# Annual Air Monitoring Network Plan for Minnesota

## 2016




Minnesota Pollution Control Agency

September 2015

## 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.*


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# Minnesota Pollution Control Agency

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www.pca.state.mn.us/air/monitoringnetwork.html

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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- pristine air quality in remote areas
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
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
SLAMS – State and Local Air Monitoring Stations
$SO_2$ – sulfur dioxide
SPM – special purpose monitoring
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

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# 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.

## Regional network assessment

In addition to this 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. 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. The 2010 Regional Network Assessment can be found on LADCO's website at http://www.ladco.org/reports/general/Regional_Network_Assessment/index.html.The MPCA is currently collaborating with other Region 5 states and LADCO to complete a network assessment in 2015. Results will be discussed in the 2017 Network Plan.

# Network overview

The MPCA monitors ambient air quality at 53 sites throughout Minnesota. This includes monitoring at four tribal sites, four Interagency Monitoring of Protected Visual Environments (IMPROVE) sites, two Chemical Speciation Network (CSN) sites, and nine National Acid Deposition Program (NADP) sites. Figure 1 shows all of these sites.

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.

## Site selection

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

- 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; or
- 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.

## 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; or
6. welfare-related impacts in the more rural and remote areas.

## 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 displays the recommended siting scales for the appropriate monitoring objective. 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 |

# Monitoring Requirements

The EPA defines the minimum number of monitoring sites required to assess compliance with each NAAQS. Ambient monitors sited to assess NAAQS compliance should be located in areas of expected maximum pollutant concentration for the scale of representativeness (e.g. source-oriented, neighborhood, etc.) defined in the NAAQS. In Minnesota, the MPCA meets or exceeds the minimum monitoring requirements for all pollutants.

**Table 2: Monitoring Requirements**

| | Twin Cities | | Greater Minnesota | |
|---|---|---|---|---|
| **Parameters** | **Minimum Required*** | **Current Sites** | **Minimum Required** | **Current Sites** |
| Fine particles | 2-Community<br>2-Near Road | 8-Community<br>2-Near Road | 0 | 9-Community |
| Ozone | 2-Community | 7-Community | 0 | 10-Community |
| Nitrogen dioxide | 1-Community<br>2-Near Road | 1-Community<br>2-Near Road<br>2-Source-oriented | 0 | 0 |
| Sulfur dioxide | 2-Community | 2-Community<br>5-Source-oriented | 0 | 1-Community |
| Carbon monoxide | 2-Near Road<br>1-SIP Maintenance<br>1-Community | 2-Near Road<br>1-SIP Maintenance<br>2-Community<br>2-Source-oriented | 0 | 0 |
| $PM_{10}$ | 0 | 6-Community | 0 | 2-Community |
| Lead | 1-Community<br>1-Source-oriented | 1-Community<br>1-Source-oriented | 0 | 0 |
| Metals (includes non-regulatory lead) | 0 | 12-Community<br>1-Near Road | 0 | 3-Community |
| VOC/Carbonyls | 0 | 10-Community<br>7-Source-oriented<br>1-Near Road | 0 | 1-Community |

*Air toxics including metals, VOCs, and carbonyls are not regulated by National Ambient Air Quality Standards.

**Table 3: Site information – Greater Minnesota**

| 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 | (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*<br>VOYA2** | International Falls | Voyageurs | 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 | Detroit Lakes | 27-005-2013 | 26624 N Tower Rd | 46.8499 | -95.8463 | 2004 |
| 3051*** | Mille Lacs | Mille Lacs | 27-095-3051 | HCR 67 Box 194 | 46.2052 | -93.7594 | 1997 |
| 2304*** | Red Lake | Red Lake Nation | 27-007-2304 | 24760 Hospital Drive | 47.8782 | -95.0292 | 2014 |
| 3052 | Saint Cloud | Talahi School | 27-145-3052 | 1321 Michigan Ave SE | 45.5497 | -94.1335 | 1998 |
| 3204 | Brainerd | Brainerd Airport | 27-035-3204 | 16384 Airport Rd | 46.3921 | -94.1444 | 2004 |
| 4210 | Marshall | Marshall 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<br>MN18*<br>BOWA1** | Ely | Fernberg Road | 27-075-0005<br>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 |
| BLMO1** | Luverne | Blue Mounds | 27-133-9000 | 1410 161st St | 43.7158 | -96.1913 | 2002 |
| 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: 2015 Air quality monitoring sites in Greater Minnesota**

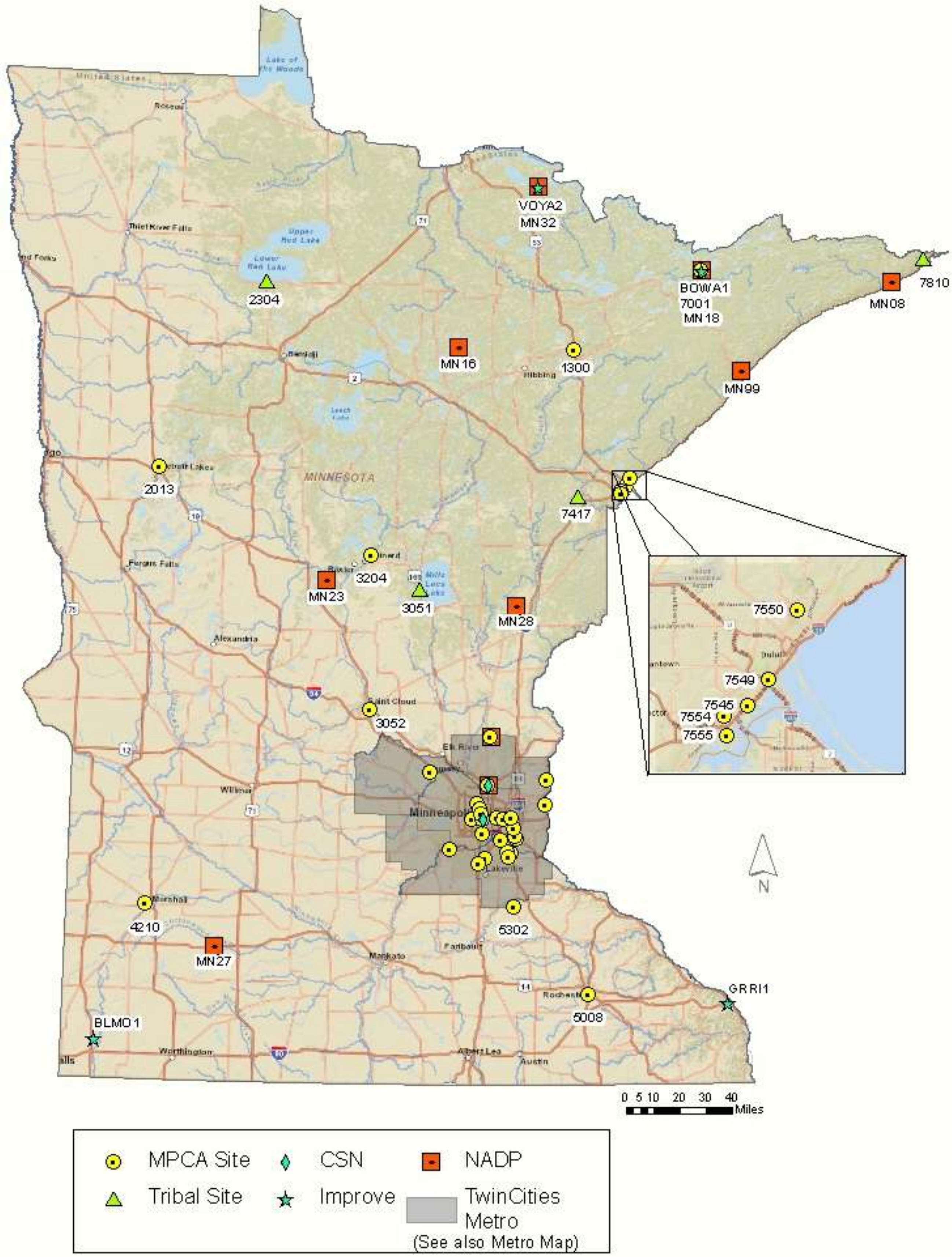
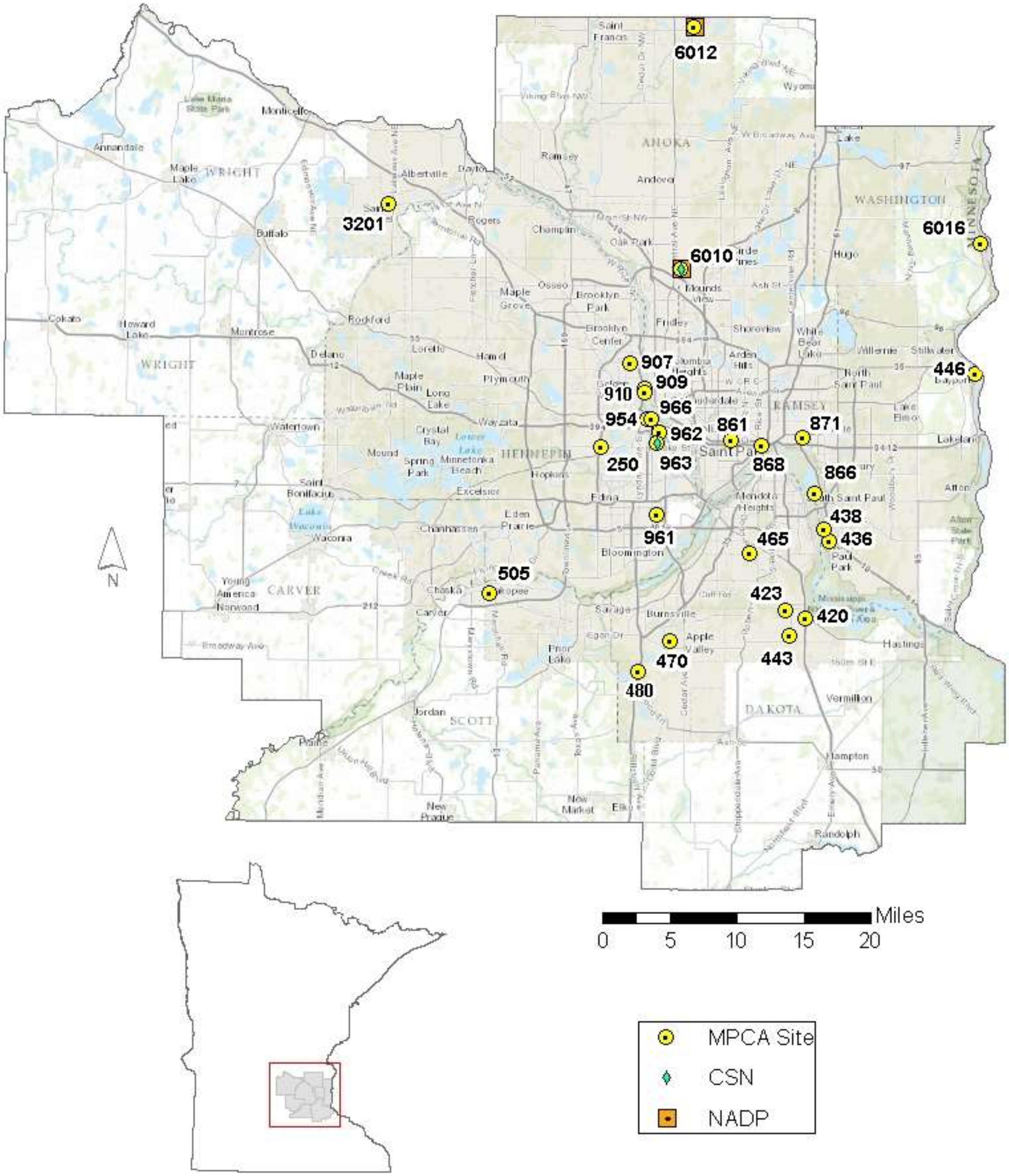


**Table 4: Site information – Twin Cities metropolitan area**

| 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 | FHR 420 | 27-037-0020 | 12821 Pine Bend Tr | 44.7632 | -93.0325 | 1972 |
| 423 | Rosemount | FHR 423 | 27-037-0423 | 2142 120th St E | 44.7730 | -93.0627 | 1990 |
| 436 | St. Paul Park | SPPRC 436 | 27-163-0436 | 649 5th St | 44.8473 | -92.9956 | 1989 |
| 438 | Newport | SPPRC 438 | 27-163-0438 | 4th Ave & 2nd St | 44.8599 | -93.0035 | 1995 |
| 443 | Rosemount | FHR 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 Lakeville | 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 |
| 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 Minneapolis | 27-053-0962 | 1444 18$^{th}$ 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 |
| 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: 2015 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, and
- 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 and performance. 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.

# 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.

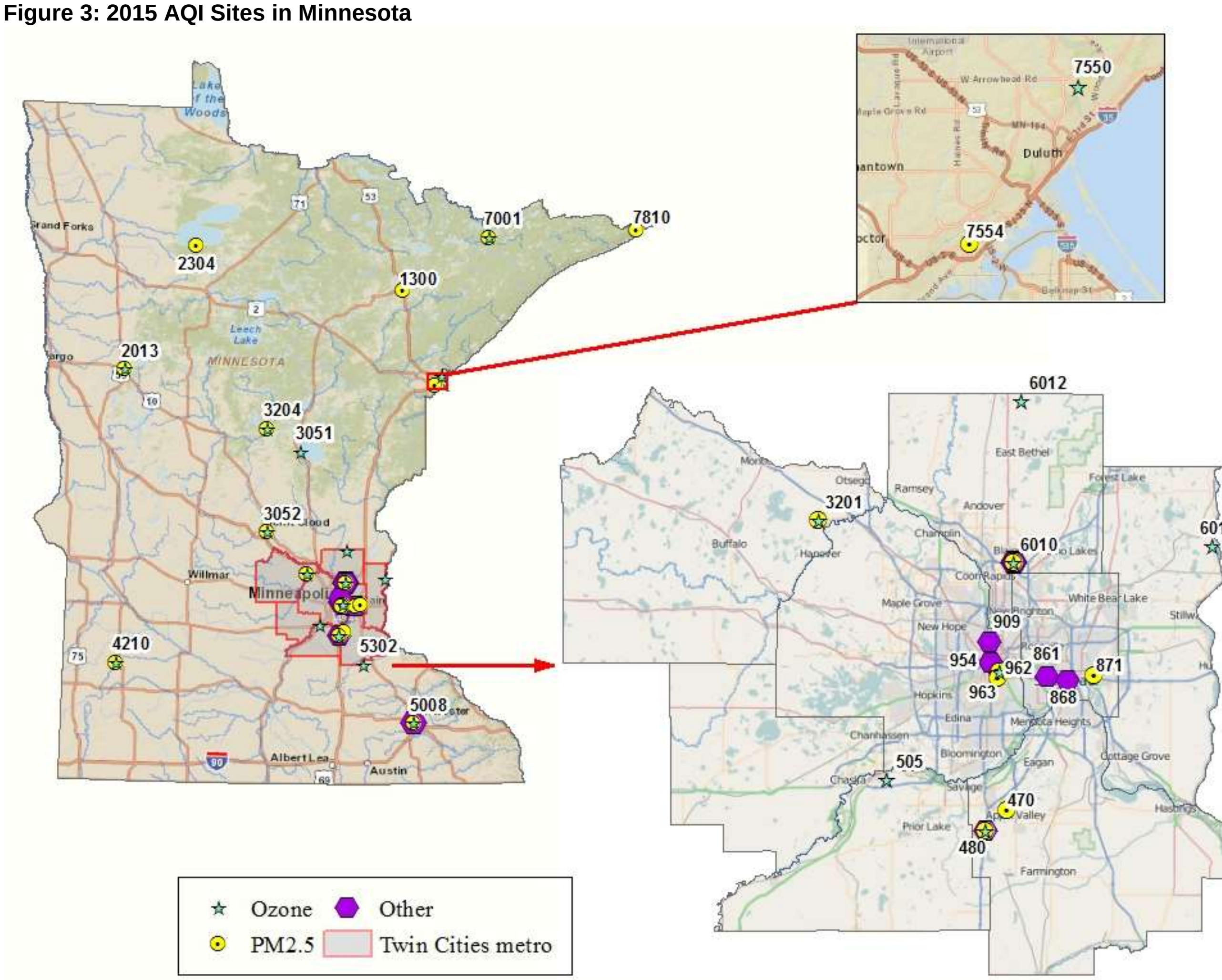
## State and Local Air Monitoring Stations (SLAMS)

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 web site at www.pca.state.mn.us/aqi. There are currently 28 sites in the AQI network in Minnesota (Figure 3).

**Figure 3: 2015 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**


Figure 5 shows the number of good, moderate, and USG days in AQI monitoring regions in Minnesota in 2014. Regions may not show a total of 365 days because of monitoring problems or non-operational days. In 2014, the cleanest air was in Ely with 343 good air days and 19 moderate days. The Twin Cities metropolitan area had the lowest number of good air quality days (169 days), experiencing 195 moderate days, and 1 day considered unhealthy for sensitive groups.  There were no unhealthy or very unhealthy days in Minnesota in 2014.

