been unreliable. The trace-level NO/NOy analyzer at the NCore site in Blaine (6010) was replaced and tested in early 2014; valid data collection has resumed as of May 1, 2014.

In February of 2010, the EPA finalized new minimum monitoring requirements for the NO_2 monitoring network in support of a 1-hour NO_2 NAAQS. In the new monitoring requirements, state and local air monitoring agencies are required to install near-road NO2 monitoring stations at locations where peak hourly NO_2 concentrations are expected to occur within the near-road environment in large urban areas. Based on population, The Minneapolis-St. Paul-Bloomington CBSA is the only CBSA in Minnesota that requires near-road monitoring, with two monitoring stations required by January 2015. The first near-road monitoring site (962) along I-94 and I-35W in downtown Minneapolis began operating in January 2013. The second near-road monitoring site (480) along I-35 in Lakeville began operating on January 1, 2015. The

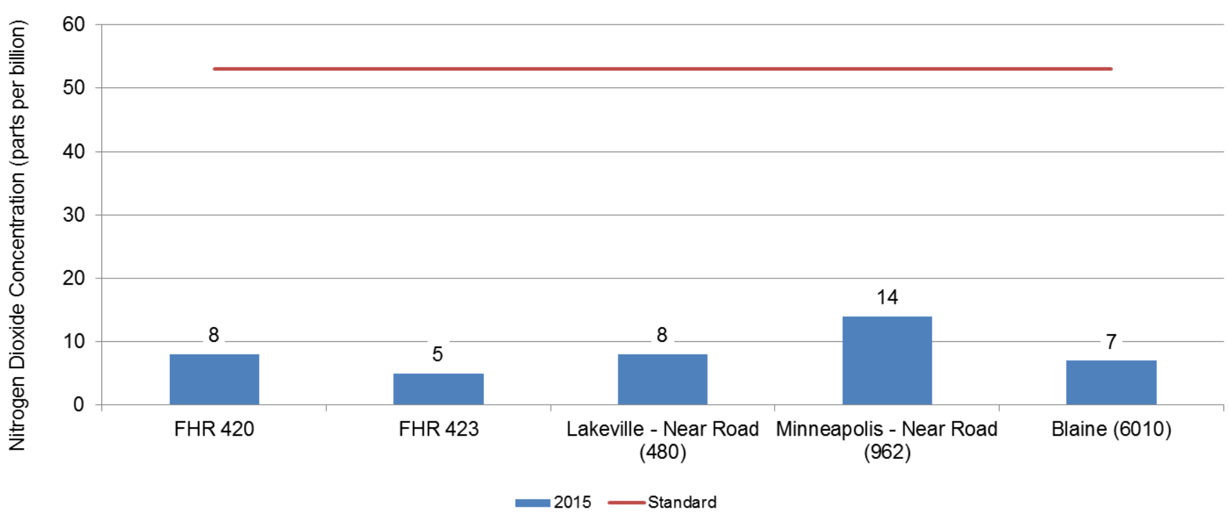
MPCA Near-road air quality monitoring is described in more detail on the MPCA Near-road website at https://www.pca.state.mn.us/air/near-road-monitoring.

Figure 20: 2016 NO_X monitoring sites in the Twin Cities metropolitan area



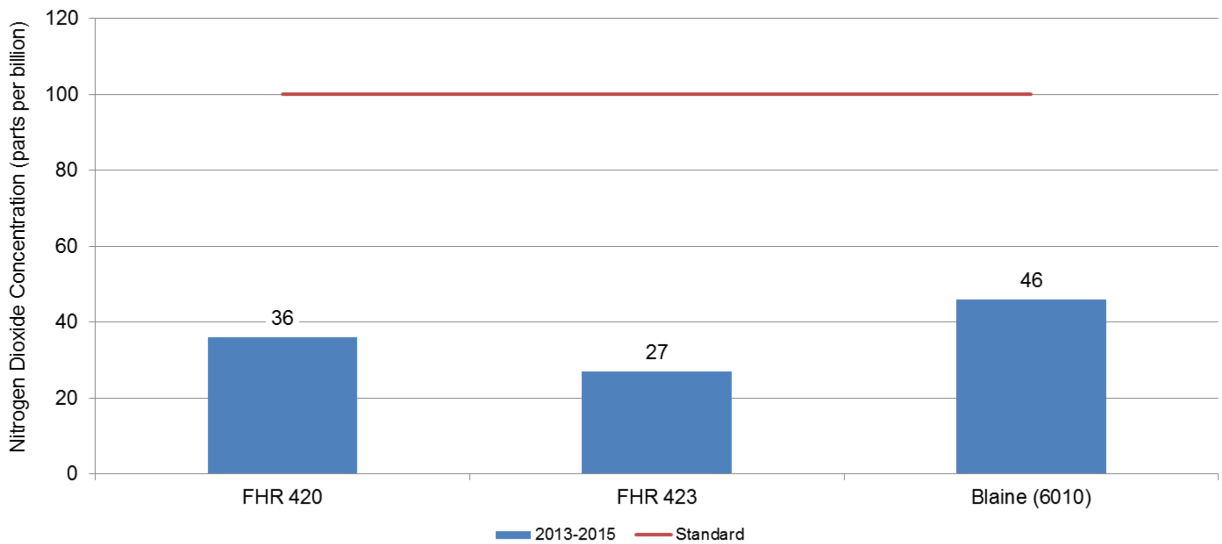
A monitoring site meets the annual NAAQS for NO_2 if the annual average is less than or equal to 53 ppb. Figure 21 shows the 2015 averages at Minnesota sites and compares them to the standard. Minnesota averages ranged from 5 ppb at Flint Hills Refinery 423 to 14 ppb at the Near Road I-35/I-94 site (962); therefore, Minnesota currently meets the annual NAAQS for NO_2.

Figure 21: Annual average NO_2 concentrations compared to the NAAQS



On January 22, 2010 the EPA finalized revisions to the NO_2 NAAQS. As part of the standard review process, the EPA retained the existing annual NO_2 NAAQS, but also created a new 1-hour standard. This new 1-hour NAAQS will protect against adverse health effects associated with short term exposures to elevated NO_2. To meet this standard, the three-year average of the annual 98th percentile daily maximum 1-hour NO_2 concentration must not exceed 100 ppb. Figure 22 shows the 2013-2015 average of the annual 98th percentile daily maximum 1-hour NO_2 concentrations at Minnesota sites and compares them to the 1-hour standard. Minnesota averages ranged from 27 ppb at Flint Hills Refinery 423 to 46 ppb at Blaine (6010); therefore, all Minnesota sites currently meet the 1-hour NAAQS for NO_2.

Figure 22: 1-hour NO_2 concentrations compared to the NAAQS

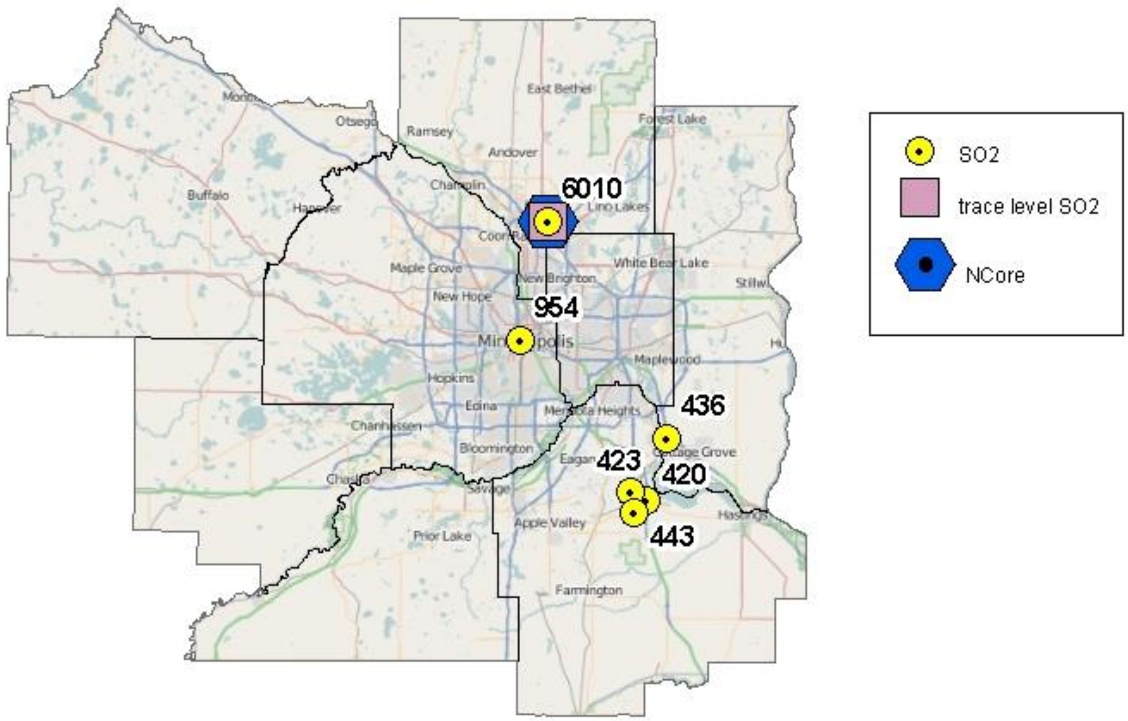


Sulfur dioxide (SO_2)

