Winona - Community Ambient Air Monitoring

Winona, Minnesota
January 2014 – December 2014

Minnesota Pollution Control Agency

May 2015

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Executive Summary

In response to community requests, the Minnesota Pollution Control Agency (MPCA) placed air monitors at the Family YMCA in downtown Winona. The monitors measure community-level air quality impacts of certain pollutants. These pollutants are associated with diesel truck traffic and activities related to silica sand mining. A MetOne Instruments Model BAM-1020 air monitor collects hourly measurements of fine particles ($PM_{2.5}$) and a modified BGI PQ100 air monitor collects 24-hour measurements of respirable crystalline silica (PM_4 Silica). Monitoring began on January 1, 2014, and concluded on December 31, 2014.

This report contains air monitoring results collected between January 1, 2014 and December 31, 2014, which includes all of the reported results from the entire ambient air sampling effort in Winona.

These data were below the respirable silica health based value and did not suggest any exceedances of ambient air quality standards.

Location of air monitors on the roof of the Winona Family YMCA buildings

Winona, Minn.
Winona Bridge (Hwy 43) to the northeast

Results

Air monitors in Winona, Minnesota

From left to right: hourly $PM_{2.5}$, wind speed and direction, respirable crystalline silica

Respirable crystalline silica

There has been increased concern about potential exposures to air pollutants from silica sand-related facilities and related transportation in Wisconsin and Minnesota. Particulates and diesel-related pollutants are two types of pollutants that are appropriate for air studies near silica sand facilities. Particle pollutants vary by size. The smallest particles are of most concern because they are able to reach farther into the human lung. Very small silica particles at elevated concentrations and long-term exposures are associated with elevated risks of silicosis. Silica measurements tend to be of particle sizes from four microns and below, or PM_4. This is because silica has historically been an important occupational exposure concern, and PM_4 is the size fraction typically measured in the occupational health field. Since most of the available health data on PM_4 are from the occupational health field, PM_4 is the size fraction referenced in the health-based value developed by the Minnesota Department of Health (http://www.health.state.mn.us/divs/eh/risk/guidance/air/table.html). It is also the reason that silica as PM_4 is the desired measurement for monitoring studies around silica sand facilities.

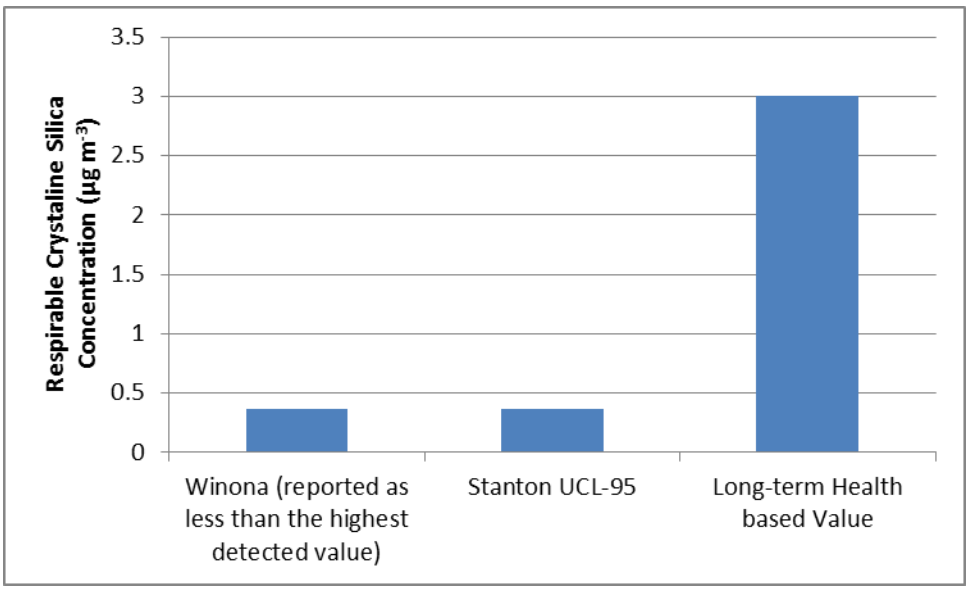
The health-based value is a comparison for long term or chronic exposure durations, and so it is not appropriate to compare single 24-hr values to the long-term health based value of 3µg/m^3. For comparison to the health based value, a high estimate of the mean (UCL-95) is calculated. The health based value is placed on the charts below for informational purposes only.