**Figure 5: 2014 AQI days in Minnesota cities**

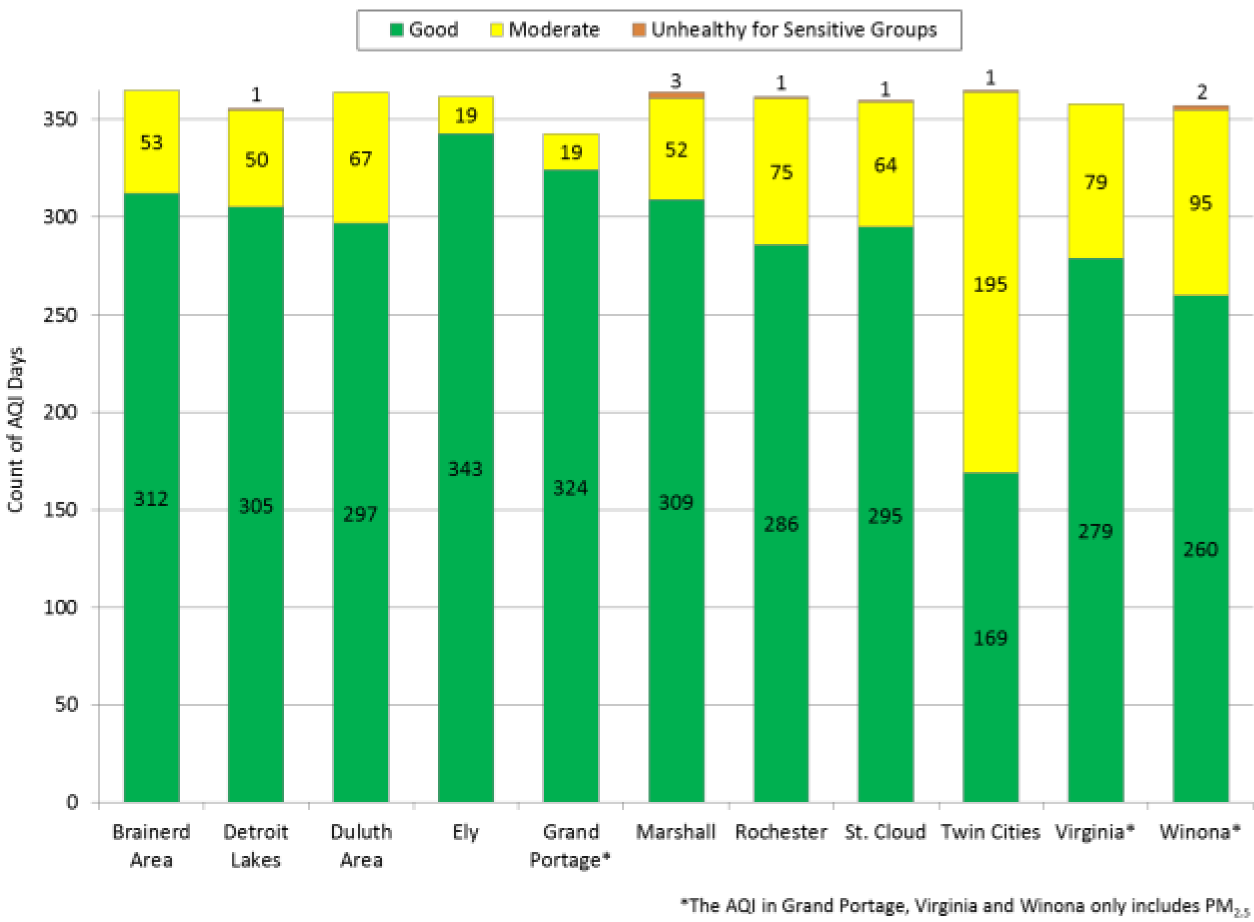


Table 5 summarizes the days the AQI exceeded 100 in 2014. In 2014, the AQI reached a level considered unhealthy for sensitive groups four times. Between March 6, 2014 and March 8, 2014, fine particle concentrations reached unhealthy for sensitive group levels in six regions across the state. This three-day fine particle event has been linked to a slow moving high pressure system that created stagnant weather conditions which limited pollutant dispersion and vertical mixing. On March 31, fine particle concentrations reached unhealthy for sensitive group levels in Marshall. This one day event has been linked to transported smoke from open-burning in the central plains.

**Table 5: 2014 days with AQI greater than 100**

| | Brainerd | Detroit Lakes | Duluth | Ely | Grand Portage | Marshall | Rochester | St. Cloud | Twin Cities | Winona |
|---|---|---|---|---|---|---|---|---|---|---|
| 3/6/2014 | | | | | | 109 | | | | |
| 3/7/2014 | | 104 | | | | 108 | 112 | 106 | 121 | 115 |
| 3/8/2014 | | | | | | | | | | 107 |
| 3/31/2014 | | | | | | 102 | | | | |
| **Total** | **0** | **1** | **0** | **0** | **0** | **3** | **1** | **1** | **1** | **2** |

**Ozone** **Fine Particles**

## Chemical Speciation Network (CSN)

The CSN is an EPA effort to gather data on the chemical composition of $PM_{2.5}$ and to provide a basic, long-term record of the concentration levels of selected ions, metals, carbon species, and organic compounds found in $PM_{2.5}$. EPA has established a chemical speciation network consisting of approximately 300 monitoring sites. The chemical speciation data provides data for assessing trends and developing mitigation strategies to reduce emissions and ambient concentrations.

The programmatic objectives of the CSN are:

- temporal and spatial characterization of aerosols;
- air quality trends analysis and tracking progress of control programs;
- comparison of the chemical speciation data set to the 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 the H.C. Andersen School (963) and at the NCore site in Blaine (6010). Figure 2 shows the locations of these sites.

## Interagency Monitoring of Protected Visual Environments (IMPROVE)

The IMPROVE Aerosol Network is a cooperative 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 and other wilderness areas that are designated 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 four IMPROVE Aerosol Network sites. They are located at Voyageurs National Park (VOYA2), near the

Boundary Waters Canoe Area Wilderness at Ely (BOWA1), Blue Mounds State Park (BLMO1), and Great River Bluffs State Park (GRRI1). Figure 1 shows the locations of these sites.

The EPA has been conducting an assessment of the National IMPROVE Protocol Network in 2015. As a result of this assessment, EPA is recommending defunding a number of monitoring sites. Should these recommendations become final, Minnesota would lose funding for Blue Mounds and Great River Bluffs. EPA is currently soliciting feedback regarding their recommendations. The MPCA has requested that EPA continue funding at the Great River Bluffs IMPROVE site. Due to the proximity of a CSN site in Sioux Falls, South Dakota, the MPCA is not requesting continued funding for the Blue Mounds IMPROVE site. The EPA is currently working to finalize the IMPROVE defunding list. Any adopted changes will take place in January 2016. If EPA does not announce its final IMPROVE defunding list prior to publication of the 2016 Monitoring Plan, final changes will be reflected in the 2017 Monitoring Plan.

## National Atmospheric Deposition Program (NADP)

Atmospheric deposition is monitored through the NADP which has over 250 sites in the NADP spanning the continental United States, Alaska, Puerto Rico, and the Virgin Islands. More information can be found at http://nadp.sws.uiuc.edu/. There are two active sub-networks in Minnesota: the National Trends Network (NTN) and the Mercury Deposition Network (MDN). There are currently nine NTN and five MDN sites in Minnesota.

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 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 and the seasonal and annual flux of total mercury in wet deposition. Samples are collected weekly and sent to Frontier Geosciences, Inc. for analysis.

Minnesota has ten NADP sites; Figure 1 shows the locations of these sites.

## 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. At a minimum, near-road monitoring sites are required to measure hourly levels of nitrogen dioxide ($NO_2$), carbon monoxide (CO), and fine particles ($PM_{2.5}$).

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. Table 6 lists the parameters at each of the near-road sites.

**Table 6: 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 Minneapolis | X | X | X | X | X | X | X | Meteorological Data, Ultrafine Particle Counter, Black Carbon |
| 480 | Lakeville | Near-road Lakeville | X | | | X | X | | | Meteorological Data |

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

## 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.

At a minimum NCore monitoring sites must measure the parameters listed in Table 7.

**Table 7: 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 |
| lead (Pb) | 24 hour sample every sixth day |
| 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 |

The NCore monitoring network addresses the following monitoring objectives which are equally valued at each site:

- timely reporting of data to the public through AIRNow, air quality forecasting, and other public reporting mechanisms;
- support development of emission strategies through air quality model evaluation and other observational methods;
- accountability of emission strategy progress through tracking long-term trends of criteria and non-criteria pollutants and their precursors;
- compliance through establishing nonattainment/attainment areas by comparison with the NAAQS;
- support of scientific studies ranging across technological, health, and atmospheric process disciplines; support long-term health assessments that contribute to ongoing reviews of the NAAQS; and
- support of 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, http://tinyurl.com/pl47ja8.

Minnesota's NCore site focuses on providing multi-pollutant monitoring data. 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 release multiple pollutants or their precursors simultaneously. 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 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 existing facilities, begin construction on new facilities, or to modify existing facilities. Air quality permits contain state and federal requirements to minimize the environmental impact of air emissions from these facilities. Some federal programs involve performance standards for specific types of units 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, and submitting 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
- Shakopee Sands in Jordan, MN
- Titan Lansing Transload in North Branch, MN

## Clean Air Status and Trends Network (CASTNET)

CASTNET provides long-term monitoring of air quality in rural areas to determine trends in regional atmospheric nitrogen, sulfur, and ozone concentrations and deposition fluxes of sulfur and nitrogen pollutants in order 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. More information can be found at http://epa.gov/castnet.

There are two CASTNET sites in Minnesota. One site is located at Voyageurs National Park and operated by the National Park Service. The other is in Red Lake 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 $PM_{2.5}$, $PM_{10}$, lead (Pb), $O_3$, $NO_2$, $SO_2$, and 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 six 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) at the near-road monitoring site 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 Hg are monitored through the NADP 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 and 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 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 five or 15 minutes or every hour. Integrated samples are usually 24-hour averages. Integrated samples are collected daily, 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.

Table 8 lists the types of parameters monitored by the MPCA along with the methods and equipment used. Tables 9 and 10 list all of the air quality monitoring sites in Minnesota and the parameters monitored at each.

**Table 8: 2014 Site parameters - Greater Minnesota**

| MPCA Site ID | City Name | Site Name | $PM_{2.5}$ FRM | $PM_{2.5}$ FEM | $PM_{2.5}$ pre-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*<br>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<br>MN18*<br>BOWA1** | Ely | Fernberg Road | | X | | IMP | | | X | | | | | | Acid and Hg Deposition |
| 7417 | Cloquet | Cloquet | | X | | | | | X | | | | | | |
| 7526 | Duluth | Torrey Building | | | | | | | | | | X | | | |
| 7545 | Duluth | Oneota Street | | | | | X | | | | | | | | Collocated $PM_{10}$ |
| 7549 | Duluth | Michigan Street | | | | | | | | | | | 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 | | | | | | | | | | |
| BLMO1** | Luverne | Blue Mounds | | | | IMP | | | | | | | | | |
| 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)

**Table 9: 2014 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 | FHR 420 | | | | | X | | X | X | X | X | X | TRS, Meteorological Data |
| 423 | Rosemount | FHR 423 | | | | | | | X | X | X | X | X | TRS, Meteorological Data |
| 436 | St. Paul Park | SPPRC 436 | | | | | | | | X | | X | X | TRS, Collocated VOCs and Carbonyls |
| 438 | Newport | SPPRC 438 | | | | | X | | | | | X | X | |
| 443 | Rosemount | FHR 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 Lakeville | | X | | | | | X | | X | | | Meteorological Data |
| 505 | Shakopee | Shakopee | X | | | | | 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 | |
| 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 Minneapolis | | X | | | X | X | X | | X | X | X | Meteorological Data, Ultrafine Particle Counter, Black Carbon, PAHs |
| 963 | Minneapolis | H.C. Andersen School | X | X | CSN | | X | | | | | X | X | PAHs |
| 966 | Minneapolis | City of Lakes | | | | X | X | | | | | X | X | Collocated VOCs and Carbonyls |
| 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 10: 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 |
| **Particle sizer/counter** | TSI Model 3031 Ultrafine Particle Monitor | 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 |
| **VOCs** | Gas Chromatography and Mass Spectrometry – ATEC Model 2200 sampler | MPCA |

## Criteria pollutants

In 1970, the CAA established standards 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 EPA. The criteria pollutants are particulate ($PM_{2.5}$ and $PM_{10}$), lead (Pb), $O_3$, $NO_2$, $SO_2$, and CO. For each of these pollutants the EPA has developed primary and secondary 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 11, found on the EPA website at http://epa.gov/air/criteria.html, describes the NAAQS (as of December 2012).

**Table 11: 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 $\mu g/m^3$ (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 [73 FR 16436, Mar 27, 2008] | | primary and secondary | 8-hour | 0.075 ppm (3) | Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years |
| Particle Pollution Dec 14, 2012 | $PM_{2.5}$ | primary | Annual | 12 $\mu g/m^3$ | annual mean, averaged over 3 years |
| | | secondary | Annual | 15 $\mu g/m^3$ | annual mean, averaged over 3 years |
| | | primary and secondary | 24-hour | 35 $\mu g/m^3$ | 98th percentile, averaged over 3 years |
| | $PM_{10}$ | primary and secondary | 24-hour | 150 $\mu g/m^3$ | 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 March 12, 2008. The 1997 ozone standard (0.08 ppm, annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years) and related implementation rules remain in place. In 1997, EPA revoked the 1-hour ozone standard (0.12 ppm, not to be exceeded more than once per year) in all areas, although some areas have continued obligations under that standard ("anti-backsliding"). The 1-hour ozone standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is less than or equal to 1.

(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 matter (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. 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 $PM_{2.5}$. However, to date, the EPA has found insufficient health evidence to support the creation of a distinct UFP standard.

In 2014, the MPCA installed an UFP sizer and counter at the near-road monitoring site (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 measures 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 will support research activities ranging across technological, health, and atmospheric process disciplines and will 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 most of which are smaller than 2.5 microns in diameter. It contains 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 22 $PM_{2.5}$ sites in Minnesota, eight of which are in the Twin Cities metropolitan area. Figure 6 shows the locations of the sites in Minnesota. Five types of $PM_{2.5}$ monitors run in Minnesota: FRM, Federal Equivalent Method (FEM), continuous, CSN, and IMPROVE. 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 continuous, 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 and continuous $PM_{2.5}$ monitors are MetOne Instruments BAM-1020 (BAM) continuous mass monitors that collect and report hourly $PM_{2.5}$ concentrations. With the exception of the BAM monitor operated by the Grand Portage Band of Lake Superior Chippewa, 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 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.

### $PM_{2.5}$ regulatory network

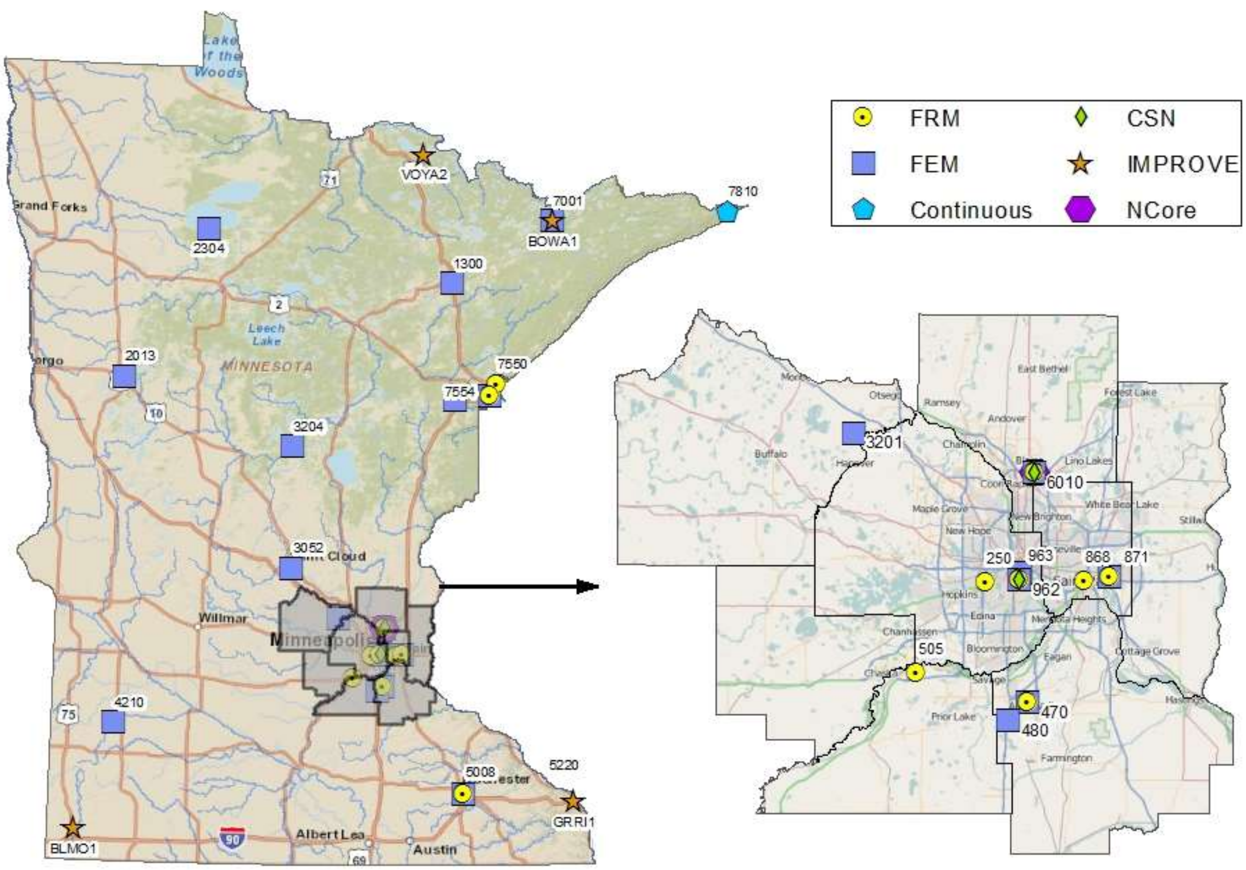
The $PM_{2.5}$ regulatory network includes FRM and FEM monitors. Currently the MPCA is operating 10 FRM sites and 17 FEM sites (figure 6).