SO_2 belongs to the family of sulfur oxide gases. SO_2 reacts with other chemicals in the air to form sulfate particles. Exposures to SO_2, sulfate aerosols, and $PM_{2.5}$ contribute to respiratory illness, and aggravate existing heart and lung diseases. High levels of SO_2 emitted over a short period, such as a day, can be particularly problematic for people with asthma. SO_2 also contributes to the formation of $PM_{2.5}$, visibility impairment, and acid rain. SO_2 is monitored on a continuous basis and reported in hourly increments. Data are used to determine compliance with the NAAQS and are reported as part of the AQI. Minnesota currently meets all applicable NAAQS for SO_2; however, continued reductions are sought due to its role in forming $PM_{2.5}$.

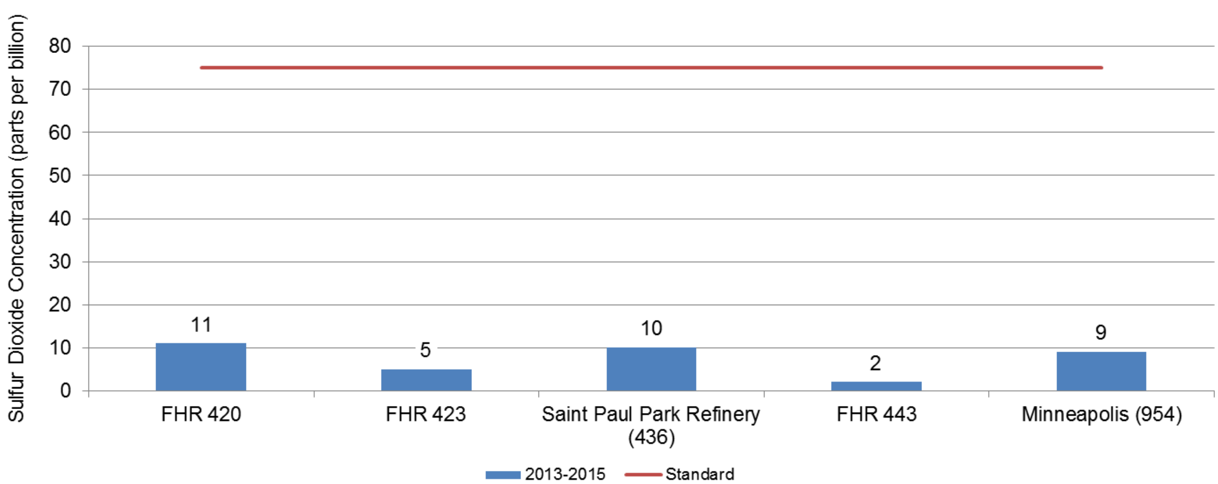
The MPCA monitors SO_2 at six sites in the Twin Cities metropolitan area shown in Figure 23. In 2014, an SO_2 monitor was added to Rochester (5008); monitoring will be discontinued at the end of 2016 after collecting 3 years of data. Trace level SO_2 at the NCore site in Blaine (6010) will help us understand the role of SO_2 at levels far below the NAAQS.

Figure 23: 2016 SO_2 monitoring sites in the Twin Cities metropolitan area



On June 2, 2010, the EPA finalized revisions to the primary SO_2 NAAQS. EPA established a new 1-hour standard which is met if the three-year average of the annual 99th percentile daily maximum 1-hour SO_2 concentration is less than 75 ppb. In addition to creating the new 1-hour standard, the EPA revoked the existing 24-hour and annual standards. Figure 24 describes the 2013 -2015 average 99th percentile 1-hour SO_2 concentration and compares them to the 1-hour standard. Minnesota averages ranged from 2 ppb at Flint Hills Refinery 443 to 11 ppb at Flint Hills Refinery 420; therefore, all Minnesota sites currently meet the1-hour NAAQS for SO_2.

Figure 24: 1-hour SO_2 concentrations compared to the NAAQS

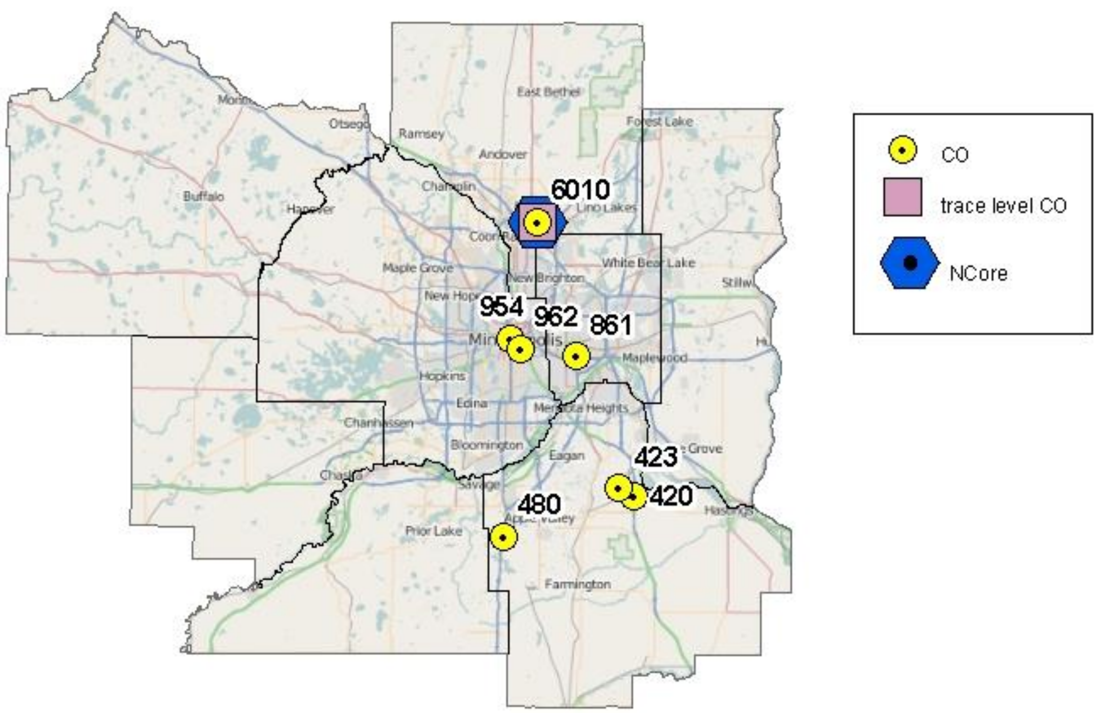


Carbon monoxide (CO)

CO is a colorless and odorless toxic gas formed when carbon in fuels is not burned completely. 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. Carbon monoxide is also oxidized to form carbon dioxide (CO_2) which contributes to climate change and the formation of ground-level O_3.