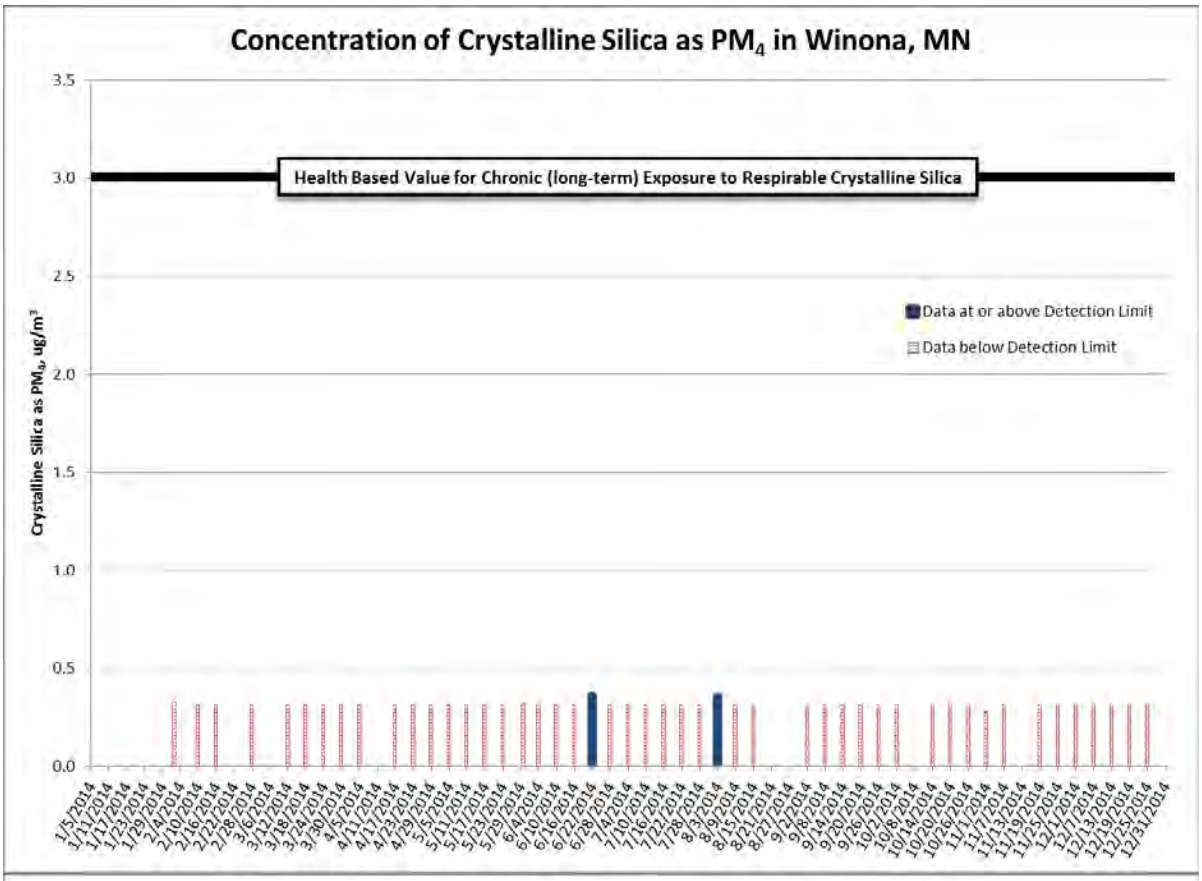
There is no U.S. Environmental Protection Agency (EPA)-approved measurement method to collect hourly silica PM_4 data. Air measurements are taken over a 24-hour period. These measurements are repeated on a frequency of one every 6 days or one every 12 days. This allows a non-biased data set, where measurements do not always occur on weekdays or one specific day of the week.