Two special purpose $PM_{2.5}$ FEM monitors closed in 2015. The special purpose monitor at site 909 in Minneapolis closed upon completion of two years of monitoring. More information on this project can be found on the project website (http://www.pca.state.mn.us/rx6ffwu). In addition, the special purpose monitor at site 5220 in Winona closed upon completion of one year of monitoring. More information on this project can be found on the project website (http://www.pca.state.mn.us/6f6dhkf).

In 2015 $PM_{2.5}$ FEM monitors were added to a new tribal site in Red Lake, MN and to the second near-road monitoring station along I-35 in Lakeville. In addition, special purpose $PM_{2.5}$ monitors were added to short term sites as part of the Community Air Monitoring Project; more information can be found on the project website (http://www.pca.state.mn.us/9xc4ahc); this project will continue in 2016. No other changes are expected to the $PM_{2.5}$ regulatory network in 2016.

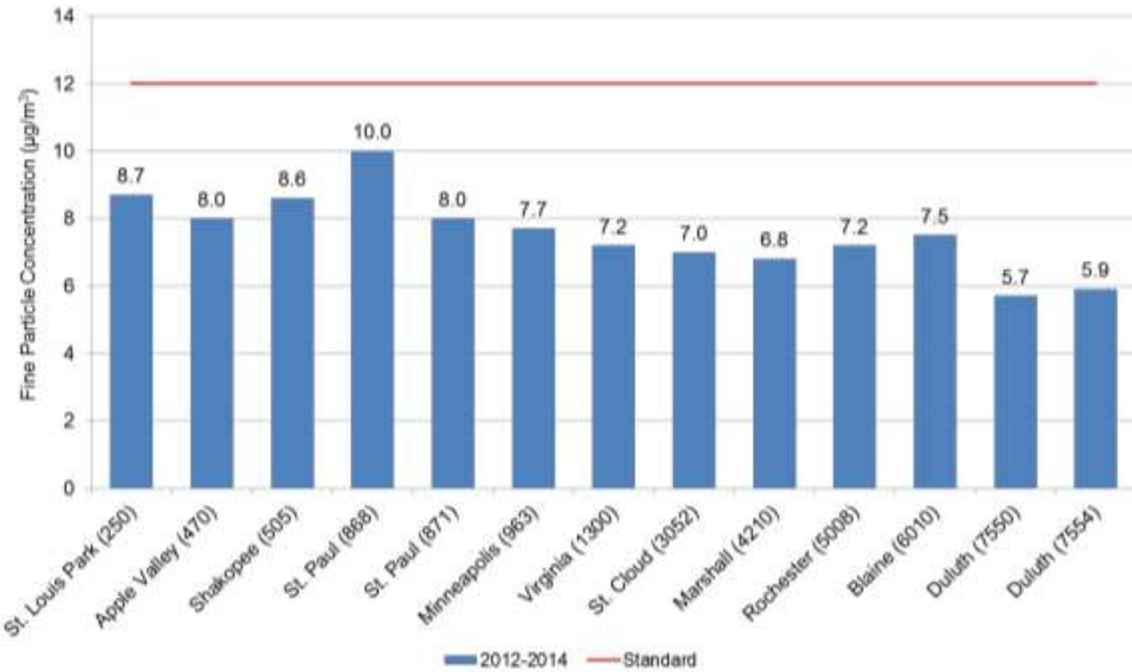
If a $PM_{2.5}$ FRM monitoring site were lost due to circumstances beyond the MPCA's control, a replacement site would be established if the lost site exceeded the NAAQS or if it is the "design value site" for a particular metropolitan statistical area (MSA). In this case, all possible efforts would 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.

**Figure 6: 2015 $PM_{2.5}$ monitoring sites in Minnesota**



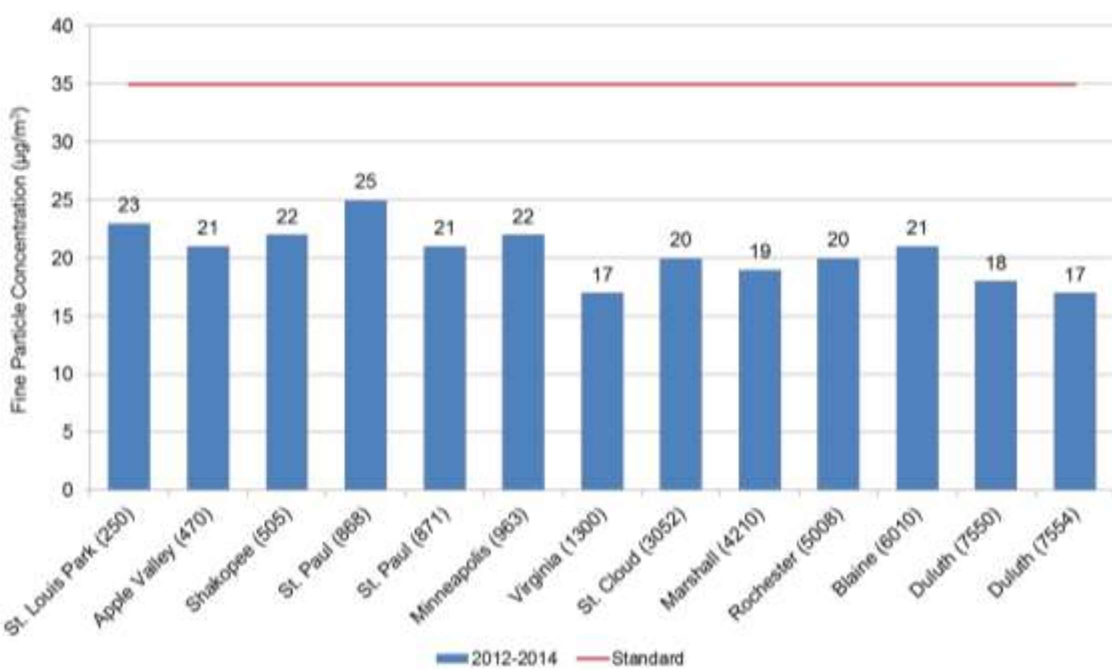
A monitoring site meets the annual $PM_{2.5}$ NAAQS if the three-year average of the annual average $PM_{2.5}$ concentration is less than or equal to 12 μg/m$^3$. Figure 7 shows the average of the 2012 through 2014 annual average $PM_{2.5}$ concentrations at Minnesota sites and compares them to the standard. Minnesota averages ranged from 5.7 μg/m$^3$ in Duluth (7550) to 10.0 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 standard 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 2012 through 2014 98th percentile of the daily $PM_{2.5}$ averages at Minnesota sites and compares them to the standard. Minnesota averages ranged from 17 μg/m$^3$ in Virginia (1300) and Duluth (7554) to 25 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 17 FEM $PM_{2.5}$ sites in Minnesota. There is also a non-FEM $PM_{2.5}$ monitor at Grand Portage (7810) which is owned and operated by the Grand Portage Band of Lake Superior Chippewa. As discussed in the $PM_{2.5}$ regulatory network, monitors were closed in Minneapolis (909) and Winona (5220) and added in Lakeville (480) and Red Lake (2304) in 2015. Short term special purpose monitors will also be added as part of the Community Scale Monitoring project in 2015 and 2016.

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 $PM_{2.5}$ concentrations from eight 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 concentrations in July 2014**

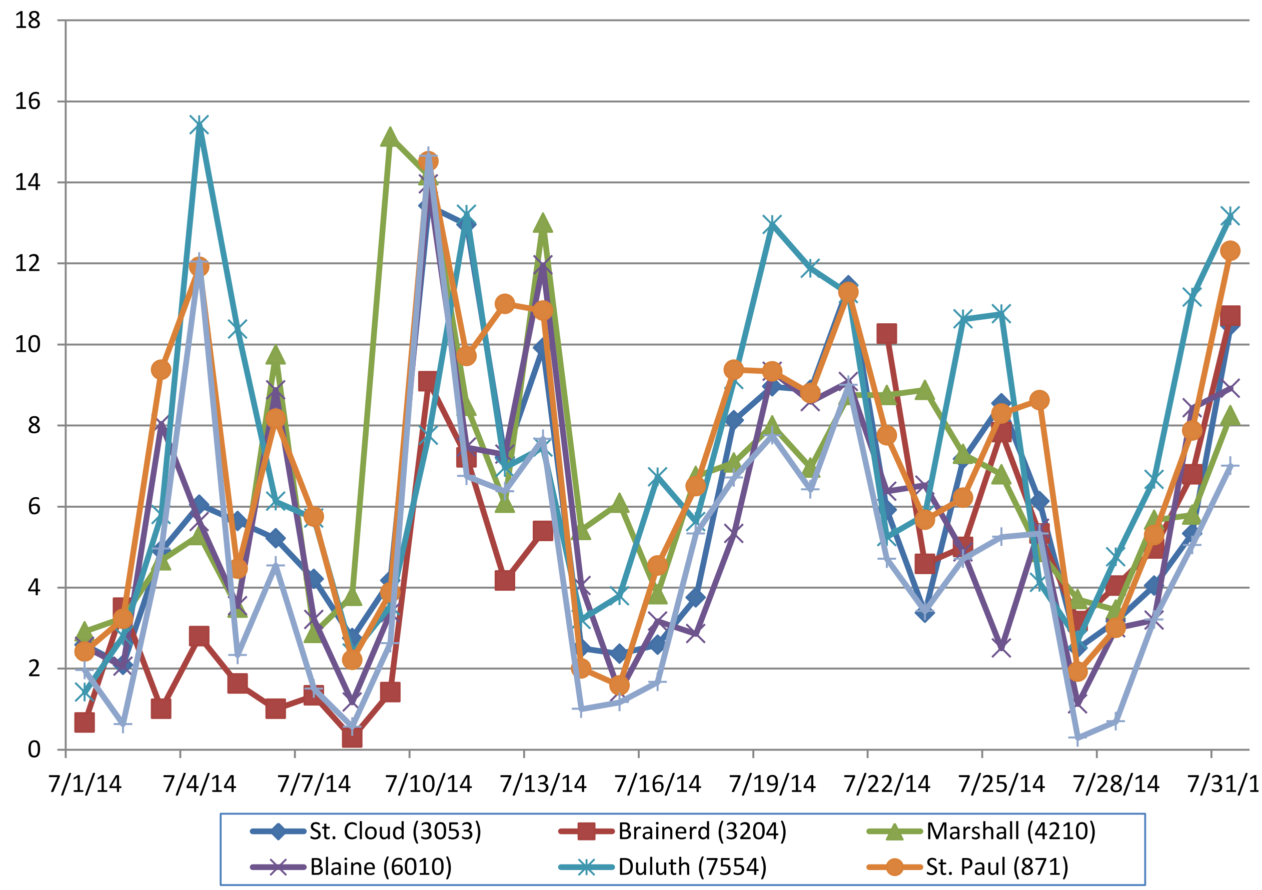
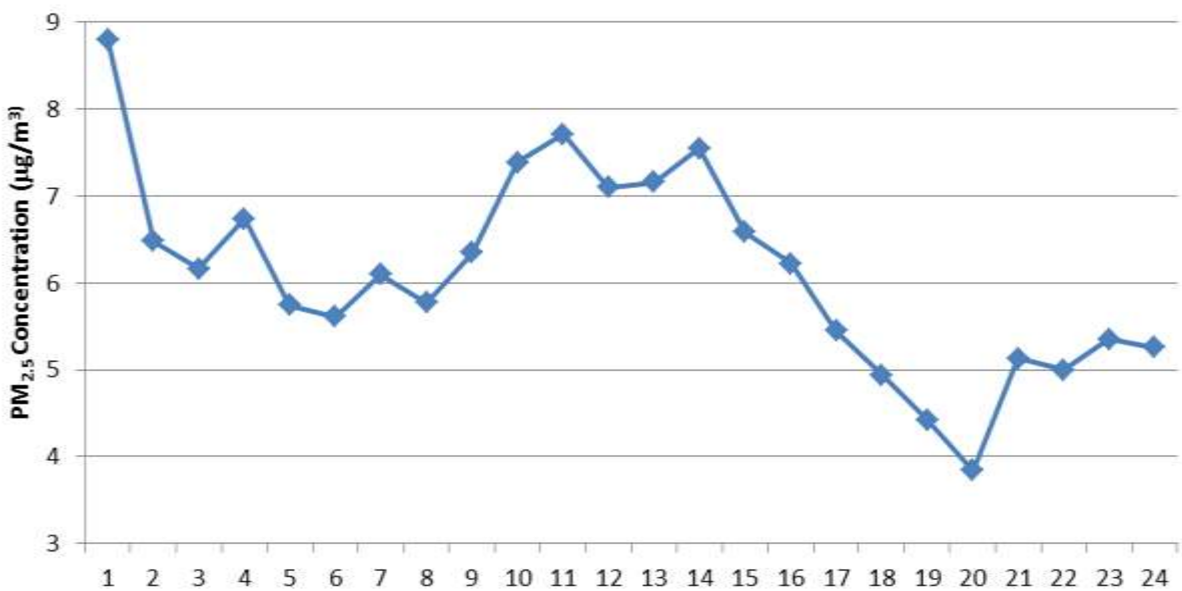



Figure 10 shows the average hourly concentrations in July 2014 in Minneapolis (site 963). It shows a classic traffic pattern in an urban area. The mid-day peak concentration results from traffic. As temperatures rise in the day, the atmospheric mixing height increases. This allows for dilution of fine 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 HC Andersen School (963) in August 2014**




### $PM_{2.5}$ speciation

Currently, six 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), Blue Mounds (BLMO1), 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 mass, 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.

In 2014, the EPA conducted an assessment of the CSN in an effort to optimize the network and create an efficient network that is financially sustainable going forward. The final recommendations of the assessment included defunding 42 sites, including the CSN site in Rochester (5008), elimination of the CSN $PM_{2.5}$ mass measurement, and minor changes to sampling frequency, carbon blank frequency, and shipping procedures. A comprehensive presentation about the assessment can be found at http://www.epa.gov/ttn/amtic/files/2014conference/tuelandis.pdf

The EPA has been conducting an assessment of the IMPROVE Protocol Sites in 2015. As a result of this assessment, EPA is recommending defunding a number of monitoring sites, including two sites in Minnesota: Blue Mounds and Great River Bluffs. EPA is currently soliciting feedback regarding their recommendations. The MPCA has requested that EPA continue funding at the Great River Bluffs IMPROVE site. Due to the proximity of a CSN site in Sioux Falls, South Dakota, the MPCA is not requesting continued funding for the Blue Mounds IMPROVE site. The EPA is currently working to finalize the IMPROVE defunding list. Any adopted changes will take place in January 2016. If EPA does not announce its final IMPROVE defunding list prior to publication of the 2016 Monitoring Plan, final changes will be reflected in the 2017 Monitoring Plan.

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

The 2006 Ambient Air Monitoring Regulations contain a requirement for $PM_{10-2.5}$ mass and speciation monitoring to be conducted at NCore multipollutant monitoring sites. The collocation of both $PM_{10-2.5}$ and $PM_{2.5}$ speciation monitoring at NCore sites is consistent with the multipollutant objectives of the NCore network and will support further research in understanding the chemical composition and sources of $PM_{10}$, $PM_{10-2.5}$, and $PM_{2.5}$ at a variety of urban and rural locations. This additional data will inform future regulation, providing more targeted protection from the health effects associated with $PM_{10-2.5}$.