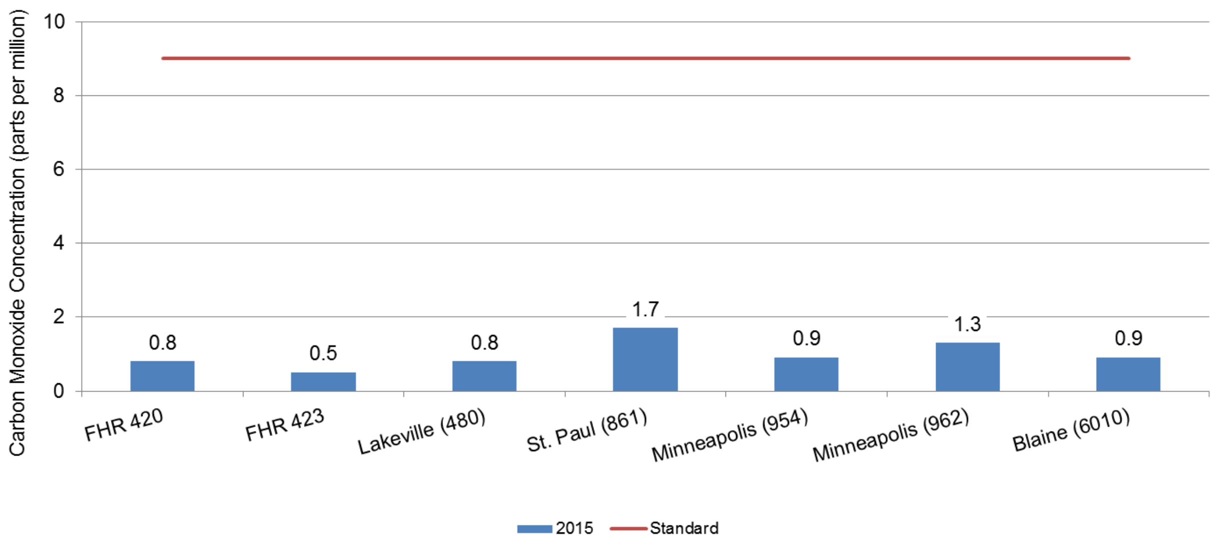
The MPCA monitors CO at seven sites in the Twin Cities metropolitan area (Figure 25). CO is monitored on a continuous basis and reported in hourly increments. Data is used to determine compliance with the NAAQS and reported as part of the AQI. Trace level CO at the NCore site in Blaine (6010) also helps us understand the role of CO at levels far below the NAAQS.

Figure 25: 2016 CO monitoring sites in the Twin Cities metropolitan area



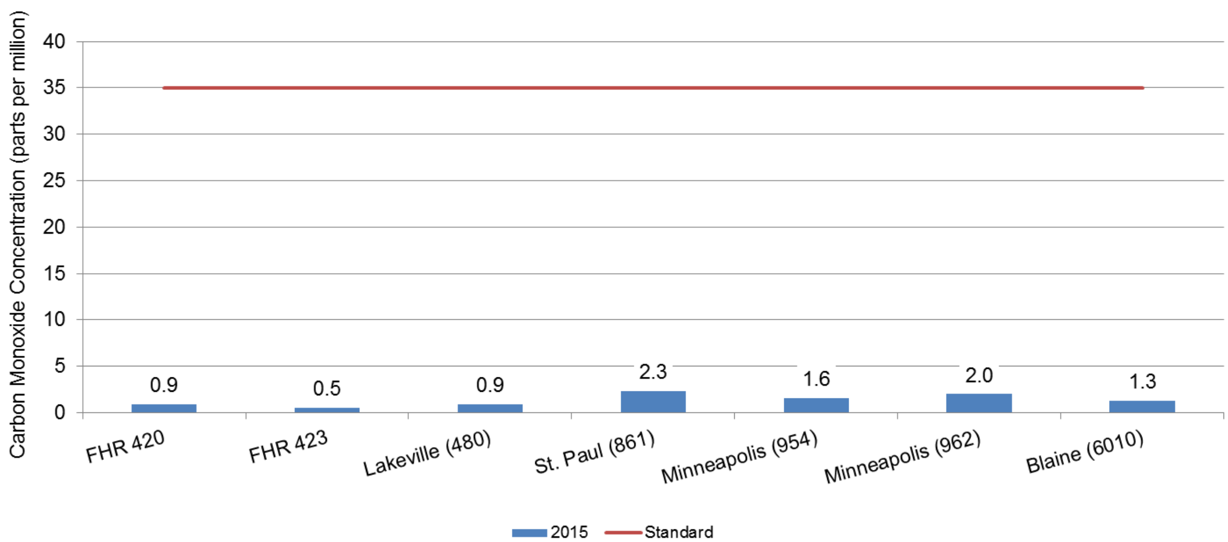
Minnesota currently meets applicable NAAQS for CO. A monitoring site meets the 8-hour CO NAAQS when the level of 9 ppm is not exceeded more than once per year. Figure 26 shows the second highest non-overlapping 8-hour average at Minnesota sites in 2015 and compares them to the standard. Minnesota values range from 0.5 ppm at Flint Hills Refinery 423 to 1.7 ppm at St. Paul (861).

Figure 26: 8-hour average CO concentrations compared to the NAAQS



The 1-hour CO NAAQS is met when the level of 35 ppm is not exceeded more than once per year. Figure 27 shows the second highest 1-hour average at Minnesota sites in 2015 and compares them to the standard. Minnesota values range from 0.5 ppm at Flint Hills Refinery 423 to 2.3 ppm in St. Paul (861).

Figure 27: 1-hour average CO concentrations compared to the NAAQS



Air toxics

The EPA defines air toxics as those pollutants that cause or may cause cancer or other serious health effects (such as reproductive or birth defects), 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 (see http://www.epa.gov/ttn/atw/orig189.html for a list of HAPs). There are no federal requirements for air toxics monitoring, but the MPCA monitors for a variety of compounds in order to understand potential risks to Minnesota citizens and to track reductions in emissions and concentrations.

The MPCA uses guidelines called health benchmarks to determine risk. These benchmarks come from a variety of sources including the Minnesota Department of Health's Health Risk Values (HRVs) found at http://www.health.state.mn.us/divs/eh/risk/guidance/air/table.html, the EPA's Integrated Risk Information System (IRIS) found at http://www.epa.gov/iris/, and California's Office of Health Hazard Assessment (OEHHA) found at http://www.oehha.ca.gov/air.html.

The MPCA monitors three types of air toxics: 55 volatile organic compounds (VOCs), seven carbonyls, and 15 metals. For information on concentrations of and risks from air toxics in Minnesota, visit the MPCA website at https://www.pca.state.mn.us/air/air-toxics-minnesota. Samples are collected once every six days over a 24-hour period; the resulting concentration is a 24-hour average.

In 2016 air toxics monitors were added to South St. Anthony Park (1908) as part of the Community Air Monitoring Project; more information can be found on the project website (https://www.pca.state.mn.us/air/community-air-monitoring-project). This project will continue in 2017. No other changes to the air toxics network are expected in 2017.

Air Toxics Monitoring Web App

Annual air toxics monitoring results are now available online at https://www.pca.state.mn.us/air/air-toxics-data-explorer. The Minnesota Air Toxics Monitoring Web App provides interactive maps, charts, and data tables that summarize annual air toxics monitoring results.