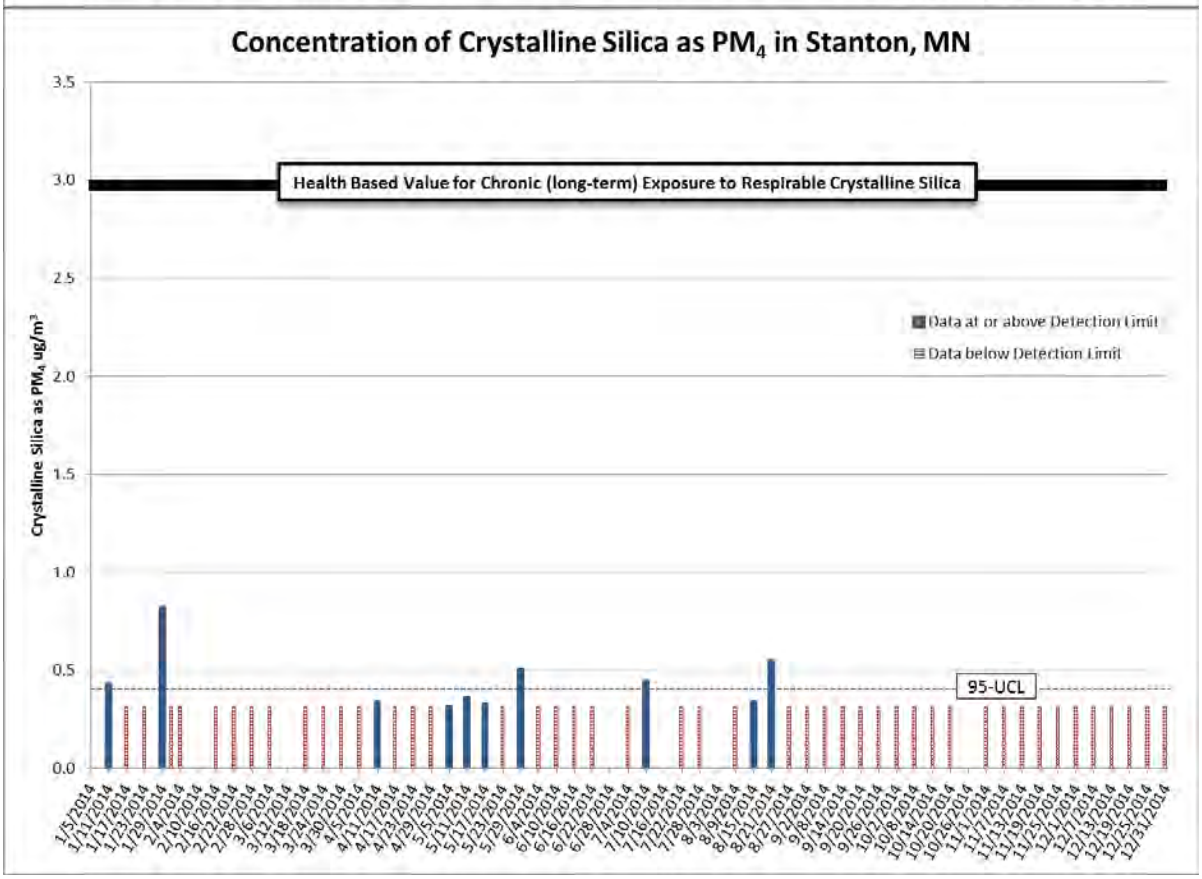
Respirable crystalline silica (PM_4 silica) samples are collected in Winona once every 6 days, and final results are presented below. There was one silica monitor placed on the top of the Family YMCA in Winona, and another silica monitor placed in Stanton, MN to serve as a reference. Stanton, MN does not house silica sand related facilities or transportation, but does have other sources of airborne silica such as unpaved roads and farm fields. Airborne silica is a fairly ubiquitous pollutant and is not unique to silica sand mining and processing facilities.