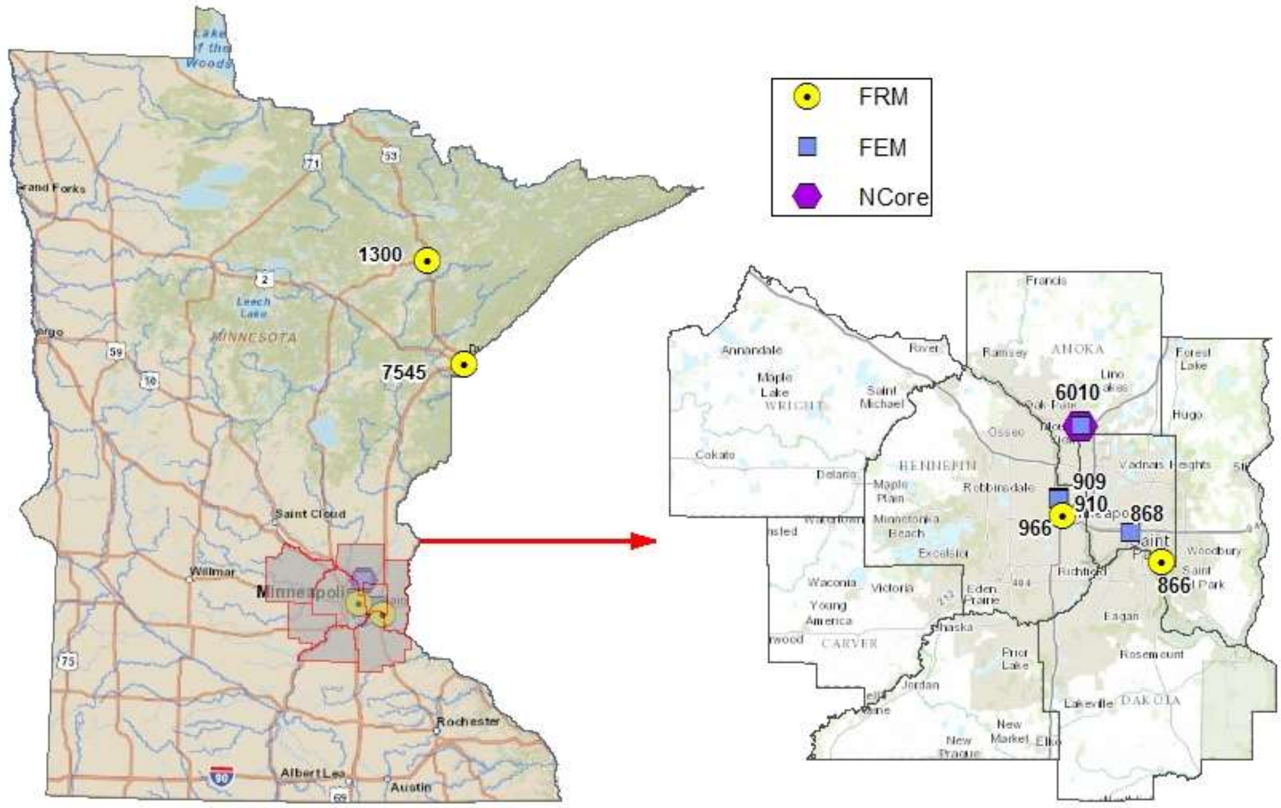
The MPCA started monitoring $PM_{10-2.5}$ at the NCore site in Blaine (6010) in 2011. No additional sites are expected at this time.

### $PM_{10}$

$PM_{10}$ 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.

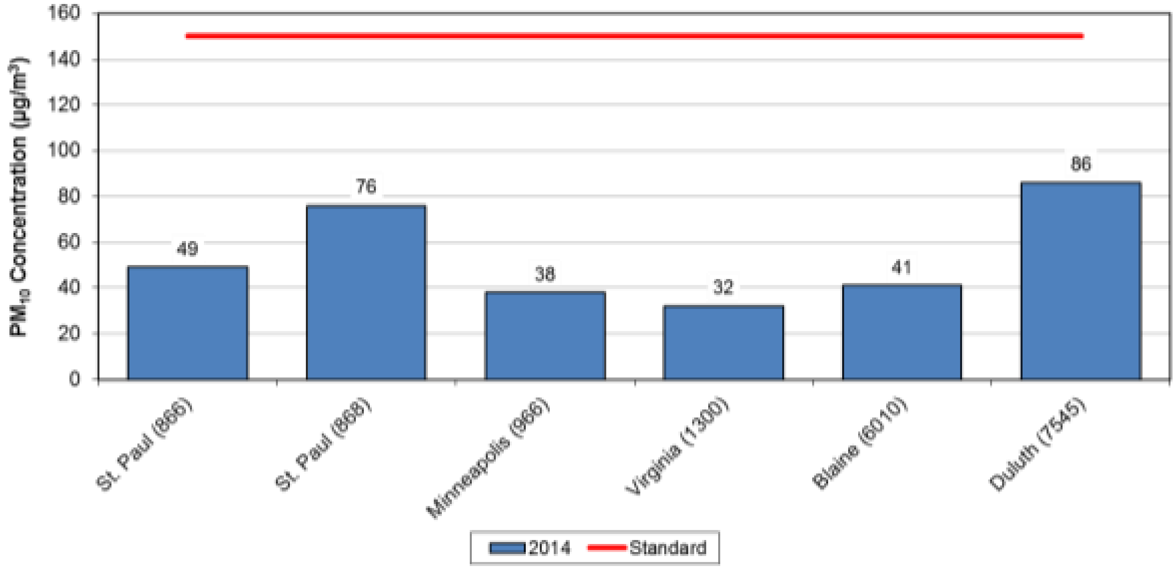
The MPCA currently operates four $PM_{10}$ FRM monitors. This method collects mass samples of $PM_{10}$ over a 24-hour period once every six days. There are also continuous $PM_{10}$ FEM monitors that measure hourly $PM_{10}$ concentrations at four sites: St. Paul (868), Minneapolis (909), Minneapolis (910), and Blaine (6010). Figure 11 shows the locations of the $PM_{10}$ monitors in Minnesota in 2015. The majority of the $PM_{10}$ monitors are located in the Twin Cities metropolitan area with additional monitors in Duluth (7545) and Virginia (1300). In response to violations of the state TSP standard at site 909, the MPCA began monitoring hourly $PM_{10}$ at two sites in an industrial area of North Minneapolis. Special purpose monitoring for hourly $PM_{10}$ began in January 2015 at site 909 and in June 2015 at site 910.

**Figure 11: 2015 $PM_{10}$ 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 $\mu g/m^3$ is not exceeded more than once per year on average over 3-years. To describe the magnitude of daily PM10 measurements, the MPCA reports the annual second high daily PM10 concentration and compares the results to the level of the daily standard. These results should not be used to demonstrate compliance with the NAAQS. Figure 12 shows the 2014 second highest daily maximums at Minnesota sites and compares them to the standard. The Minnesota values ranged from 32 $\mu g/m^3$ in Virginia (1300) to 86 $\mu g/m^3$ in Duluth (7545). While there is no annual NAAQS for $PM_{10}$, there is a Minnesota Ambient Air Quality Standard (MAAQS). All $PM_{10}$ monitoring sites with one year of data meet the annual $PM_{10}$ MAAQS of 50 $\mu g/m^3$.

**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 12: 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/m$^3$ |
| | Annual | 75 micrograms per cubic meter | ...the annual geometric mean is less than or equal to 75 µg/m$^3$ |
| 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/m$^3$ |
| | Annual | 60 micrograms per cubic meter | ...the annual geometric mean is less than or equal to 60 µg/m$^3$ |

[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.

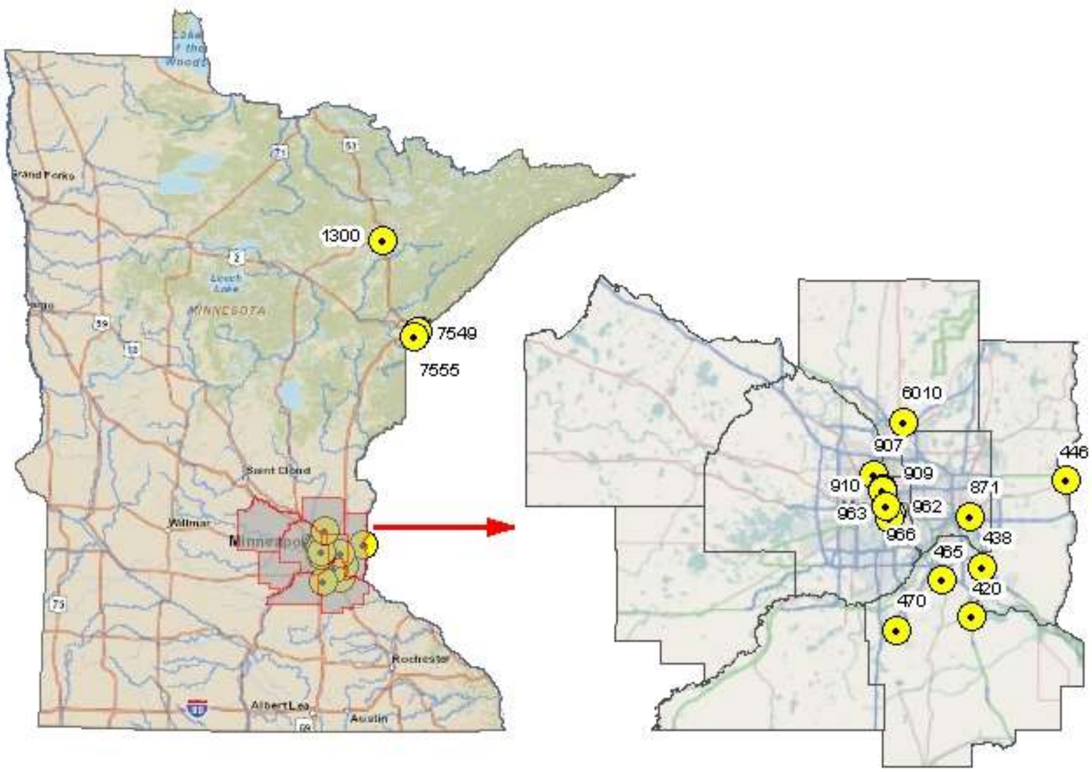
The MPCA currently operates 16 TSP monitoring sites; figure 13 shows the location of the sites. Mass samples of TSP are collected over a 24 hour period once every six days.

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, http://www.pca.state.mn.us/rx6ffwu.

In 2015 TSP monitors were also added to short term sites as part of the Community Air Monitoring Project; more information can be found on the project website (http://www.pca.state.mn.us/9xc4ahc). This project will continue in 2016.

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. TSP monitors will be added to three sites in 2016 that currently have VOC and carbonyl monitors but no TSP and metals; these sites include St. Louis Park (250), Rosemount (423), and Richfield (962). A TSP monitor may also be added to the Red Rock Road (866) PM10 monitoring site to assess metals.

Figure 13: 2015 TSP monitoring sites in Minnesota




In 2014, all TSP monitoring sites met the annual TSP MAAQS, but two air monitoring sites violated the secondary daily TSP MAAQS. The two monitoring sites that violated the secondary daily TSP MAAQS include the near-road monitoring site in Minneapolis (962) and the Lowry Ave site in Minneapolis (909). Due to its proximity to the roadway, the violation at Minneapolis (962) was likely the result of winter time plowing and road treatment activities. The 2014 and 2015 TSP violations at the Lowry Ave site (909) remain under investigation. More information about the Lowry Ave TSP violation is available on the MPCA's website, http://www.pca.state.mn.us/rx6ffwu.

Figure 14 shows the 2014 annual average TSP concentrations at Minnesota sites and compares them to the secondary standard. Minnesota averages ranged from 22 μg/m$^3$ in Bayport (446) and Blaine (6010) to 57 μg/m$^3$ at the Minneapolis near-roadway site; therefore, all sites were below the annual standard in 2014.

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

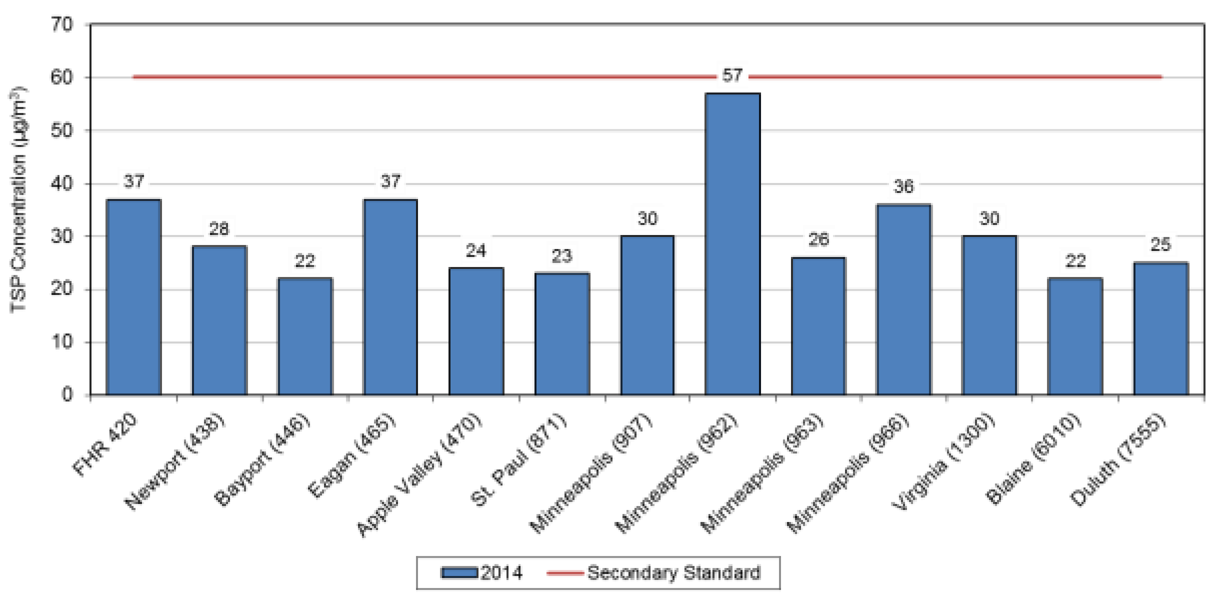
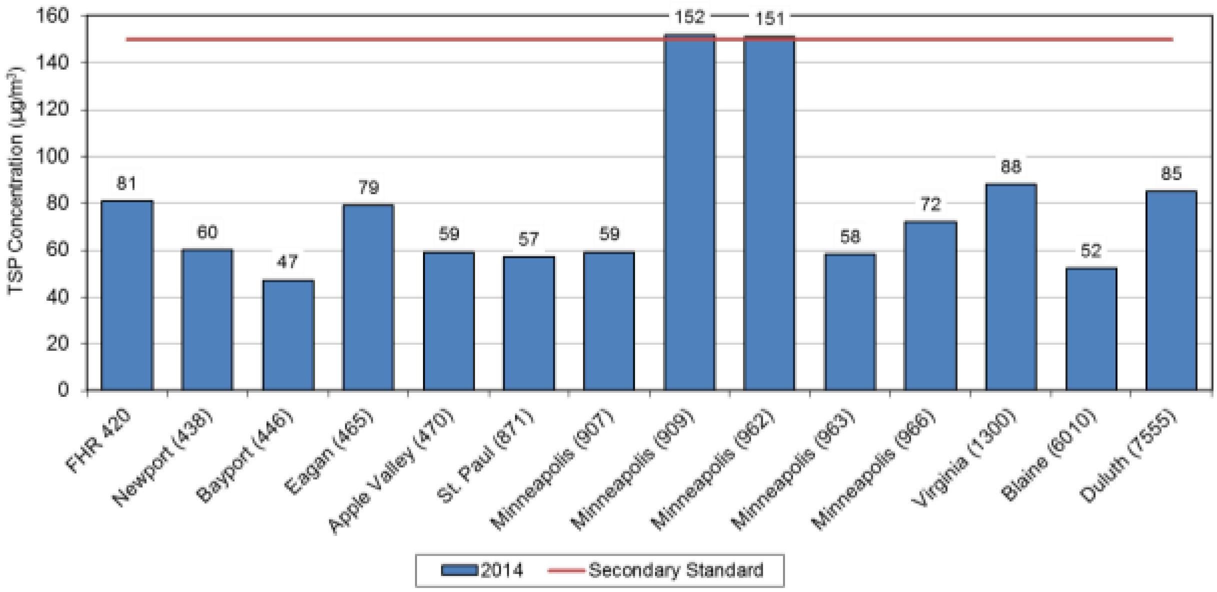


Figure 15 shows the 2014 second highest daily maximum TSP concentrations at Minnesota sites and compares them to the secondary TSP standard. Minnesota values ranged from 47 µg/m$^3$ in Bayport (446) to 152 µg/m$^3$ in Minneapolis (909). In 2014, the TSP monitoring sites at Lowry Ave (909) and near-road (962) in Minneapolis violated the secondary TSP standard.

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




## Lead (Pb)

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 lead is monitored in 2015. The MPCA monitors lead at one source-oriented monitoring site in Eagan (465) and at one population-oriented NCore site in Blaine (6010). Additionally, as part of our Air Toxics Program, the MPCA also monitors heavy metals at 10 other TSP sites. Lead is part of our analytical metal scan, which includes 12 other metals including iron, cadmium and zinc. These Air Toxics Program sites are non-regulatory and as such, do not meet the same rigorous EPA mandated quality assurance protocols, which includes quarterly flow audits and monthly flow verifications that are required for the regulatory source-oriented monitoring site in Eagan.

In 2016, a new population-oriented lead monitoring site will be added in the St. Paul Westside neighborhood. During the 3-month Community Air Monitoring Project sampling period in the St. Paul Westside neighborhood, the 3-month average lead concentration was 0.09 µg/m$^3$, which is more than 50% of the lead standard (0.15 µg/m$^3$). The MPCA is actively looking for a monitoring site for a one year study to monitor metals in the area near the original Community Air Monitoring Project site.

As discussed in the TSP section, TSP monitors will be added to short term sites as part of the Community Air Monitoring Project in 2015 and 2016; more information can be found on the project website (http://www.pca.state.mn.us/9xc4ahc). In addition, a TSP monitor was added to a new site in Minneapolis (910) in 2015 following violations of the secondary daily TSP MAAQS at site in 909 in 2014 and 2015; the violations at site 909 remains under investigation. More information is available on the MPCA's website, http://www.pca.state.mn.us/rx6ffwu.

TSP monitors will be added to three sites in 2016 that currently have VOC and carbonyl monitors but no TSP and metals; these sites include St. Louis Park (250), Rosemount (423), and Richfield (962). A TSP monitor may also be added to the Red Rock Road (866) PM10 monitoring site to assess metals concentrations.