Figure 28: Air Toxics Monitoring Web App

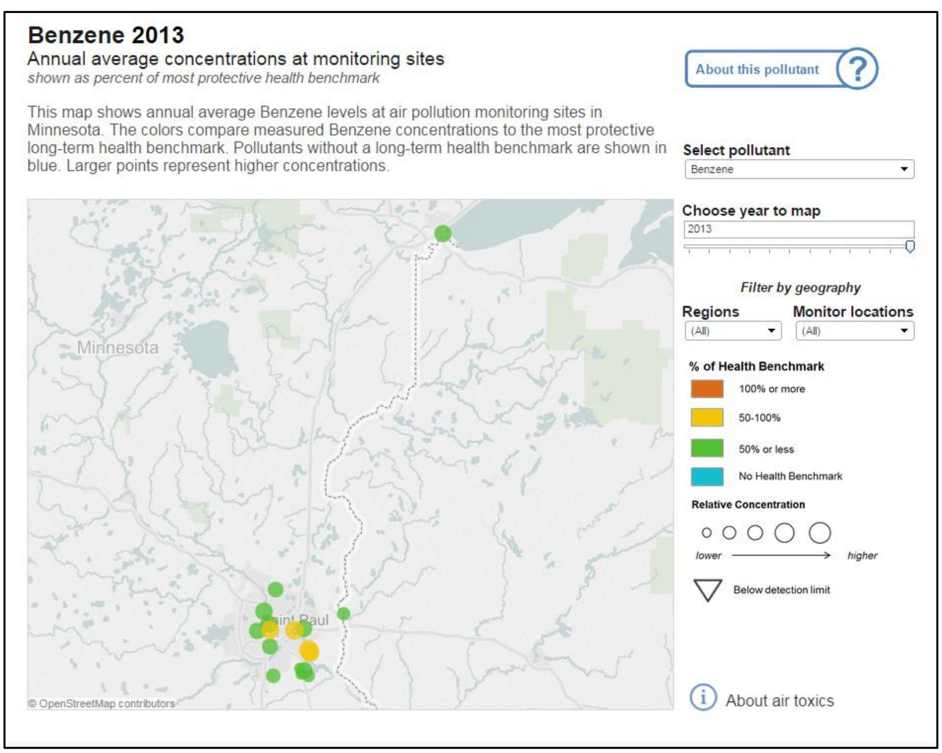
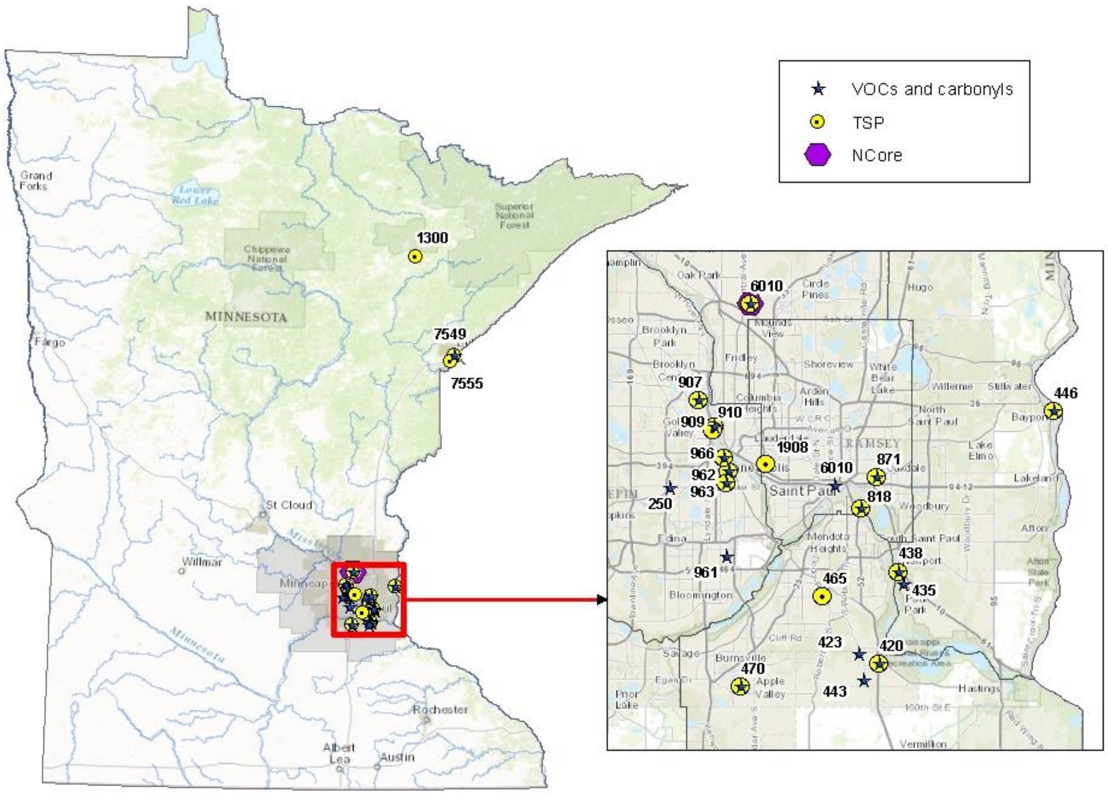


Figure 29: 2016 Air toxics monitoring sites in Minnesota



Metals

Metals are extracted from TSP filters and analyzed using ICP-AES following an EPA FEM method for Pb determination (EQL-0311-196). Table 13 lists the metals analyzed by the MPCA.

The MPCA monitors metals at 18 sites in Minnesota. These sites are primarily located in the Twin Cities metropolitan area with additional sites in Virginia (1300) and Duluth (7555). Figure 29 shows the locations of the sites.

During the 3-month Community Air Monitoring Project sampling period in the St. Paul Westside neighborhood, monitoring results indicated average metal values were below health benchmarks but were higher than other Twin Cities metro monitoring sites. In addition, the 3-month average lead concentration was 0.09 $\mu g/m^3$, which is more than 50% of the lead standard (0.15 $\mu g/m^3$). In response to these elevated metals levels, the MPCA established a monitoring site at the St. Paul Downtown Airport (818) to evaluate lead levels and potential sources near the original Community Air Monitoring Project site. Monitoring will be conducted for at least one year.

In 2016 a TSP monitor was added to South St. Anthony Park (1908) as part of the Community Air Monitoring Project; more information can be found on the project website (https://www.pca.state.mn.us/air/community-air-monitoring-project). This project will continue at a new site in 2017. No other changes to the TSP network are expected in 2017.

Table 12: 2016 Metals monitored by MPCA

Parameter	CAS #	EPA Parameter Code
Antimony (Sb)	7440-36-0	12102
Arsenic (As)	7440-38-2	12103
Barium (Ba)	7440-39-3	12107
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
Zinc (Zn)	7440-66-6	12167

Volatile organic compounds (VOCs) and carbonyls

The MPCA analyzes samples for 55 VOCs and seven carbonyls. Table 14 lists the Carbonyls and table 15 lists the VOCs monitored by the MPCA. Samples are analyzed using EPA Compendium Methods TO-15 for VOCs and TO-11A for carbonyls.

The MPCA monitors VOCs and Carbonyls at 19 sites in Minnesota. These sites are primarily located in the Twin Cities metropolitan area, with an additional site for VOCs and Carbonyls in Duluth (7549). Figure 29 shows the locations of the sites.

In 2016 a VOC and carbonyl sampler was also added to South St. Anthony Park (1908) as part of the Community Air Monitoring Project; more information can be found on the project website (https://www.pca.state.mn.us/air/community-air-monitoring-project). This project will continue in 2017. No other changes to the TSP network are expected in 2017.

Table 13: 2016 Carbonyls monitored by MPCA

Parameter	CAS #	EPA Parameter Code
Acetaldehyde	75-07-0	43503
Acetone	67-64-1	43551
Benzaldehyde	100-52-7	45501
Butryaldehyde	123-72-8	43510
Trans-Crotonaldehyde	123-73-9	43516
Formaldehyde	50-00-0	43502
Propionaldehyde	123-38-6	43504

Table 14: 2016 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
Benzene	71-43-2	45201
Benzyl chloride	100-44-7	45809
Bromodichloromethane	75-27-4	43828
Carbon disulfide	75-15-0	42153
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 Chloride	75-00-3	43812
Ethylbenzene	100-41-4	45203
Ethylene chloride	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 methacrylate	91-20-3	43441
Methyl tert-butyl ether	1634-04-4	43372
Naphthalene	80-62-6	17141
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 acetate	108-05-4	43447
Vinyl chloride	75-01-4	43860
Xylene (m&p)	108-38-3	45109
Xylene (o)	95-47-6	45204

Atmospheric deposition

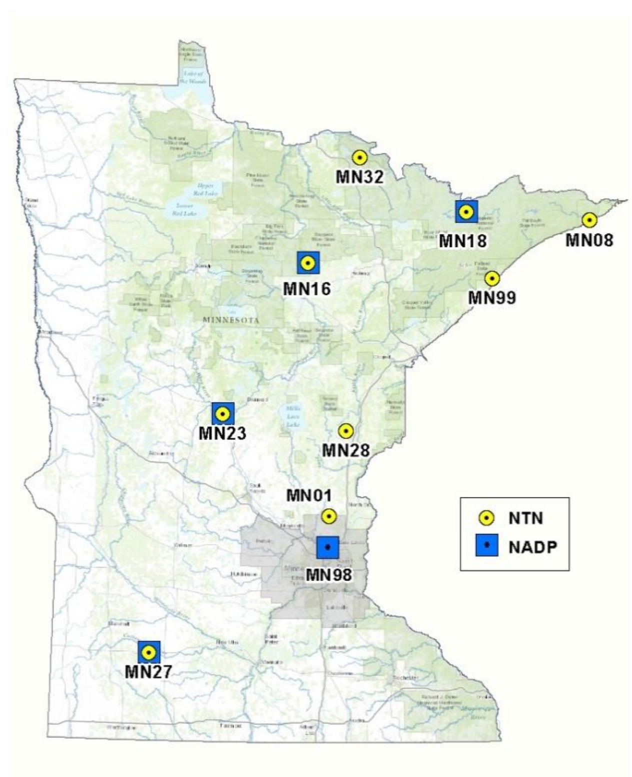
Atmospheric deposition is monitored through the NADP. The NADP has two active sub-networks in Minnesota: the National Trends Network (NTN) and the Mercury Deposition Network (MDN).

NTN collects weekly precipitation samples for pH, sulfate, nitrate, ammonium, chloride, and base cations (such as calcium and magnesium). NTN provides long-term, high-quality data for determining spatial and temporal trends in the chemical composition of precipitation. MDN collects weekly precipitation samples for analysis of total Hg and methylmercury concentrations. It supports a regional database of the weekly concentrations of Hg in precipitation and the seasonal and annual flux of total Hg in wet deposition.