During the study period, the Winona monitor had two detected silica measurements: one occurred on June 22, 2014, and the second occurred on August 3, 2014. During the study period, the Stanton monitor has had ten detected samples of silica. Based on these results, the data do not suggest an elevated airborne level of respirable crystalline silica in the City of Winona in comparison to the reference location.

In Stanton, MN there were 10 detected samples, and the UCL-95 for this site is 0.4µg/m^3. As stated above, a high estimate of an annual mean is compared to chronic health based values. The high estimate of a mean that is recommended by the EPA is a 95% upper confidence limit of the arithmetic mean (UCL-95). This UCL-95 is calculated in a way that incorporates the values that are not detected, without biasing the data by detection limit replacement. There were not enough detected values in Winona to conduct this calculation. Therefore, the average silica concentration in Winona is estimated to be less than the detection limit of 0.3 µg/m^3.




Concentration of Crystalline Silica as PM4 in Winona, MN
Health Based Value for Chronic (long-term) Exposure to Respirable Crystalline Silica
Data at or above Detection Limit
Data below Detection Limit
Crystalline Silica as PM4, ug/m3
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0


Concentration of Crystalline Silica as PM4 in Stanton, MN
Health Based Value for Chronic (long-term) Exposure to Respirable Crystalline Silica
Data at or above Detection Limit
Data below Detection Limit
95-UCL
Crystalline Silica as PM4, ug/m3
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

Fine particles ($PM_{2.5}$)

Fine particle pollution is a complex mixture of extremely small particles and liquid droplets. While there are many sources of fine particle pollution, one of the most common sources is fuel combustion. The EPA has established standards for daily and annual fine particle concentrations to protect the public from adverse health effects associated with exposure to fine particle pollution. Exposure to high levels of fine particles can impact heart and lung health, resulting in increased hospital and emergency room visits, lost work and school days, and premature death.

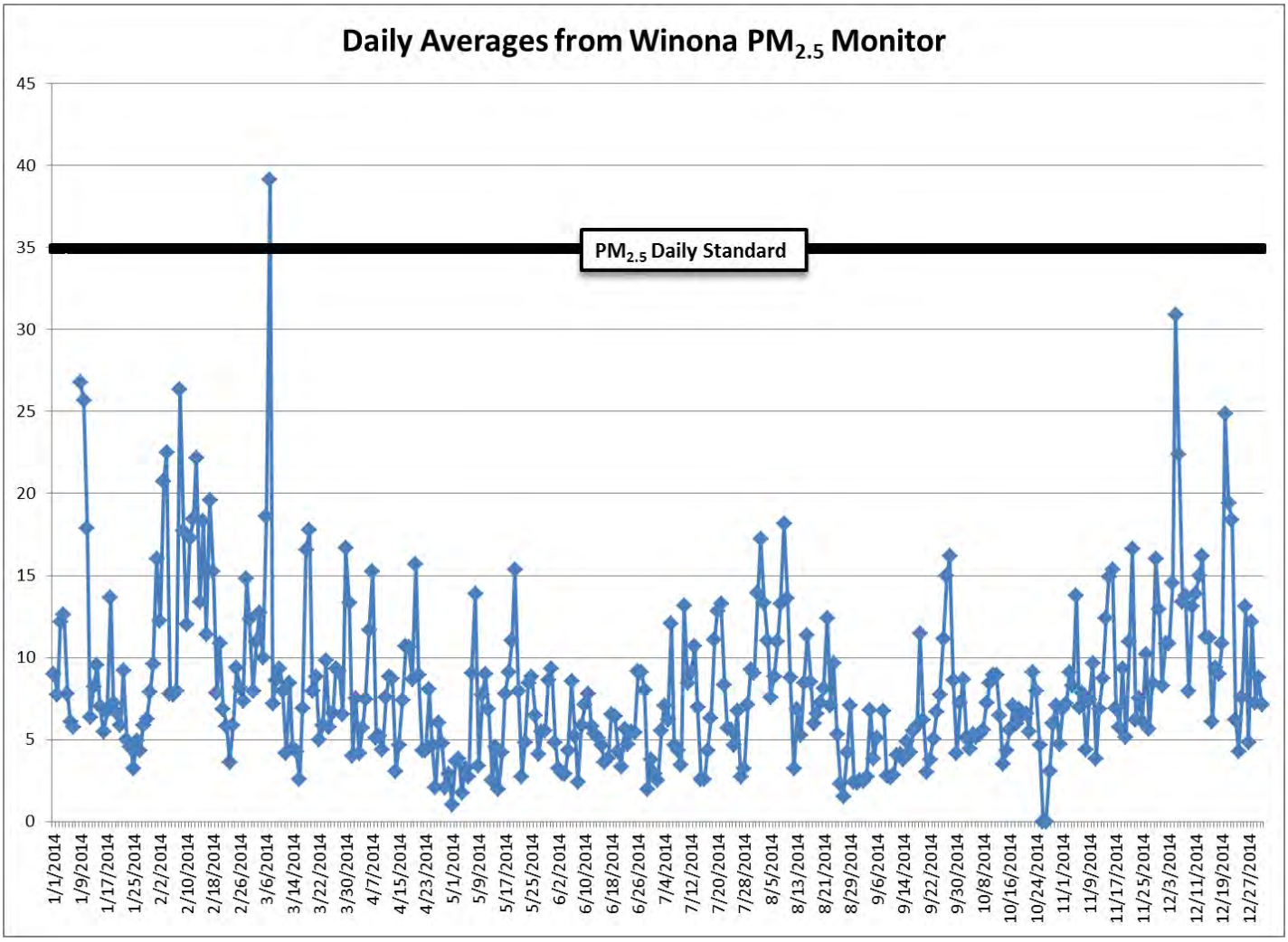
In Winona, fine particle samples were collected with a semi-continuous air monitor that reports hourly results.