All lead monitoring sites in Minnesota meet the 2008 lead NAAQS of 0.15 µg/m$^3$. Figure 17 shows the 3-year maximum rolling quarter average concentration at monitored sites from 2012-2014. Minnesota values range from 0.003 µg/m$^3$ in Bayport (446) to 0.12 µg/m$^3$ in Eagan (465) with the majority of sites below 0.01µg/m$^3$.

**Figure 16: 2015 Lead monitoring sites in Minnesota**

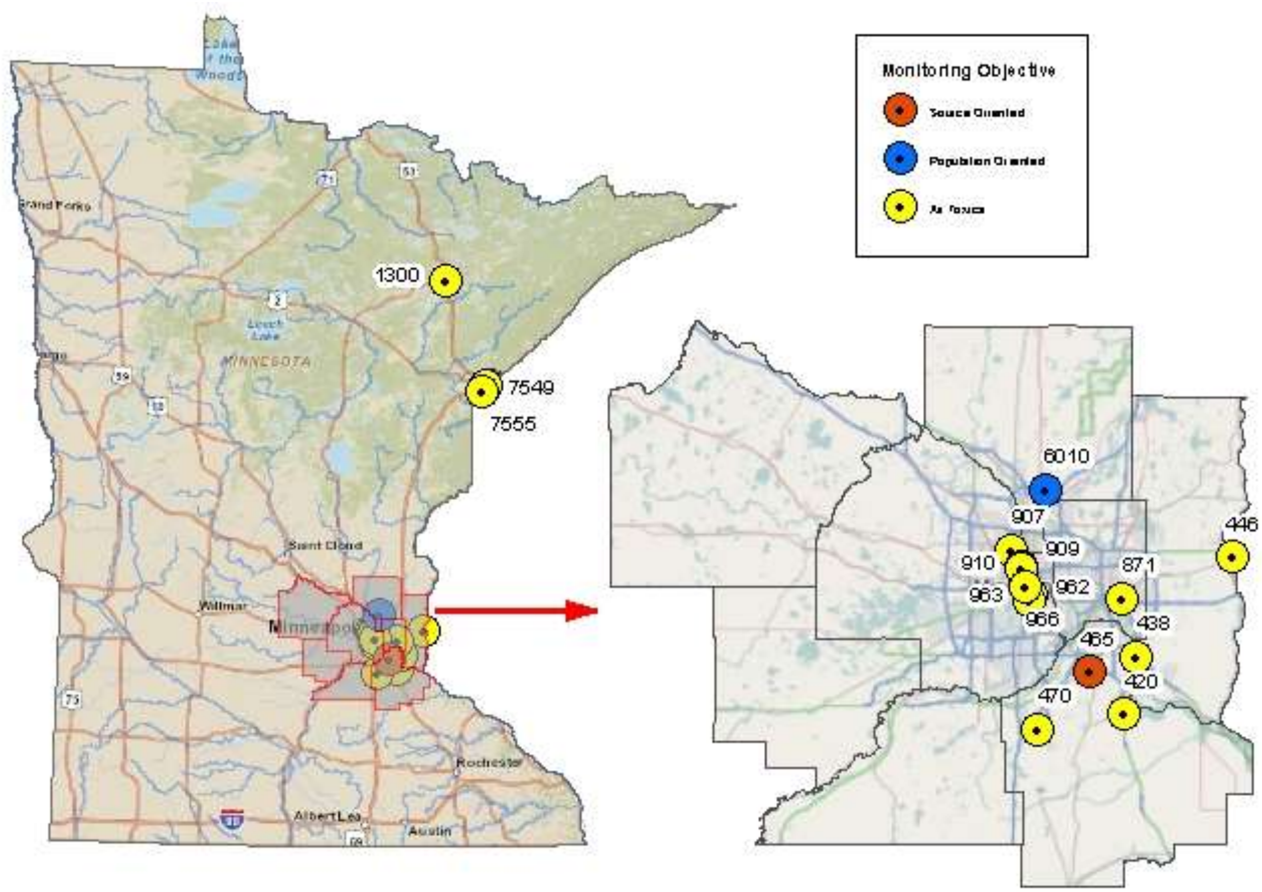
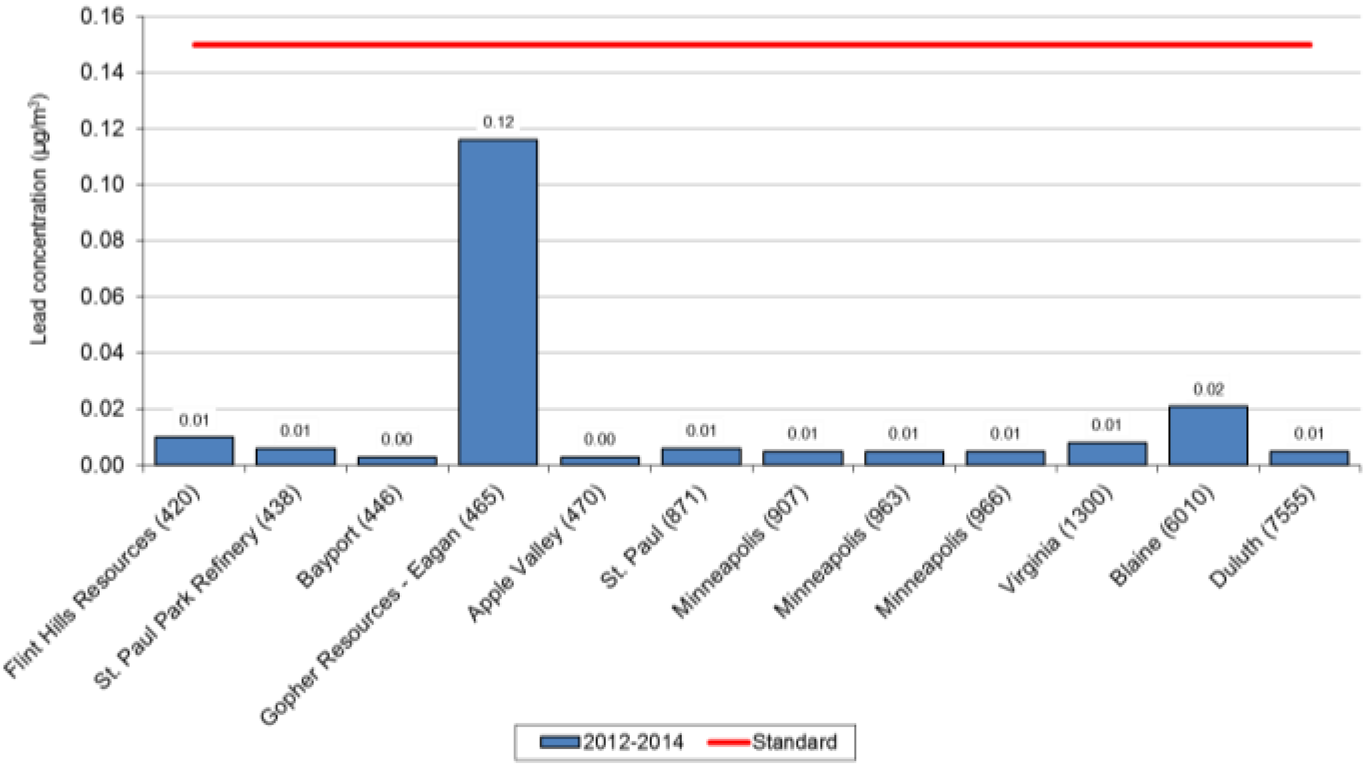


**Figure 17: Lead concentrations compared to the NAAQS***




*Note: Only sites 465 and 6010 meet all regulatory requirements associated with lead NAAQS monitoring. Lead concentrations from the MN Air Toxics monitoring network are also shown for comparison, but these sites do not meet all QA requirements needed for demonstrating compliance with 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.

$O_3$ is monitored on a continuous basis at 17 monitoring sites (figure 18) and is reported in hourly increments. Because $O_3$ formation requires high temperatures and sunny conditions, the EPA only requires Minnesota to monitor $O_3$ from April 1 – 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 $O_3$ (2014) in Minnesota. 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. No changes are expected in 2016.

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 75 ppb. Figure 19 shows the 2012 through 2014 8-hour averages at Minnesota sites and compares them to the standard. Minnesota averages ranged from 52 ppb in Duluth (7550) to 67 ppb in Blaine (6010) and East Bethel (6012); therefore, all sites were below the 8-hour standard.

**Figure 18: 2015 Ozone monitoring sites in Minnesota**

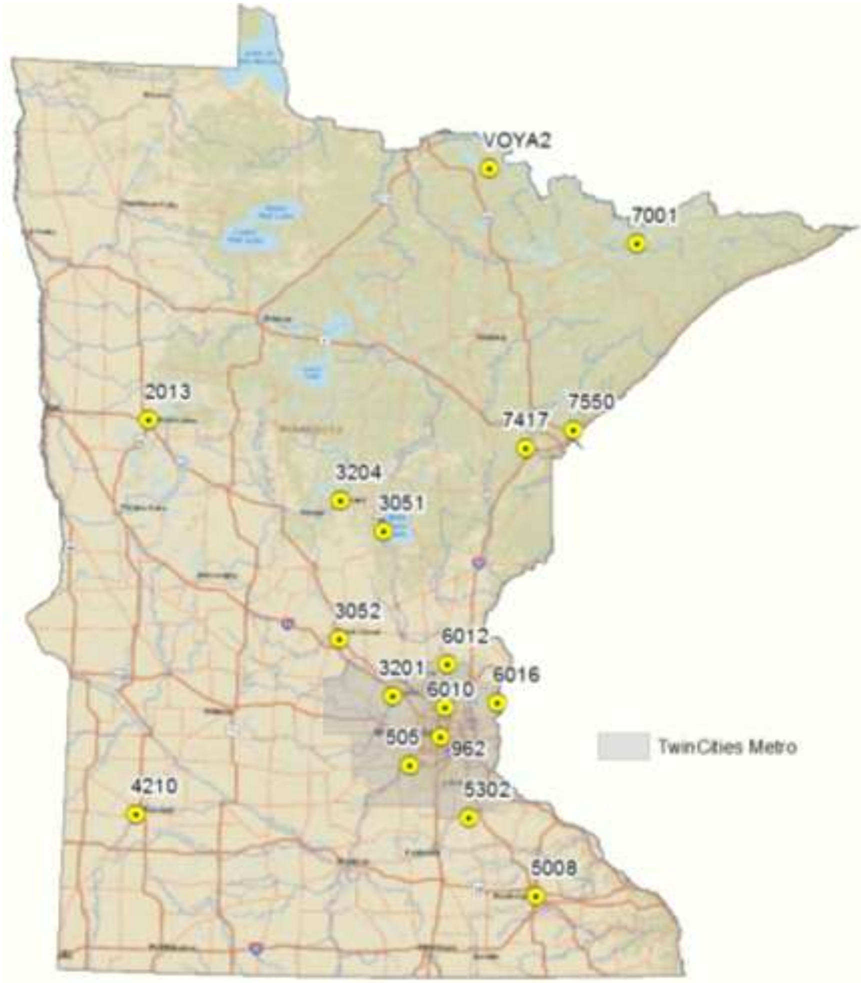
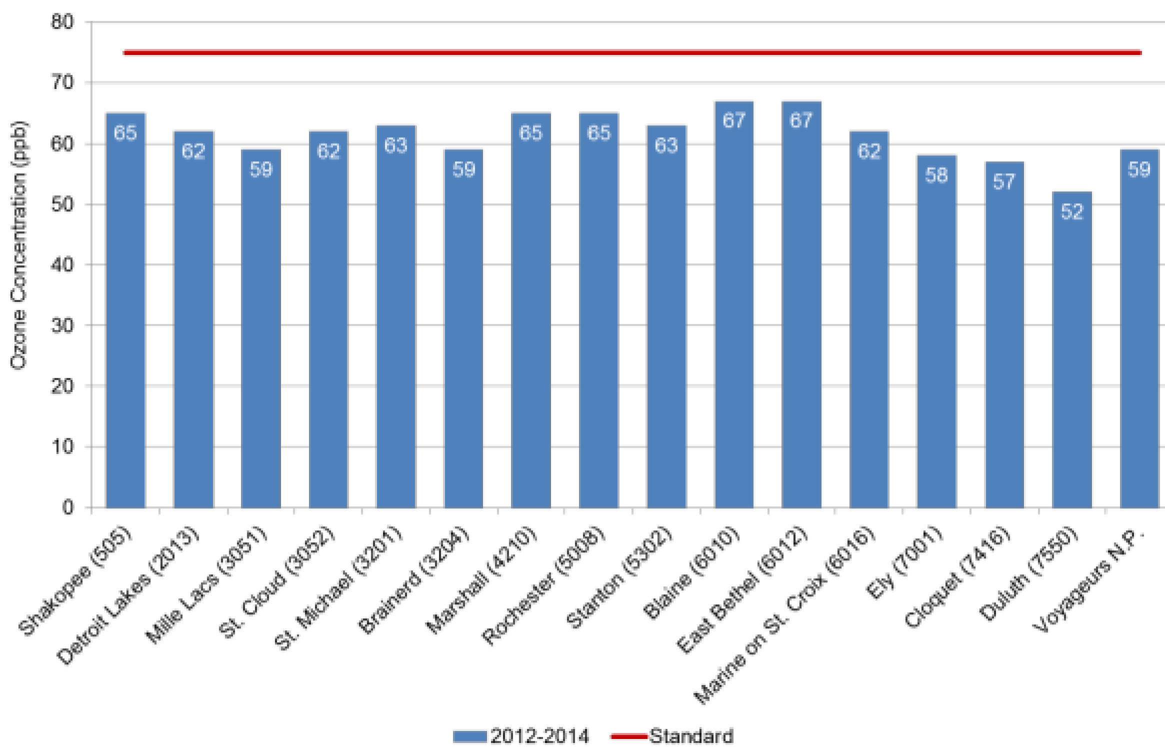



**Figure 19: 8-hour average ozone concentrations compared to the NAAQS**



## Oxides of nitrogen ($NO_X$)

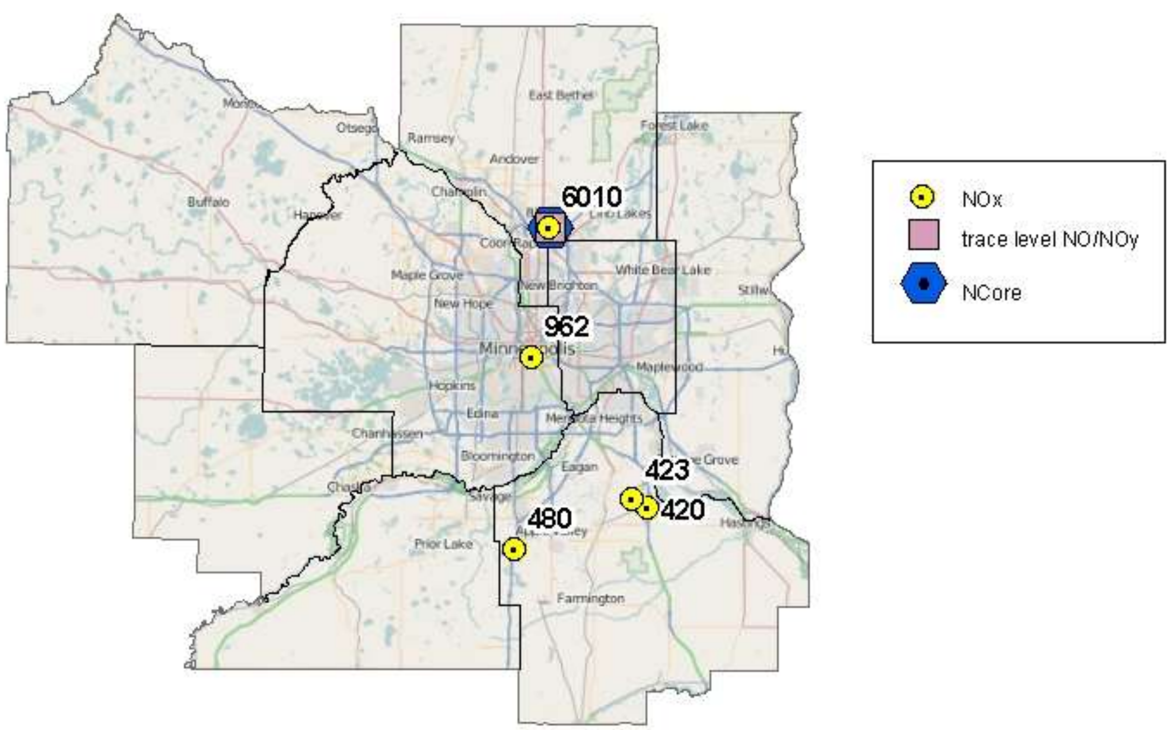
$NO_X$ is the generic term for a group of highly reactive gases, all of which contain nitrogen and oxygen in varying amounts. The two primary components are nitric oxide (NO) and nitrogen dioxide ($NO_2$). $NO_2$ is the regulated pollutant; it can often be seen as a reddish-brown layer in urban areas.

$NO_X$ 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 $NO/NO_y$ 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.