Acid deposition

Acid deposition, or acid rain, is monitored as part of the NTN. Acid deposition begins with the burning of fossil fuels (such as coal, gas, or oil) for energy. The 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.

Figure 30: Atmospheric Deposition sites in Minnesota



The MPCA sponsors several sites that are part of the NADP (http://nadp.sws.uiuc.edu/) to monitor acid rain and Hg. 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, and cations (such as calcium, magnesium, potassium, and sodium). Minnesota has nine monitoring sites for wet deposition. These sites are highlighted in Figure 30.

Mercury (Hg) deposition

Hg contamination of fish is a well-documented problem in Minnesota. Because of wide-spread Hg contamination, the Minnesota Department of Health (MDH) advises people to restrict their consumption of large sport fish from all lakes and rivers. More than 95 percent of the Hg in Minnesota surface water comes from the atmosphere. In 2007, the EPA accepted Minnesota's Hg total maximum daily load (TMDL) plan that concludes that atmospheric Hg deposition must be reduced by 76% to achieve compliance with aquatic Hg standards.

Mercury is monitored in wet deposition in Minnesota as part of the NADP through the Mercury Deposition Network (MDN), which began in 1996 and now consists of over 85 sites. The MDN website can be found at http://nadp.sws.uiuc.edu/mdn/. The MDN collects weekly samples of precipitation, which are analyzed for total Hg. The objective of the MDN is to provide a nationally consistent survey of Hg 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 Hg monitoring, establishing four sites as part of the MDN network in 1996, which are still operating. They include 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 opened in Blaine (MN98) in February 2008. Figure 30 shows the locations of these sites.

In addition to quantifying total Hg, the MPCA also cooperates with the MDN network to measure methylmercury in four-week composites of the precipitation samples. Only a few of the sites participate in the methylmercury analysis.

The MPCA also cooperates with the states of Michigan and Wisconsin to share the use of a trailer equipped with atmospheric Hg monitoring equipment. The equipment includes two Tekran 2537 Hg vapor analyzers, a generator, and a meteorological tower that can record wind speed and direction. The trailer is used to identify local sources of Hg vapor.

Hydrogen sulfide (H_2S)

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. H_2S is a flammable, colorless gas that smells like rotten eggs even at low levels. Exposure to low concentrations of H_2S may cause irritation to the eyes, nose, and throat and may also cause difficulty in 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.

Total reduced sulfur (TRS)

TRS consists of the total sulfur from various compounds, including hydrogen sulfide, 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 standard for TRS is available. The MPCA measures TRS at sites 420 and 423 near the Flint Hills Refinery in Rosemount and at site 436 near the St. Paul Park Refining Company in St. Paul Park. Boise White Paper, L.L.C. in International Falls discontinued TRS monitoring in 2015. No changes are planned for the MPCA operated monitors in 2017.

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 sites 420 and 423 in Rosemount near the Flint Hills Resources refinery, 909 in North Minneapolis, at the near road sites in Lakeville (480) and Minneapolis (962), and at the NCore site in Blaine (6010). In Blaine, temperature, relative humidity, and barometric pressure are also measured.

Special studies

Black carbon

Black carbon (or soot) is a component of fine particulate. It is correlated with elemental carbon which is monitored as part of the $PM_{2.5}$ speciation networks. Elemental carbon particles are emitted into the air from virtually all combustion activity, but are especially prevalent in diesel exhaust and smoke from the burning of wood, other biomass, and wastes. Black carbon can be continuously monitored using an aethalometer, while elemental carbon is only available in Minnesota as a 24-hour average every three days. MPCA began monitoring black carbon at the near-road site in Minneapolis (962) in 2014.

Community air monitoring project

In 2013, the Minnesota Legislature funded a two-year air monitoring study to monitor air quality in seven Minnesota communities where low income or communities of color might be disproportionately impacted by pollution from highway traffic, air traffic, and industrial sources. These are areas of potential concern for environmental justice. Communities were monitored for three months, after which the monitoring equipment was moved to the next site. The first community monitored started October 1, 2013. The seventh community monitoring ended on June 20, 2015.

With renewed funding in 2015, community monitoring continued with monitoring in the Duluth area. Using and supplementing two existing Duluth air monitoring sites, additional monitors were added to sites 7549 and 7554 in Duluth from July 1, 2015 to December 31, 2015. The community monitor was then moved to the South St. Anthony Park community in St. Paul (Figure M). Monitoring in this community will continue until the end of 2016.

Table 15 lists all of the community air monitoring study sites. Figure 31 shows the location of the sites in the Twin Cities metropolitan area.

Figure 31: Locations of community air monitoring project sites in the Twin Cities metropolitan area

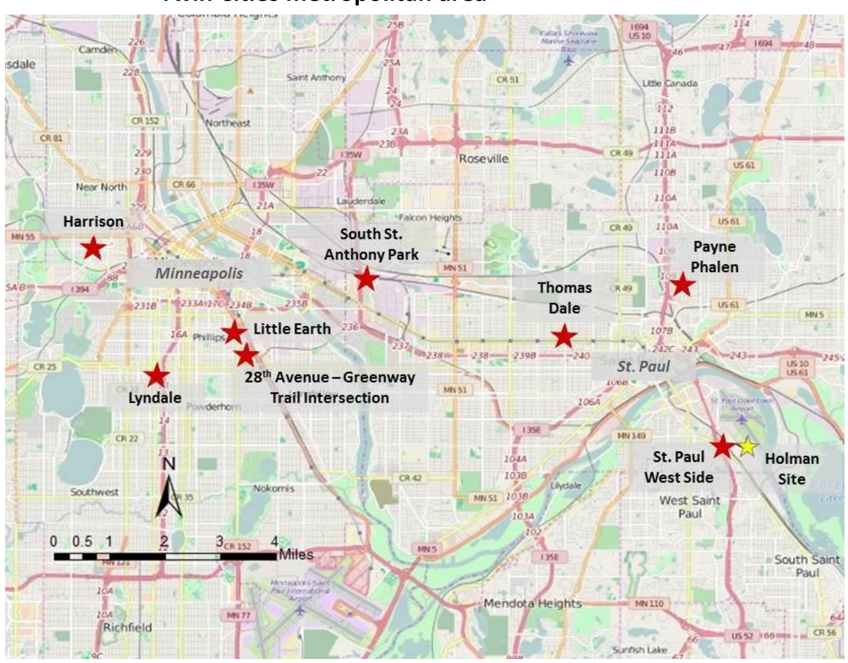


Table 15: Community air monitoring project sites and dates of operation

MPCA Site	AQS Site ID	Operation Dates	Site Name	City
1901	27-053-1901	Oct-Dec 2013	Little Earth	Minneapolis
1902	27-123-1902	Jan-Mar 2014	Thomas Dale	St. Paul
1903	27-123-1903	Apr-Jun 2014	West Side	St. Paul
1904	27-053-1904	Jul-Oct 2014	Greenway	Minneapolis
1905	27-053-1905	Oct-Dec 2014	Harrison	Minneapolis
1906	27-053-1906	Jan-Mar 2015	Lyndale	Minneapolis
1907	27-123-1907	Apr-Jun 2015	Payne Phalen	St. Paul
7549	27-137-7549	Jul-Dec 2015	Michigan Street	Duluth
7554	27-137-7554	Jul-Dec 2015	Laura MacArthur School	Duluth
1908	27-123-1908	Jan-Dec 2016	South St. Anthony Park	St. Paul
TBD	TBD	Jan-Dec 2017	TBD	TBD

While monitoring from April to June, 2014 in the St. Paul West Side community, monitoring results indicated average metal values that were below health benchmarks but were higher than other Twin Cities metro monitoring sites. In response to these findings and community concerns, MPCA has returned to the St. Paul West Side area to monitor levels of metal particles in the community ambient air. This monitor has been placed in the southwest corner of the St. Paul Downtown Airport (818). Monitoring started the first week of January, 2016 and will continue for a minimum of one year.

A Community Air Monitoring Project website provides site information, summaries of completed data analyses and raw data for each community site - https://www.pca.state.mn.us/air/community-air-monitoring-project. As data analyses are completed for the remaining monitoring sites, results will be posted on this project website. An interim report discussing lessons learned from the data analyses of the first three sites can also be found on the project website.