Winona daily fine particle results

The EPA has established a daily (24-hour) fine particle standard to protect against health effects associated with short-term exposures to elevated levels of fine particle pollution. A monitoring site meets the daily standard if the three-year average of the annual 98^{th} percentile daily average $PM_{2.5}$ concentration does not exceed 35 $\mu g/m^3$ (micrograms per cubic meter). The daily standard allows fine particle levels to exceed 35 $\mu g/m^3$ several days each year without violating the standard.

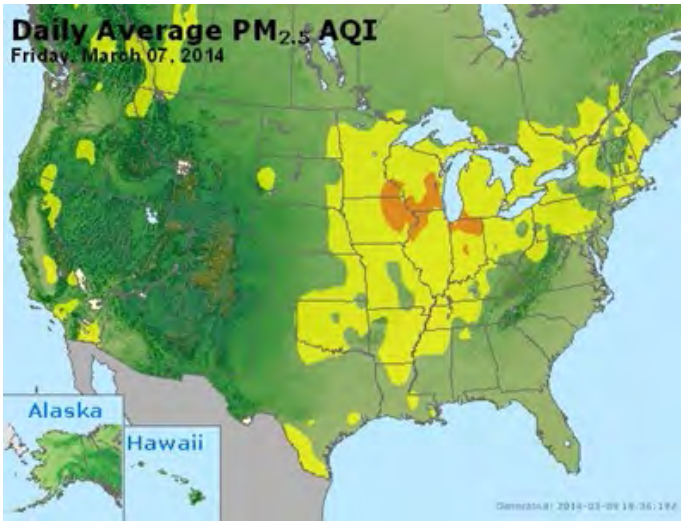
Between January 1, 2014, and December 31, 2014, the monitor at Winona recorded one exceedance of the daily fine particle standard. (See graphic next page.) This occurred on March 7, 2014, and was the result of a regional weather pattern that included a strong temperature inversion, light winds, and heavy fog. These weather conditions trap fine particle pollution near the surface, allowing concentrations to increase to unhealthy levels. A monitoring site may experience several exceedances each year without violating the air quality standard.