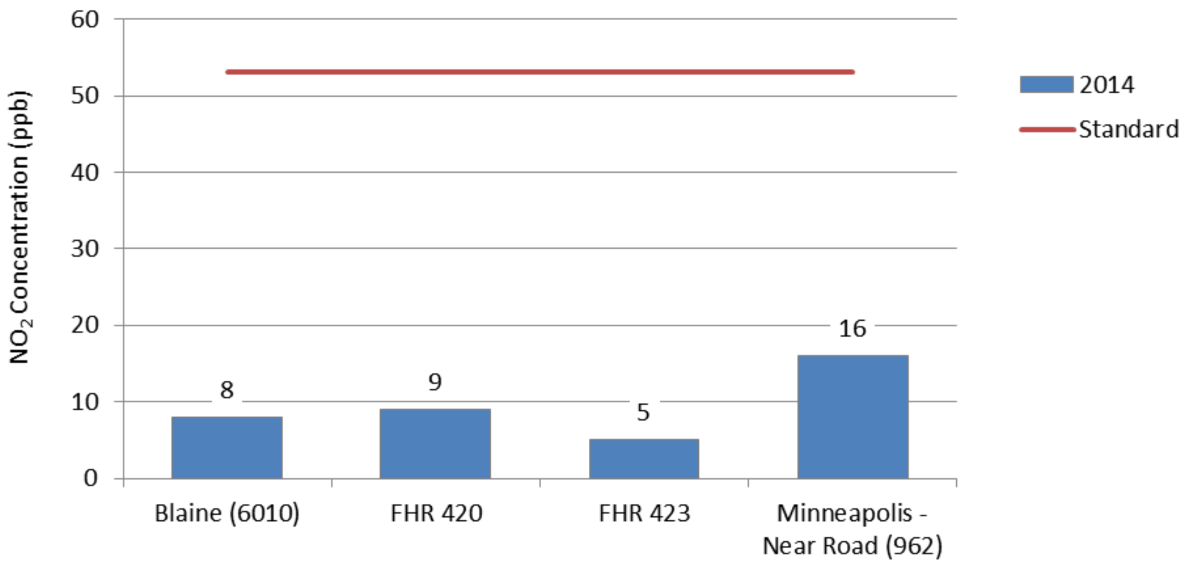
In February of 2010, the EPA finalized new minimum monitoring requirements for the $NO_2$ monitoring network in support of a 1-hour $NO_2$ NAAQS. In the new monitoring requirements, state and local air monitoring agencies are required to install near-road $NO_2$ monitoring stations at locations where 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 (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 www.pca.state.mn.us/wdkwyry.

**Figure 20: 2015 $NO_X$ monitoring sites in the Twin Cities metropolitan area**



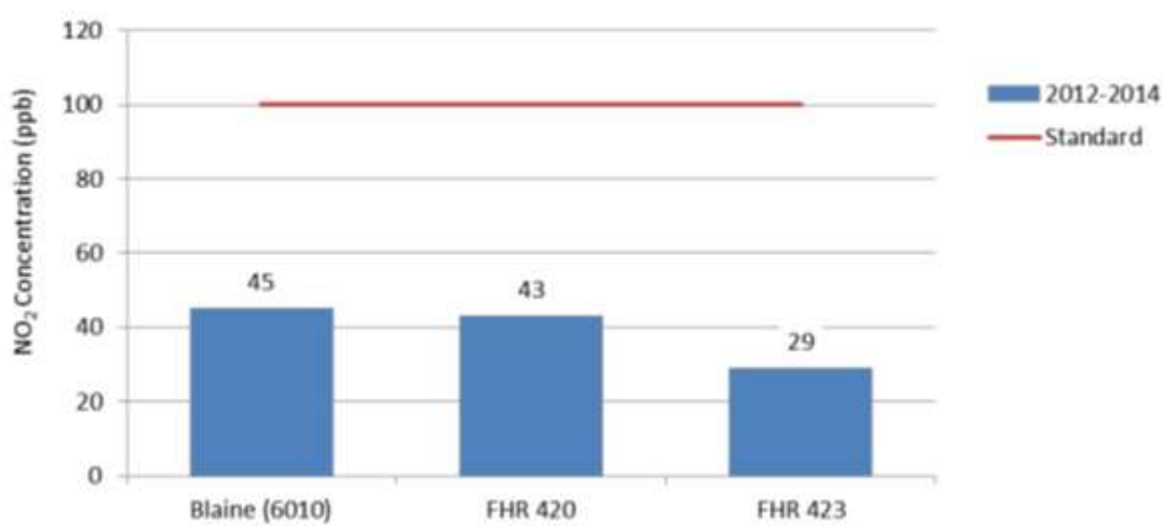
A monitoring site meets the annual NAAQS for $NO_2$ if the annual average is less than or equal to 53 ppb. Figure 21 shows the 2014 averages at Minnesota sites and compares them to the standard. Minnesota averages ranged from 5 ppb at FHR 423 to 16 ppb at the Minneapolis Near Road (962) site; therefore, 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 98$^{th}$ percentile daily maximum 1-hour $NO_2$ concentration must not exceed 100 ppb. Figure 22 shows the 2012-2014 average of the annual 98$^{th}$ percentile daily maximum 1-hour $NO_2$ concentrations at Minnesota sites and compares them to the 1-hour standard. Minnesota averages ranged from 29 ppb at FHR 423 to 45 ppb at Blaine (6010); therefore, all Minnesota sites currently meet the1-hour NAAQS for $NO_2$.

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

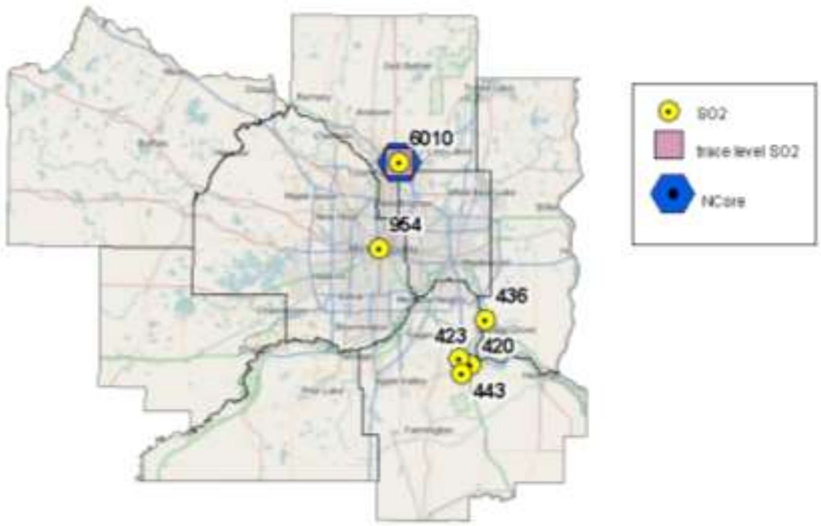


## Sulfur dioxide ($SO_2$)

$SO_2$ 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 $PM_{2.5}$.

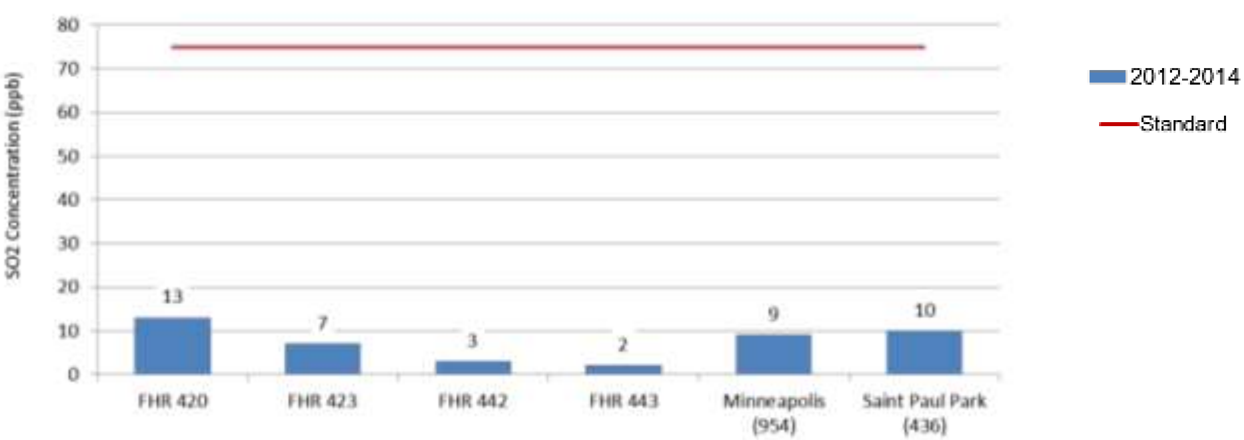
The MPCA monitors $SO_2$ at eight sites in the Twin Cities metropolitan area shown in Figure 23. In 2014, a $SO_2$ monitor was added to Rochester (5008); monitoring will continue for three years so data can be used for model verification. In 2015, one SO2 site near Flint Hills Resources (442) was closed due to the sale of the property. Trace level $SO_2$ has been at the NCore site in Blaine (6010) since 2009. This trace level data will help us understand the role of $SO_2$ 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 $SO_2$ analyzer at the NCore site in Blaine (6010) was replaced in early 2014; valid data collection has resumed as of May 1, 2014

**Figure 23: 2015 $SO_2$ 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 $99^{th}$ 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 2012 -2014 average $99^{th}$ percentile 1-hour $SO_2$ concentration and compares them to the 1-hour standard. Minnesota averages ranged from 2 ppb at FHR 443 to 13 ppb at FHR 420; therefore, all Minnesota sites currently meet the1-hour NAAQS for $SO_2$.

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



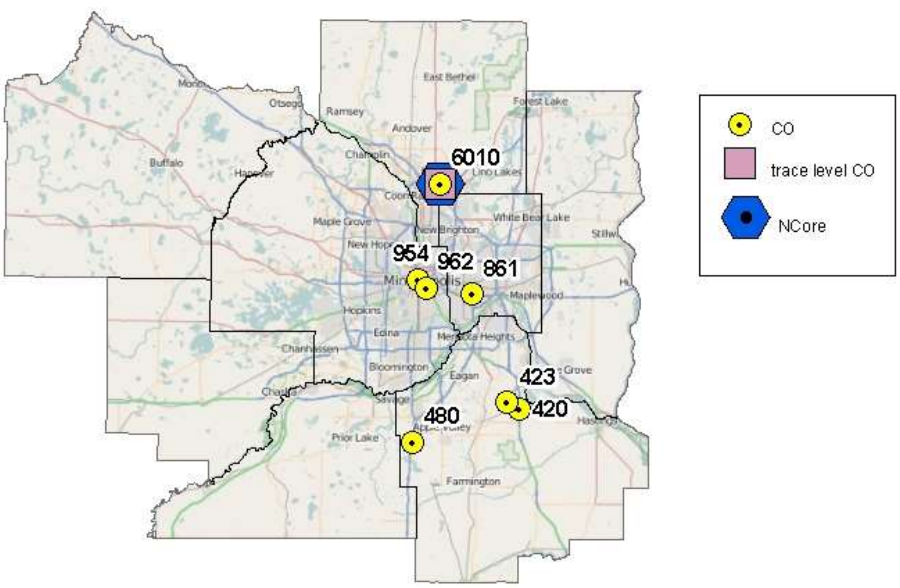
## Carbon monoxide (CO)

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 six 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.

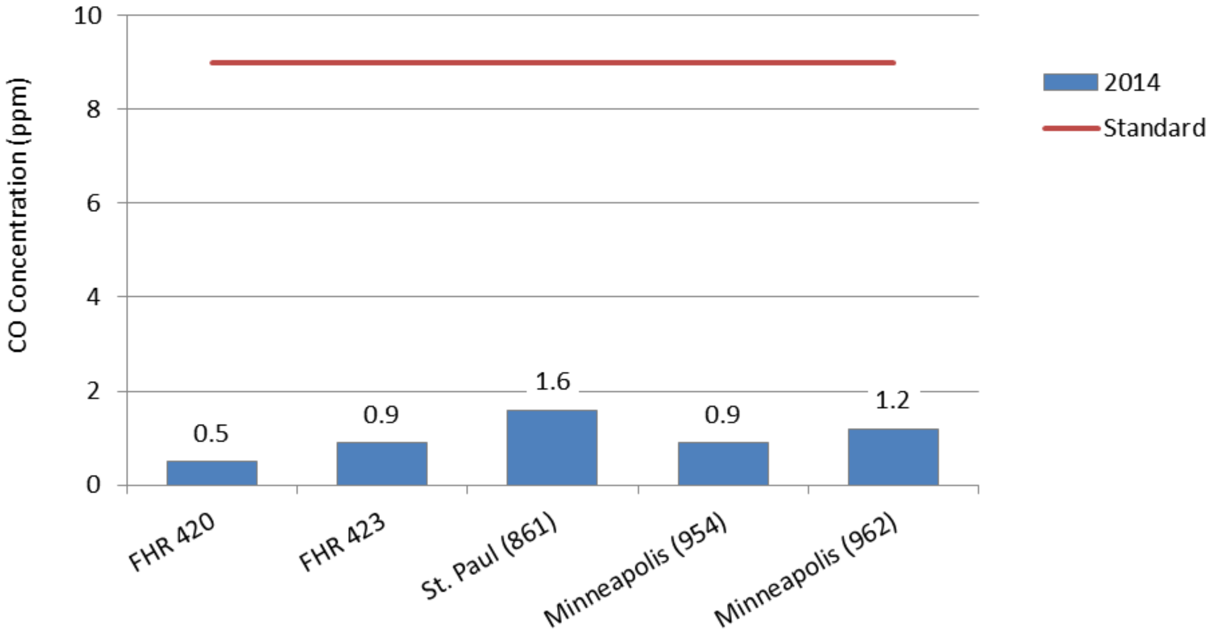
Trace level CO was added to the NCore site in Blaine (6010) in 2008. This trace level data will help us understand the role of CO at levels far below the NAAQS; however, due to performance issues with the monitoring equipment, trace level monitoring results have been unreliable. The trace-level CO analyzer at the NCore site in Blaine (6010) was replaced in early 2014; valid data collection has resumed as of May 1, 2014.

**Figure 25: 2015 CO monitoring sites in the Twin Cities metropolitan area**



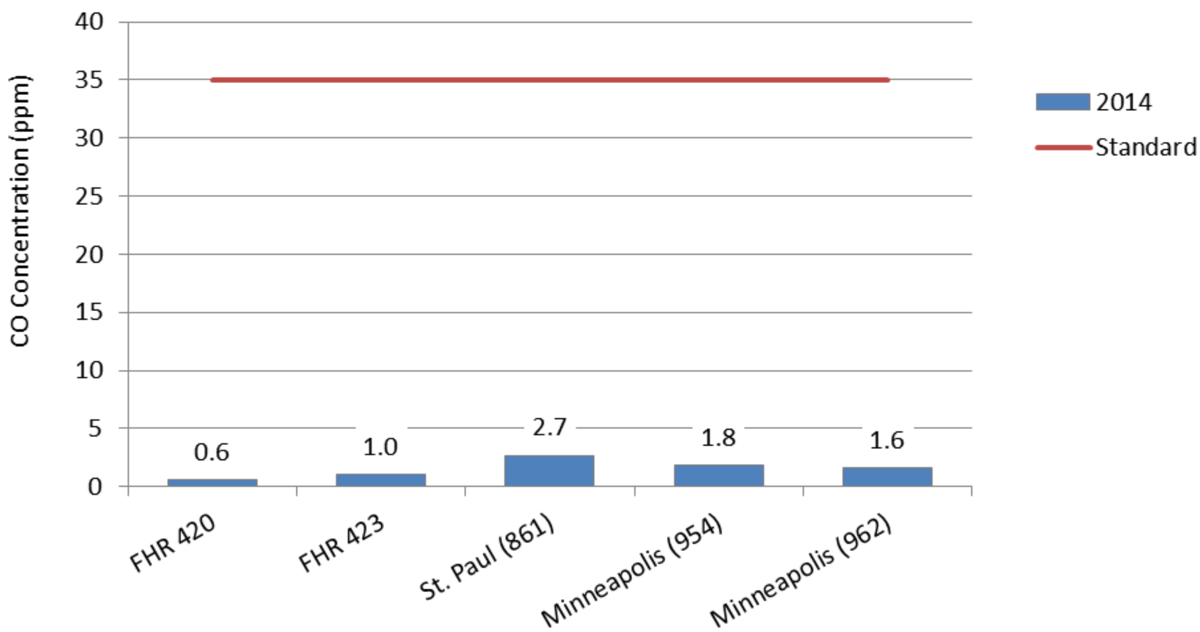

Minnesota currently meets applicable NAAQS for CO. A monitoring site meets the 8-hour CO NAAQS when the level of 9 ppm is not exceeded more than once per year. Figure 26 shows the second highest non-overlapping 8-hour average at Minnesota sites in 2014 and compares them to the standard. Minnesota values range from 0.5 ppm at FHR 420 to 1.6 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 2014 and compares them to the standard. Minnesota values range from 0.6 ppm at FHR 420 to 2.7 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: 59 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 http://www.pca.state.mn.us/air/airtoxics.html. Samples are collected once every six days over a 24-hour period; the resulting concentration is a 24-hour average. In 2015, one air toxics site near Flint Hills Resources (442) was shut down due to the sale of the property. Air toxics monitors are being added to short term (3 month) sites as part of the Community Air Monitoring Project in 2014 and 2015; more information can be found on the project website (http://www.pca.state.mn.us/9xc4ahc). Beginning in January 2016, existing air toxics sites that did not previously measure the full suite of air toxics parameters (e.g. metals, VOCS, and carbonyls) will have the missing parameters/monitors added to the site.