Fibers

As a requirement of its air permit, Northshore Mining Company in Silver Bay monitors for fibers, which are defined as chrysotile and amphibole mineral particles with 3-to-1 or greater aspect ratio. The permit requires that the ambient air in Silver Bay contain no more fibers than that level ordinarily found in the ambient air of a control city. The MPCA chose the city of St. Paul as a control city and is presently monitoring mineral fibers in air at the Ramsey Health Center (868). Northshore Mining Company is responsible for operating two fiber monitoring sites, one in Silver Bay and another in Beaver Bay, MN. The fiber levels in St. Paul are being monitored by the MPCA. MDH is responsible for the analysis of all fiber samples collected by both parties.

Figure 32 shows the locations of the fiber monitors in Minnesota. No changes are planned for 2017.

Figure 32: 2016 Fiber monitoring sites

Silica sand mining and facility related monitoring

In 2010 the MPCA began receiving public inquiries about projects to mine silica sand for use in hydraulic fracturing, or “fracking,” a drilling method used for natural gas and oil wells. Southeastern and south central Minnesota and southwestern Wisconsin have extensive deposits of sand that meets the specifications required for fracking. Mining of certain types of these deposits has been occurring in the region for many years; however, there are new issues based on the quantity, type and depth of mining.

There are no federal or state standards for silica concentrations in ambient air. The MPCA uses a health based value, developed by MDH, to assess potential human health effects from ambient air exposure to respirable crystalline silica (particle size smaller than 4 microns). There are state standards for TSP and state and federal air quality standards for PM_{10} and for $PM_{2.5}$. This is an evolving field, and therefore no generally accepted ambient monitoring method exists for PM_4 silica. However, certain Minnesota facilities are monitoring for silica using a method adapted from common regulatory monitoring techniques.

Ambient air monitors were placed at two sites at the Shakopee Sands facility (Jordan, MN), and collected TSP, PM_{10}, and respirable crystalline silica (measured as PM_{10}) data starting in third quarter of 2012. Ambient air data was also collected at the Titan Lansing Transload facility in North Branch, MN (previously Tiller LLC) for PM_{10}, $PM_{2.5}$, and PM_4 silica. Jordan Sands, LLC in Mankato, MN began monitoring for TSP, PM_{10}, $PM_{2.5}$, and PM_4 silica at their industrial sand mining and processing facility in 2014. One year of data are required for comparison to the TSP standards and the respirable crystalline silica health benchmark and three years of data are required for comparison to the PM_{10} and $PM_{2.5}$ standards.

The MPCA also conducted community based monitoring at two sites. A new site was created in Winona (5520) where PM_4 silica, $PM_{2.5}$ FEM, and meteorological parameters were monitored. In addition, PM4 silica was added to the existing ozone site in Stanton (5302). This monitoring started in January 2014 and closed in December 2014 upon the completion of one year of monitoring.

Preliminary data from these monitoring efforts and more information about silica sand mining are available on the MPCA’s website (https://www.pca.state.mn.us/air/air-monitoring-minnesota-silica-sand-facilities).

The MPCA air monitoring program will continue to provide technical support to local units of government, permitted facilities, and to a Technical Advisory Team being formed by the Environmental Quality Board.

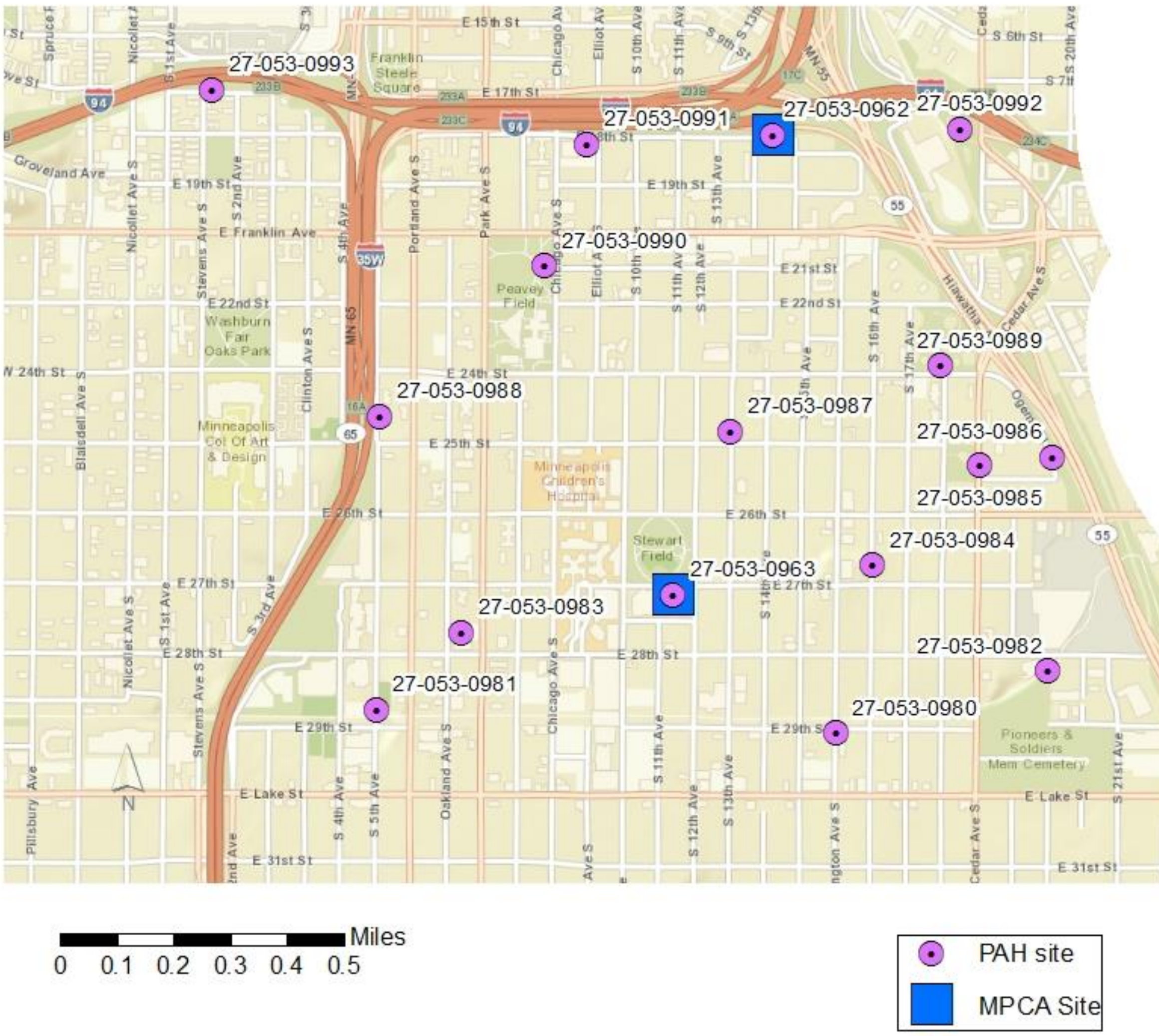
Polycyclic aromatic hydrocarbons (PAHs)

Polycyclic aromatic hydrocarbons (PAHs) can occur naturally in the environment, but they are also created during combustion (examples include motor vehicles burning fuel, home heating, diesel trucks, tobacco smoke, and wood smoke). PAHs are a priority to environmental health agencies because they stay in the environment for long periods of time and exposure to high levels of PAHs are associated with health effects such as cancer and respiratory irritation.

The MPCA received an EPA Community Scale Air Toxics Grant to study PAH levels in the air in South Minneapolis and Mille Lacs. The MPCA, the Minnesota Department of Health (MDH) and the Mille Lacs Band of Ojibwe Department of Natural Resources and Environment (DNRE) monitored PAHs using passive and active techniques during the two-year study.

Approximately 30 PAH compounds were chemically analyzed, which is an extension of the EPA list of 16 priority PAHs. The monitoring includes four fixed-site active samplers; including two collocated at the near-road site (962), one at the H.C. Andersen School (963), and one at the Mille Lacs site (3051). The 20 passive samplers include two collocated at the near-road site (962), one at the H.C. Andersen School (963), two at Mille Lacs (3051), and the remaining samplers located around South Minneapolis centered in the Phillips communities. Figure 33 is a map of the monitoring sites in Minneapolis with AQS site identification numbers. The monitoring started in June 2013 and was completed in June 2015. Monitored concentrations of PAHs were compared to estimated health values. A video describing the project, and all the data visualized in maps and bar charts are available at the project website: https://www.pca.state.mn.us/air/air-monitoring-polycyclic-aromatic-hydrocarbons-urban-and-rural-sites.