## Air Toxics Monitoring Web App

Annual air toxics monitoring results are now available online at http://www.pca.state.mn.us/rxcwk99. 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**

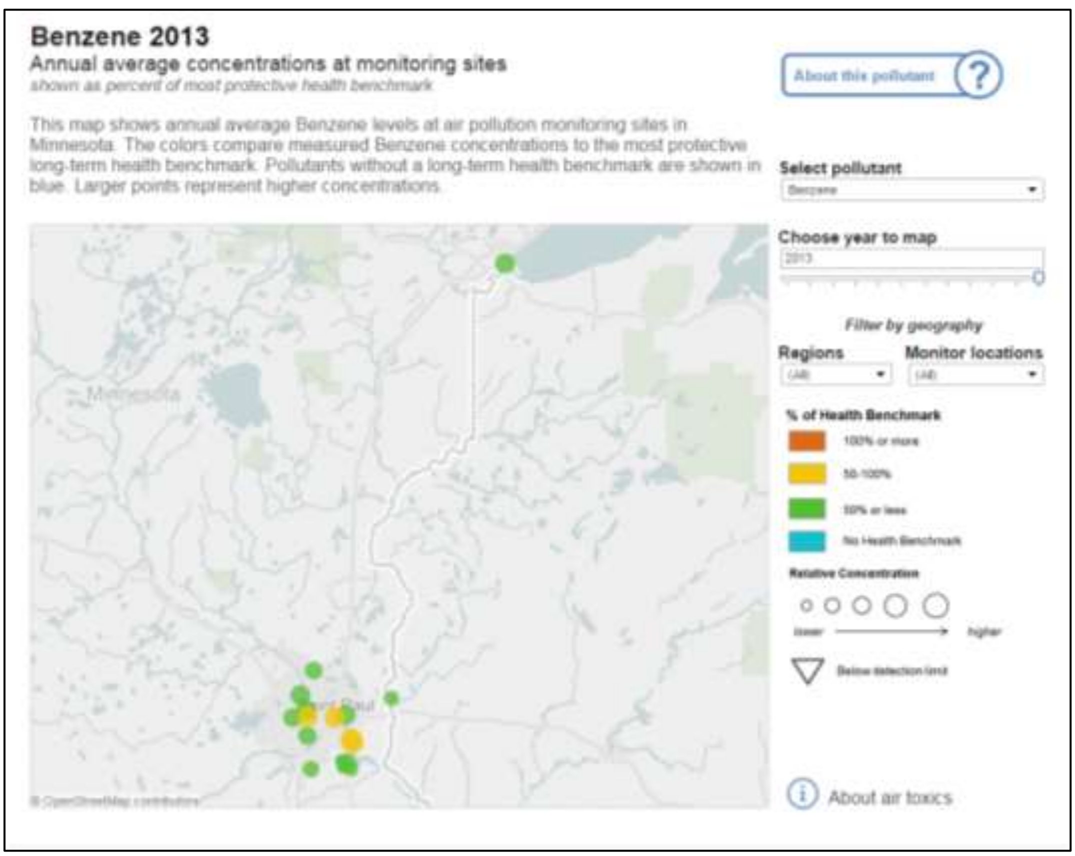
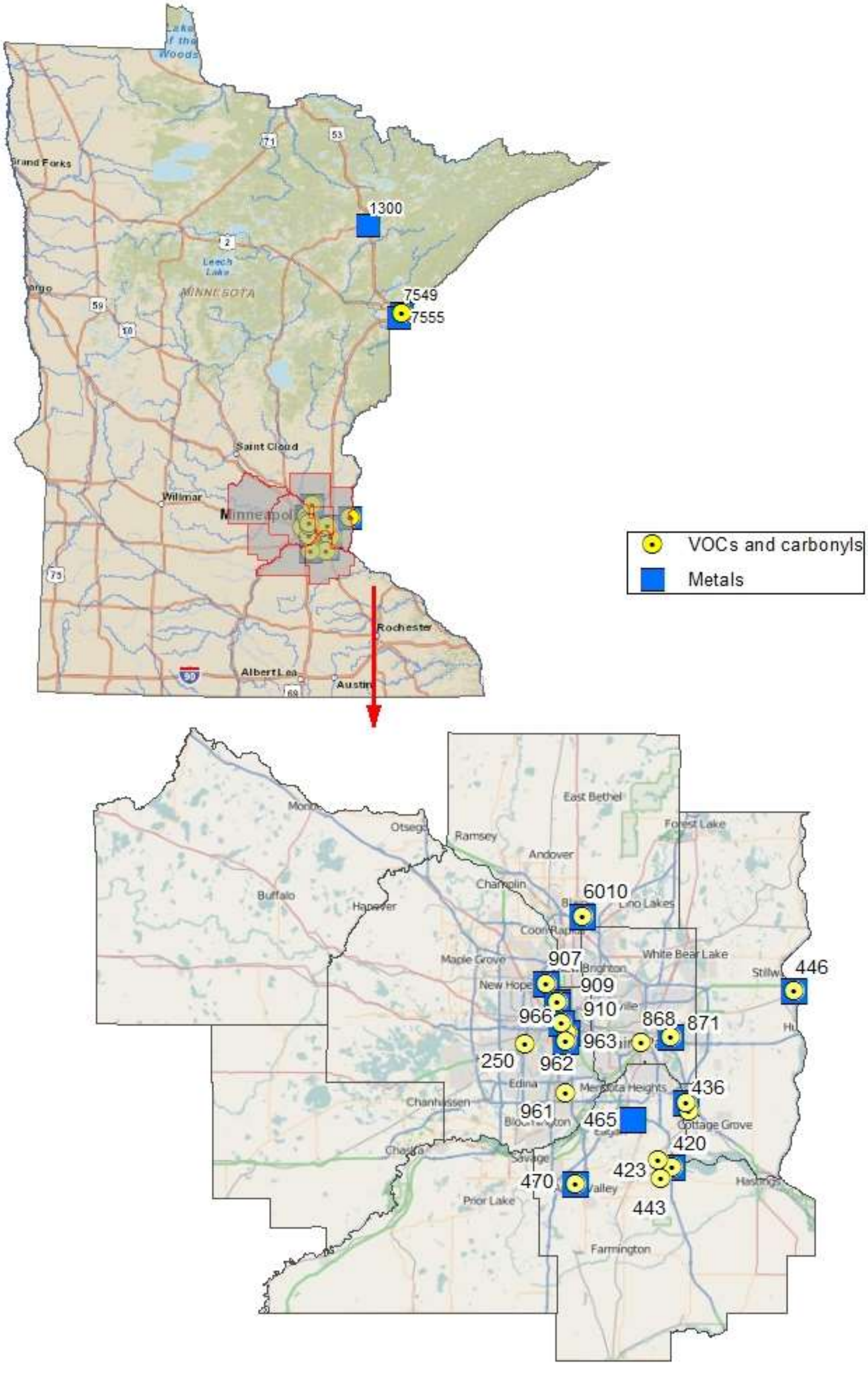


**Figure 29: 2015 Air toxics monitoring sites in Minnesota**



## 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 14 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.

Metals are being added to sites on a short term basis as part of the Community Air Monitoring Project in 2015 and 2016; more information can be found on the project website (http://www.pca.state.mn.us/9xc4ahc).

**Table 13: 2015 Metals monitored by MPCA**

| Parameter | CAS # | EPA Parameter Code |
|---|---|---|
| Antimony | 7440-36-0 | 12102 |
| Arsenic | 7440-38-2 | 12103 |
| Barium | 7440-39-3 | 12107 |
| Beryllium | 7440-41-7 | 12105 |
| Cadmium | 7440-43-9 | 12110 |
| Chromium | 16065-83-1 | 12112 |
| Cobalt | 7440-48-4 | 12113 |
| Iron | 15438-31-0 | 12126 |
| Lead | 7439-92-1 | 14129 |
| Manganese | 7439-96-5 | 12132 |
| Nickel | 7440-02-0 | 12136 |
| Selenium | 7782-49-2 | 12154 |
| Zinc | 7440-66-6 | 12167 |

## Volatile organic compounds (VOCs) and carbonyls

The MPCA analyzes samples for 57 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.

VOC and carbonyl monitors are being added to short term (3 month) sites as part of the Community Air Monitoring Project in 2014 and 2015; more information can be found on the project website (http://www.pca.state.mn.us/9xc4ahc).

**Table 14: 2015 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 15: 2015 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 ethyl ketone | 78-93-3 | 43552 |
| Methyl methacrylate | 91-20-3 | 43441 |
| Methyl tert-butyl ether | 1634-04-4 | 43372 |
| Naphthalene | 80-62-6 | 17141 |
| Propylene | 115-07-1 | 43205 |
| 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.

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.

**Figure 30: Atmospheric Deposition sites in Minnesota**


## 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 percent 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 2016.

## 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

### Community air monitoring project

With funding from the 2013 Minnesota Legislature and in keeping with the agency's environmental justice initiative, the MPCA has conducted a two-year air quality monitoring project to assess whether low-income or communities of color are disproportionately impacted by air pollution emissions from highways, air traffic, or industrial sources. In 2015, the Minnesota Legislature provided an additional 2-years of funding for the community air monitoring project.

Project objectives were to: 1) sample ambient air at seven locations, giving priority to criteria listed in legislation, 2) analyze and compare results to data from the agency's existing air monitoring network, 3) determine if there were significant differences between the community monitor locations and MPCA's existing stationary monitors, and 4) share results with legislators, neighborhood groups, and the general public.

Community locations were chosen via criteria identified in the funding legislation, along with community input and ability to meet physical monitor siting requirements. Each community location was monitored for approximately three months, after which the equipment was moved to the next community site. Monitored pollutants included fine particles ($PM_{2.5}$) and air toxics (metals, volatile organic compounds, and carbonyls).

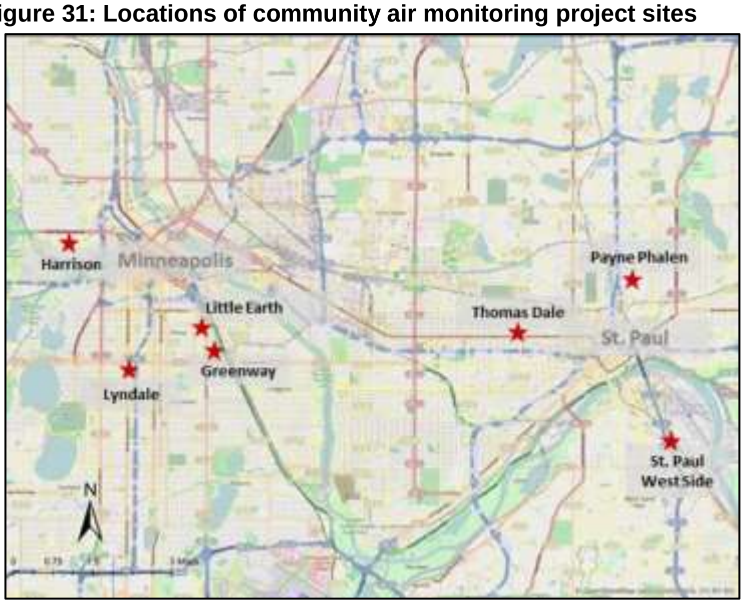
This project began October 1, 2013 with three months of monitoring at the Little Earth Residential Complex in the East Phillips neighborhood of Minneapolis. Over the time frame of the project, seven communities hosted the community air monitor (Table 16 and Figure 31).

The Community Air Monitoring Project website provides site information, summaries of completed data analyses and raw data for each community site http://www.pca.state.mn.us/9xc4ahc. As data analyses are completed for the last few 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.

**Table 16: Community air monitoring project sites and dates of operation**

| MPCA Site ID | 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 |

**Figure 31: Locations of community air monitoring project sites**



## 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.

## 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 2016.

**Figure 32: 2015 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 have been collecting TSP, $PM_{10}$, and respirable crystalline silica (measured as $PM_{10}$) data since the third quarter of 2012. Ambient air data are also being 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.

Preliminary data from this monitoring and more information about silica sand mining are available on the MPCA's website (http://www.pca.state.mn.us/6f6dhkf).

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, $PM_4$ 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.

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 Boar

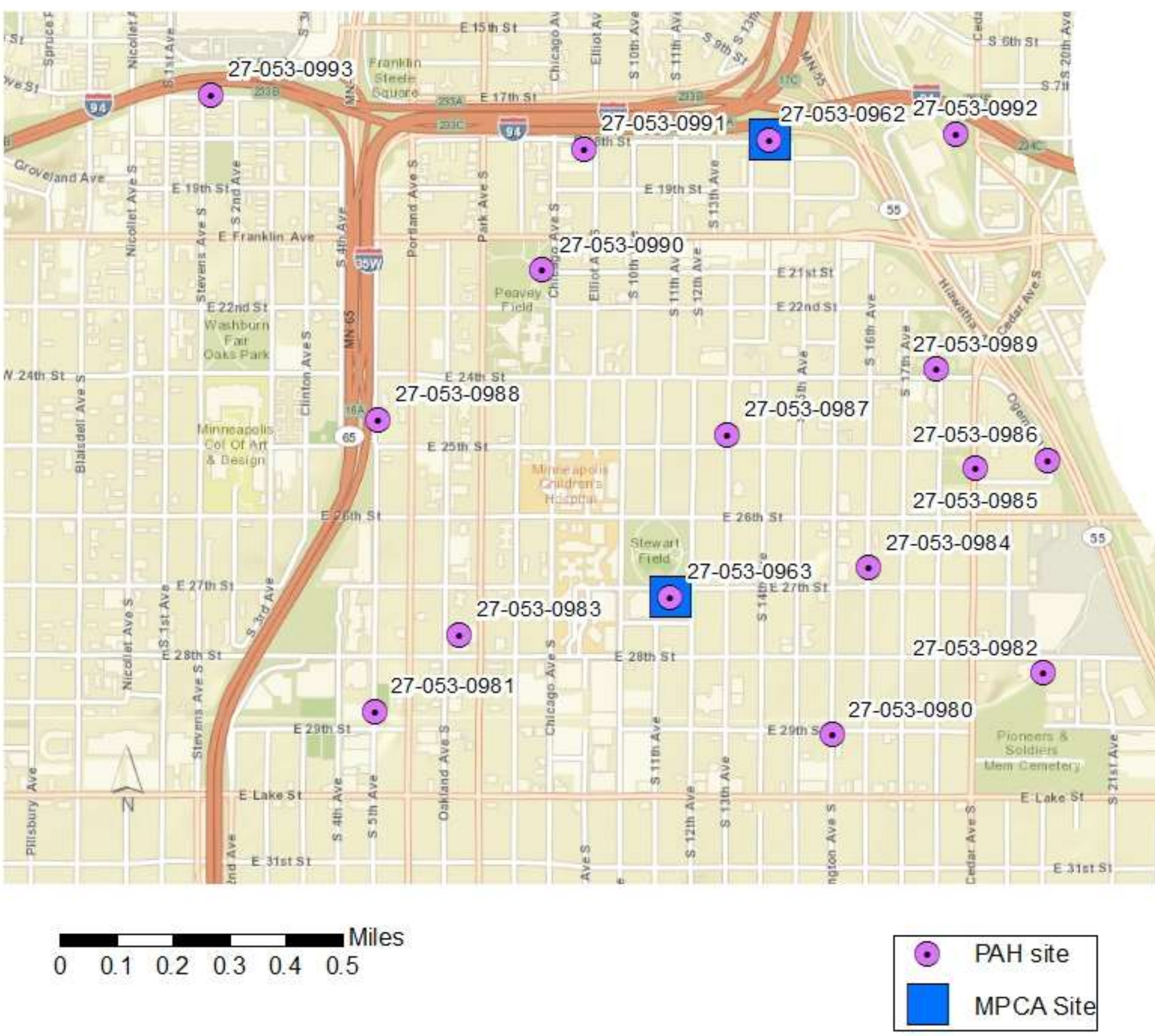
## Polycyclic aromatic hydrocarbons (PAHs)

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, etc.). 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) are monitoring PAHs using passive and active techniques during the two year study.

Approximately 30 PAH compounds are 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 will be compared to health values to estimate risks. These measured air concentrations risk results will also be compared to model results from Minnesota State Risk Screening tool (MNRiskS). For more information, visit the project website: [http://www.pca.state.mn.us/yqq4pfk](http://www.pca.state.mn.us/yqq4pfk).

**Figure 33: 2015 PAH monitoring sites in Minneapolis**



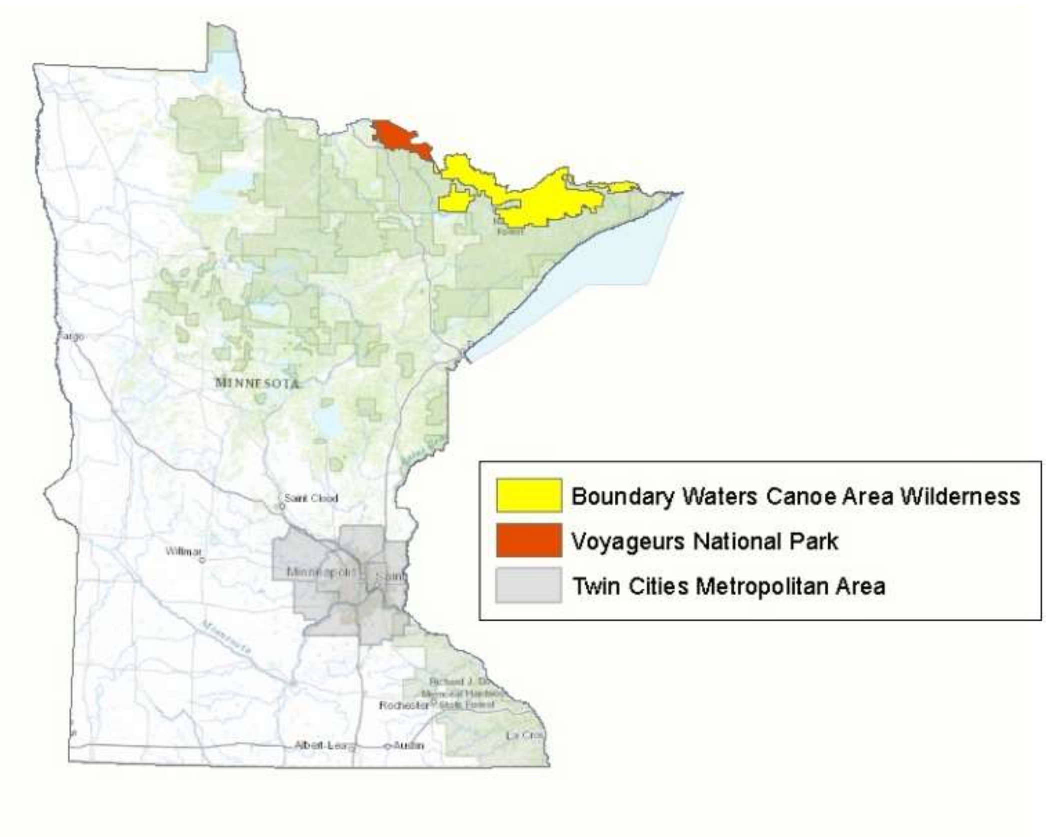
## Visibility

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 are additional sites in two southern Minnesota state parks, Blue Mounds and Great River Bluffs, to help better understand the regional transport of pollutants that impair visibility.

Both Boundary Waters and Voyageurs are expected to meet the 2018 interim progress goal toward natural visibility conditions (Figures 35 and 36). Visibility improvements at the Boundary Waters were impacted in 2011 by the Pagami Creek wildfire, which burned 145 square miles of forest that year.

**Figure 35: Boundary Waters visibility progress**

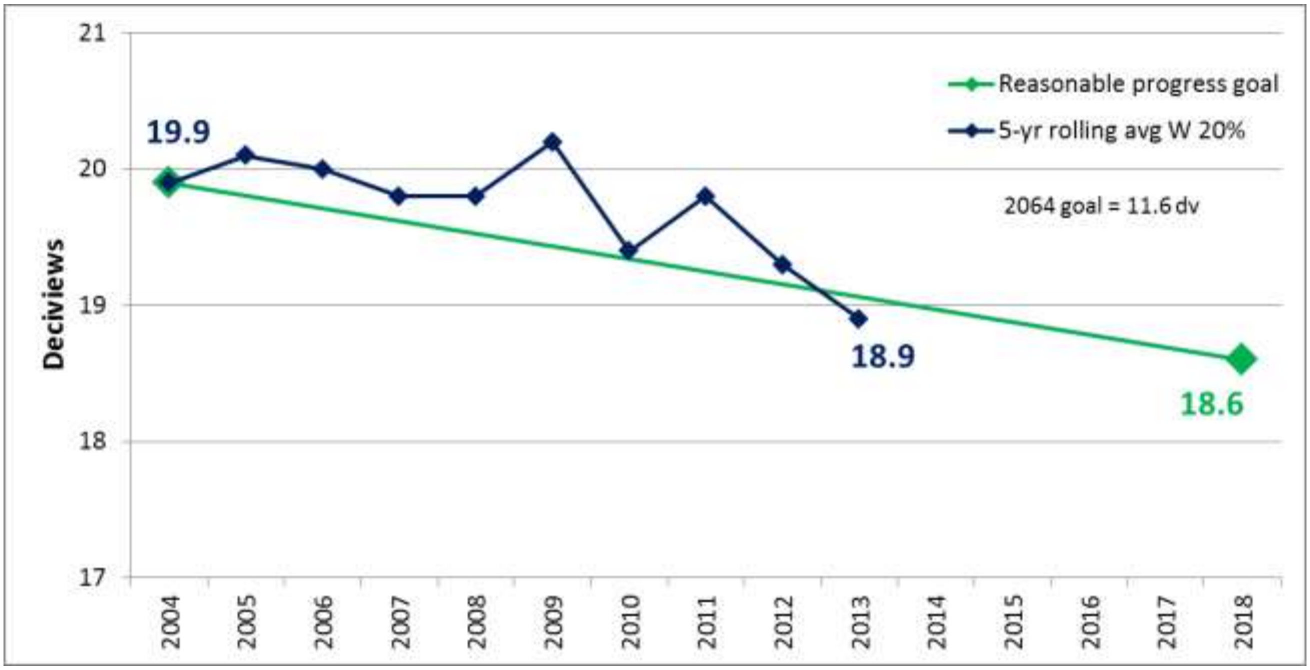
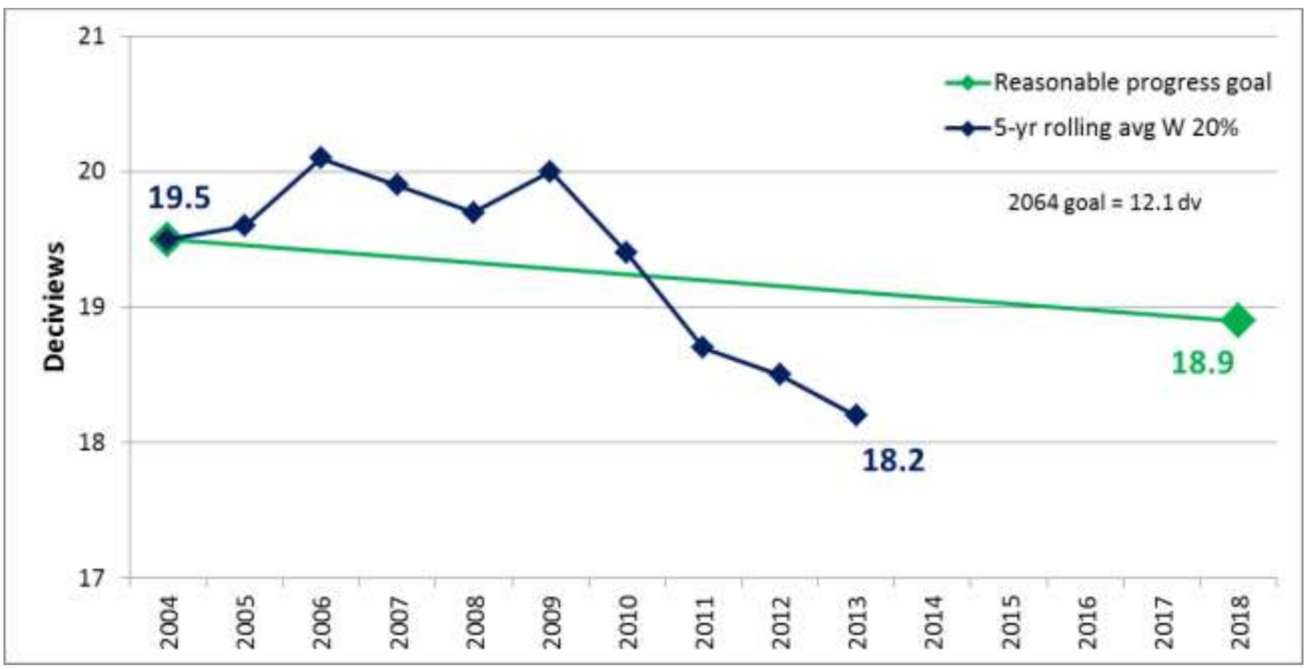



**Figure 36: Voyageurs visibility progress**



# 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 2015 and the changes that are planned for 2016.

## 2015 Network Changes

Table 17 lists the sites that were affected by changes in 2015 and details those changes. Following the table, the changes are summarized according to parameter network.

**Table 17: 2015 Changes**

| MPCA Site ID | City Name | Site Name | Site Status | $PM_{2.5}$ Continuous FEM | $PM_{2.5}$ Chemical Speciation | $PM_{10}$ Continuous | $NO_X$ | CO | $SO_2$ | $O_3$ | TSP and Metals | VOCs | Carbonyls | Meteorological Data | Poly Aromatic Hydrocarbons (PAHs) | $PM_4$ Silica |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 442 | Rosemount | FHR 442 | T | | | | | | T | | | T | T | | | |
| 480 | Lakeville | Near Road Lakeville | A | A | | | A | A | | | | | | A | | |
| 909 | Minneapolis | Lowry Ave | | T | | A | | | | | A | A | A | | | |
| 910 | Minneapolis | Pacific Street | | | | A | | | | | A | | | | | |
| Various | Minneapolis and Duluth | Community Sites | A | A | | | | | | | A | A | A | | | |
| Various | Minneapolis and Mille Lacs | PAH sites | T | | | | | | | | | | | | T | |
| 2304 | Red Lake | Red Lake Nation | A | A | | | | | | | | | | | | |
| 5008 | Rochester | Ben Franklin | | | T | | | | | | | | | | | |
| 5220 | Winona | Winona | T | T | | | | | | | | | | | | T |
| 5302 | Stanton | Stanton Air Field | | | | | | | | | | | | | | T |
| 7416 | Cloquet | Cloquet | T | | | | | | | T | | | | | | |
| 7417 | Cloquet | Fond du Lac | A | | | | | | | A | | | | | | |
| 7549 | Duluth | Michigan Street | | | | | | | | | A | | | | | |

A = added
T = terminated

### Fine particulate matter ($PM_{2.5}$)

- A semi-continuous FEM $PM_{2.5}$ monitor was added to the new near-road site (480) in January 2015.
- The $PM_{2.5}$ monitor at site 909 in Minneapolis was shut down in December 2014 upon completion of two years of monitoring. More information on this project can be found on the project website (http://www.pca.state.mn.us/rx6ffwu).
- In 2015 $PM_{2.5}$ monitors were added to short term sites as part of the Community Air Monitoring Project; more information can be found on the project website (http://www.pca.state.mn.us/9xc4ahc). $PM_{2.5}$ FEM will be added to sites 7549 in Duluth in July 2015 as part of this project.
- A $PM_{2.5}$ monitor at site 5220 in Winona closed in December 2014 upon completion of one year of monitoring. More information on this project can be found on the project website (http://www.pca.state.mn.us/6f6dhkf).

### $PM_{2.5}$ speciation

- The EPA conducted an assessment of the CSN in an effort to optimize the network and create a network that is financially sustainable going forward. As a result of this assessment, USEPA recommended defunding a number of monitoring sites, eliminating the CSN $PM_{2.5}$ mass measurement, reducing the frequency of carbon blanks, and reducing the number of icepacks in shipment during the cooler months of the year. The CSN $PM_{2.5}$ mass measurement was recommended for elimination in July 2014 and all other changes were recommended to take place in January 2015. All funded CSN sites in Minnesota were affected. In addition, the site in Rochester (5008) was recommended for defunding and closed in January 2015.

### $PM_{10}$ continuous

- $PM_{10}$ continuous was deployed to site 909 in Minneapolis in January 2015. More information on this project can be found on the project website (http://www.pca.state.mn.us/rx6ffwu).
- A new $PM_{10}$ continuous site (site 910 in Minneapolis) was established in June 2015 near site 909.

### Oxides of nitrogen ($NO_X$)

- The MPCA built a second near-road $NO_X$ monitoring site (480) in 2014 and began monitoring in January 2015. The site is located along Interstate 35 in Lakeville. The near-road network section of this report on pages 11 and 12 has a discussion of the selection process. For details on how the location of the Minneapolis near-road monitoring site was chosen, see the Near-Road Air Monitoring in Minnesota Plan.

### Carbon monoxide (CO)

- CO was added to the Lakeville near-road site (480) in January 2015.

### Sulfur Dioxide ($SO_2$)

- FHR 442 in Rosemount closed March 31, 2015.

### Ozone ($O_3$)

- The Fond du Lac Tribe moved their ozone monitoring site near Cloquet in March 2015. As a result site 7416 was shut down and moved to a new site located in a tribal administration building (7417).

### TSP and metals

- TSP was added to site 909 in Minneapolis in October 2014. Monitoring found a violation of the Minnesota standard for Total Suspended Particulate (TSP). The TSP standard was exceeded on two days in October and November 2014, which, under state rules, constitutes a violation of the standard. Three additional TSP exceedances have been measured at the site in the first three months of 2015, which has resulted in a second violation of the TSP standard at the site. The violations are under investigation. More information on this project can be found on the project website (http://www.pca.state.mn.us/rx6ffwu).
- A new TSP site (site 910 in Minneapolis) was established in June 2015 near site 909.
- In 2015 TSP monitors were added to short term (3 month) sites as part of the Community Air Monitoring Project; more information can be found on the project website (http://www.pca.state.mn.us/9xc4ahc). TSP and metals will be added to site 7554 in Duluth in July 2015 as part of this project.

- TSP and metals will be added to site 7549 in Duluth in July 2015 to complete the air toxics suite at that site (metals, VOCs, and carbonyls).

#### Air toxics – VOCs and carbonyls

- FHR 442 in Rosemount closed March 31, 2015 due to the pending sale of the property.
- VOCs and carbonyls were added to site 909 in Minneapolis in October 2015. More information on this project can be found on the project website (http://www.pca.state.mn.us/rx6ffwu).
- In 2015 air toxics monitors were added to short term (3 month) sites as part of the Community Air Monitoring Project. VOCs and carbonyls will be added to site 7554 in Duluth in July 2015 as part of this project. More information can be found on the project website (http://www.pca.state.mn.us/9xc4ahc).

#### Meteorological data

- Meteorological parameters were added to the new near-road site (480) in January 2015.

#### Poly aromatic hydrocarbons (PAHs)

- The community scale air toxics study to monitor PAHs in south Minneapolis and Mille Lacs concluded in June 2015.

#### $PM_4$ silica

- The $PM_4$ silica monitors in Winona (5220) and Stanton (5302) closed in December 2014 upon the completion of one year of monitoring. More information on this project can be found on the project website (http://www.pca.state.mn.us/6f6dhkf).

## 2016 proposed changes

The changes that are proposed for 2016 are summarized in Table 18. Following the table, the proposed changes are summarized according to parameter network.

**Table 18: 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 | FHR 423 | | A | |
| 866 | St. Paul | Red Rock Road | | A | |
| TBD | St. Paul | TBD (Westside neighborhood) | | 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

### TSP and metals

- TSP and metals will be added to three VOC and carbonyl sites that currently don't have metals.
- TSP and metals will be added to Red Rock Road (866) in St. Paul to assess metals.
- TSP and metals will be added to a new site near the location of the West Side community monitoring site (1906) to further investigate high metals levels measured during the community air monitoring project.

### $PM_{2.5}$ Speciation

- The EPA has been conducting an assessment of the National IMPROVE Protocol Network in 2015. As a result of this assessment, EPA is recommending defunding a number of monitoring sites. Should these recommendations become final, Minnesota would lose funding for Blue Mounds and Great River Bluffs. EPA is currently soliciting feedback regarding their recommendations. The MPCA has requested that EPA continue funding at the Great River Bluffs IMPROVE site. Due to the proximity of a CSN site in Sioux Falls, South Dakota, the MPCA is not requesting continued funding for the Blue Mounds IMPROVE site. The EPA is currently working to finalize the IMPROVE defunding list. Any adopted changes will take place in January 2016. If EPA does not announce its final IMPROVE defunding list prior to publication of the 2016 Monitoring Plan, final changes will be reflected in the 2017 Monitoring Plan.

# Public inspection period

This report was available for public inspection from July 10, 2015 through August 14, 2015. Three comment letters or emails were received and 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: A group of 26 residents of the St. Anthony Park neighborhood in St. Paul has asked the MPCA to establish an air monitoring site in their neighborhood. They cite population density, high truck and vehicle traffic, railroad activity, and a high density of industrial and commercial sources as reasons monitoring should be conducted in the neighborhood. They request monitoring for the following pollutants: fine particulate matter, $PM_4$ silica, ultrafine particulate matter, TSP, Ozone, $NO_X$, $SO_2$, CO, Lead, Metals, VOCs and carbonyls.

RESPONSE: Short-term monitoring for fine particles and air toxics as part of the Community Air Monitoring Program is under consideration. The residents will be contacted to discuss their request.

COMMENT: An Air Resource Specialist with the US Forest Service wrote to support maintaining federal funding for the Great River Bluffs IMPROVE site. He cited that air quality in the Boundary Waters Canoe Area Wilderness is highly impacted from southerly and southeasterly transport of $PM_{2.5}$.

RESPONSE: This request was forwarded to EPA to include in their review of the IMPROVE network.

COMMENT: Northern Metals, LLC alleges that MPCA has failed to adhere to applicable rules with regard to the preparation of the 2016 monitoring network plan and deployment of monitors near their facility. Northern Metals, LLC identified six “deficiencies” in its comment letter.

RESPONSE: A response to each “deficiency” identified by Northern Metals, LLC will be forwarded to EPA Region 5 for their consideration during the monitoring plan approval process.