Figure 33: PAH monitoring sites in Minneapolis



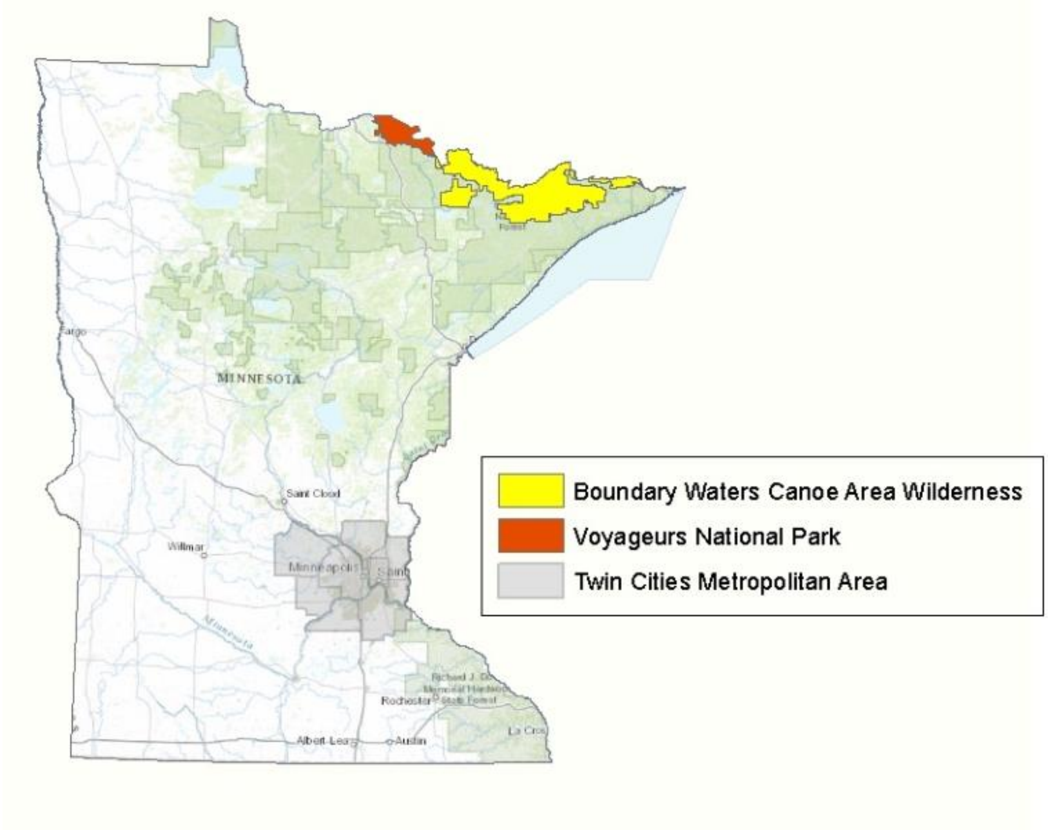
Visibility

Air pollution can reduce visibility over wide areas, called regional haze. Haze occurs when sunlight encounters fine particles in the air, which absorb and scatter light. Haze-causing pollutants come from a variety of sources, both natural and man-made, including motor vehicles, electric utilities, taconite processing facilities, agriculture, and wildfires.

In 1999, EPA established a regulatory program to reduce haze caused by man-made air pollution at national parks and wilderness (Class I) areas. The goal of the regional haze rule is to achieve natural visibility conditions in Class I areas by 2064, with interim progress goals every 10 years. The first interim progress goal is set for 2018.

Minnesota has two Class I areas – the Boundary Waters Canoe Area Wilderness and Voyageurs National Park (figure 34).

Figure 34: Class I areas in Minnesota



Visibility is calculated from measurements through the IMPROVE Aerosol Network (http://vista.cira.colostate.edu/IMPROVE/). As mentioned in the $PM_{2.5}$ section of this report, the IMPROVE network measures $PM_{2.5}$ speciation and employs transmissometers and nephelometers to measure light extinction and light scattering. Minnesota has an IMPROVE site in each of the two Class I areas. There is an additional site in Great River Bluffs State Park in southeastern Minnesota to help better understand the regional transport of pollutants that impair visibility.

IMPROVE network $PM_{2.5}$ speciation measurements are mathematically processed to express visibility as a 5-year rolling average deciview (dv) value. A human observer is thought to be able to visually perceive a 1 to 2 deciview difference in scene appearance. Figures 35 and 36 show measured progress toward the 2018 interim progress goal. We aim to see measured deciview values less than or equal to the interim progress goal by 2018. Both Boundary Waters and Voyageurs achieve the 2018 interim goal by 2014.

The EPA proposes to revise the tracking metrics used to measure visibility progress at Class I areas. The revision is intended to mitigate the impact of uncontrollable events, such as wildfires, on the progress demonstration allowing controls on anthropogenic emission sources to become apparent. For example, Figure 35 shows visibility improvements at the Boundary Waters were impacted in 2011 by the Pagami Creek wildfire, which burned 145 square miles of forest, resulting in a marked peak in the 5-year rolling average that year. Inclusion of the natural, uncontrollable wildfire impacts in the tracking metric obscures the ability to see progress associated with changes to anthropogenic emissions. Figure 36 shows that Voyageurs, which was not impacted by the fire, does not have a corresponding peak but continues downward. Progress is more clear in the 2011 tracking metric for Voyageurs. New metrics covering the entire measurement period are anticipated for the 2018 monitoring plan.

Figure 35: Reasonable progress visibility goal for Boundary Waters

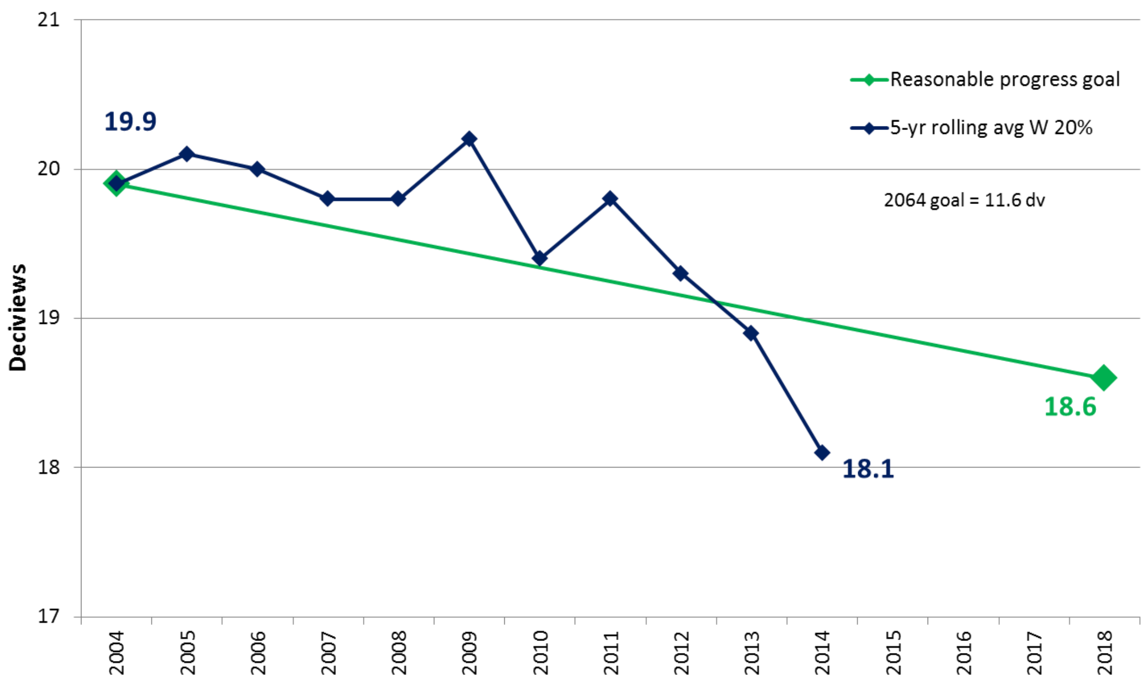
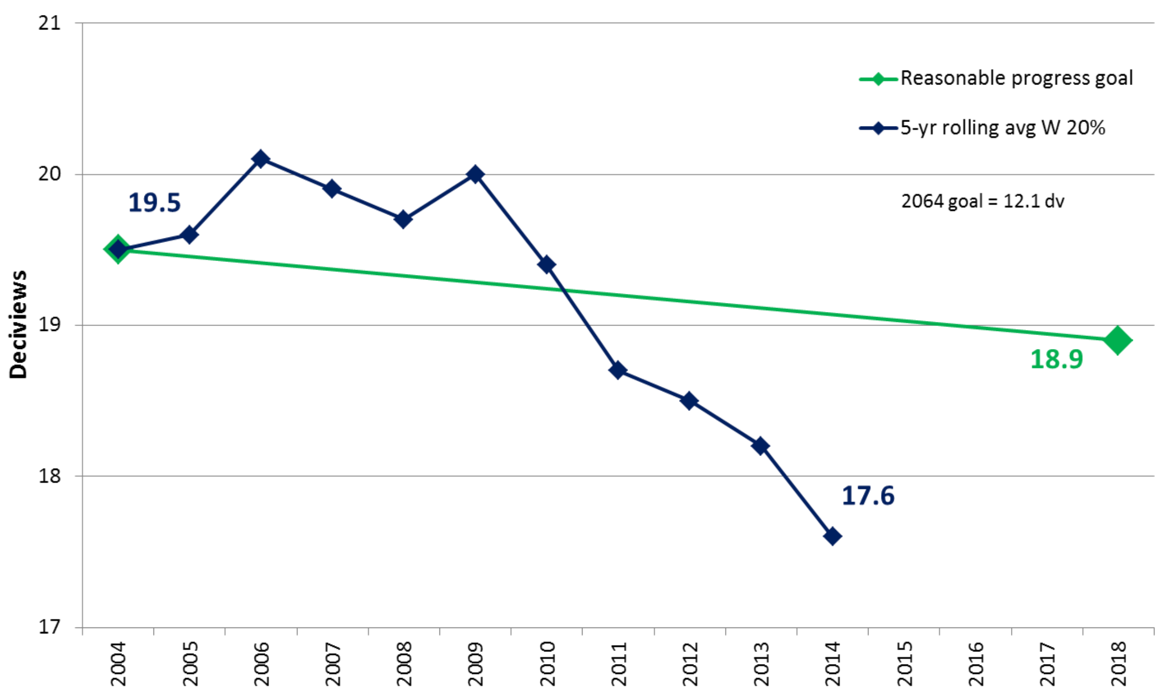


Figure 36: Reasonable progress visibility goal for Voyageurs



Network changes

Changes to the MPCA Air Monitoring Network are intended to improve the effectiveness of monitoring efforts and to ensure compliance with the EPA National Ambient Air Monitoring Strategy. Some changes are planned well in advance and are detailed in the Network Plan each year. Other changes are a result of legislation, administrative directives, land-use changes, loss of funding, enforcement actions, or in response complaints and cannot be foreseen when this report is created. This section of the document contains all changes that were made in 2016 and the changes that are planned for 2017.

2016 Network Changes

Table 16 lists the proposed changes from the 2016 Network Plan. In some cases, changes that were planned were not instituted and in other cases changes that were not foreseen did occur. Table 17 lists the sites where changes did occur in 2016 and details those changes. Following the table, the changes are summarized according to parameter network.

Table 16: 2016 Proposed Changes

MPCA Site ID	City Name	Site Name	Site Status	TSP and Metals	$PM_{2.5}$ Speciation
250	St. Louis Park	St. Louis Park		A	
423	Rosemount	Flint Hills Refinery 423		A	
TBD	St. Paul	TBD (Westside neighborhood)	A	A	
866	St. Paul	Red Rock Road		A	
961	Richfield	Richfield Intermediate School		A	
BLMO1*	Luverne	Blue Mounds	T		T
GRRI1*	Winona	Great River Bluffs	T		T

*IMPROVE Site ID

A = proposed to add
T = proposed to terminate

Table 17: 2016 Actual Changes

MPCA Site ID	City Name	Site Name	Site Status	$PM_{2.5}$ FEM	$PM_{2.5}$ pre-FEM	TSP and Metals	VOCs and Carbonyls	$PM_{2.5}$ Speciation	PAHs
420	Rosemount	Flint Hills Refinery 420							A
423	Rosemount	Flint Hills Refinery 423				A			
818	St. Paul	St. Paul Downtown Airport	A			A			
907	Minneapolis	Humboldt Avenue							A
963	Minneapolis	Andersen School							A
1908	St. Paul	South Saint Anthony Park	A	A		A	A		
7549	Duluth	Michigan Street				A			
7810	Grand Portage	Grand Portage		A	T				
BLMO1*	Luverne	Blue Mounds	T					T	

*IMPROVE Site ID
A = added
T = terminated

$PM_{2.5}$ FEM

- The $PM_{2.5}$ pre-FEM at Grand Portage (7810) was replaced with an FEM monitor. The pre-FEM monitor at this site was used for AQI purposes; FEM monitor data will also be comparable to the NAAQS.

$PM_{2.5}$ Speciation

- In 2015, the EPA completed an assessment of the National IMPROVE Protocol Network and recommended defunding a number of monitoring sites, including two sites in Minnesota: Blue Mounds and Great River Bluffs. As a result of this assessment, EPA defunded the Blue Mounds site but continued funding for the Great River Bluffs site. The Blue Mounds IMPROVE site ceased operations in January 2016.

TSP and metals

- TSP and metals were added to site 7549 in Duluth and will be added to site 423 in Rosemount when site infrastructure upgrades are complete in summer 2016.
- TSP and metals were not added to St. Louis Park (250), St. Paul (866), or Richfield (966) as planned.
- TSP and metals were added to a new site at St. Paul Downtown Airport (818) to further investigate slightly elevated metals levels measured during the St. Paul West Side (1906) three-month community air monitoring project.

PAHs

- In 2016, PAH monitors will be placed at Andersen School (963) and Humboldt Avenue (907) in Minneapolis and at Flint Hills Resources (FHR 420) in Rosemount.

2017 proposed changes

The changes that are proposed for 2017 are summarized in Table 18. Following the table, the proposed changes are summarized according to parameter network.

Table 18: 2017 Proposed Changes

MPCA Site ID	City Name	Site Name	Site Status	$PM_{2.5}$ FEM	Sulfur Dioxide	TSP and Metals	VOCs	carbonyls
1908	St. Paul	South St. Anthony Park	T	T		T	T	T
TBD	TBD	CAMP - TBD	A	A		A	A	A
5008	Rochester	Ben Franklin School			T			

A = proposed to add
T = proposed to terminate

- The Community Air Monitoring Project (CAMP) site in South St. Anthony Park (1908) will be terminated and moved a new location in 2017. The new location has yet to be determined.
- SO_2 monitoring at the Ben Franklin School in Rochester will be terminated after three years of monitoring was completed to establish the background concentration.

Public inspection period

This report was available for public inspection from June 10, 2016 through July 13, 2016. Two comment letters were received; they will be submitted along with the monitoring plan to EPA for consideration. The public is welcome to comment on our air monitoring activities at any time throughout the year.

The following is a summary of the issues addressed in the comments received and the response from the MPCA:

COMMENT: Western Refining, Inc., parent company of the St. Paul Park Refinery, supports MPCA's plan to continue monitoring near the refineries and other industrial areas in Minneapolis.

RESPONSE: MPCA thanks Western Refining for their comments and long-term support of air quality monitoring near the St. Paul Park Refinery.

COMMENT: The Fond du Lac Band near Cloquet, MN suggests that monitors be set up around some of the taconite facilities that had recent violations for particulates from tailings basins.

RESPONSE: The MPCA Air Monitoring Unit is currently not aware of any ambient air quality violations at taconite facilities. We will follow up with MPCA enforcement staff and offer assistance as needed.

COMMENT: The Fond du Lac Band near Cloquet, MN encourages the MPCA to continue monitoring at sites 909 and 910 in Minneapolis. They support continued monitoring in areas where low income or communities of color might be disproportionately impacted by pollution.

RESPONSE: MPCA thanks the Fond du Lac Band for their comments. Monitoring will continue at sites 909 and 910 until data demonstrates compliance with the MAAQS for total suspended particulates. The CAMP project will continue to assess air quality in communities disproportionately impacted by air pollution. We are currently looking for a CAMP site for 2017.

COMMENT: The Fond du Lac Band near Cloquet, MN supports the continued monitoring of $PM_{2.5}$ in West Duluth at Laura McArthur School (7554).

RESPONSE: The MPCA is committed to long-term $PM_{2.5}$ monitoring in West Duluth to demonstrate compliance with standards and publish an hourly Air Quality Index.

COMMENT: The Fond du Lac Band near Cloquet, MN would like to see NO_X monitored in West Duluth in order to analyze the effects of stagnation events in the West Duluth/Central Hillside area.

RESPONSE: The MPCA will evaluate the need for NOx monitoring in West Duluth using MNRISKs modeling and emissions inventory data.