Winona daily fine particle results compared to the standard, January – December 2014



Summary of March 7, 2014, fine particle exceedance

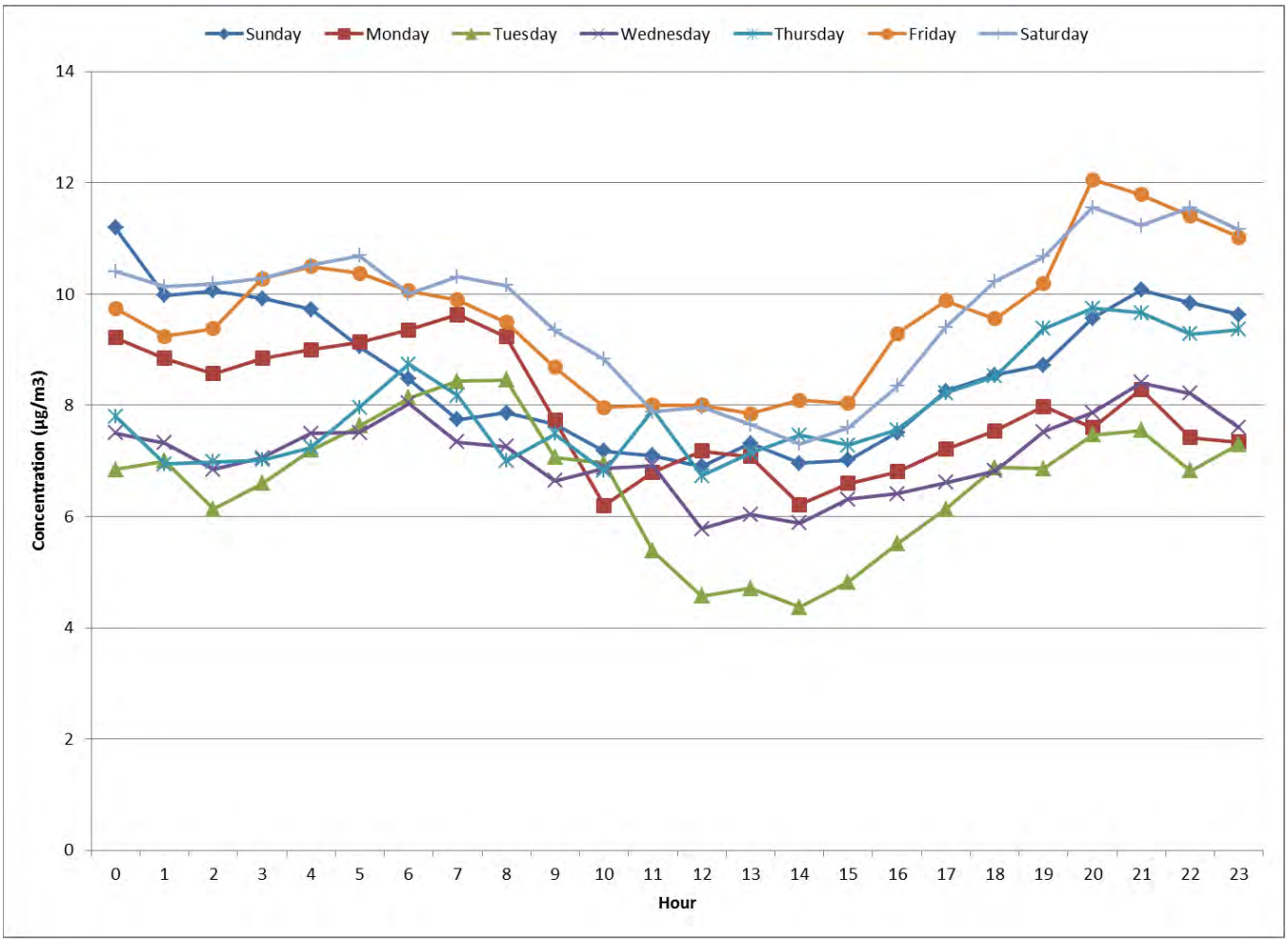
The map on the right depicts fine particle concentrations for March 7, 2014, on an AQI scale. The yellow and orange portions of the map are areas where fine particles were elevated. The daily fine particle concentration measured in Winona exceeded the daily fine particle standard, resulting in an air quality alert on March 7, 2014. This was the result of a weather pattern that impacted much of the central and eastern United States. On this day, the highest fine particle concentrations in the U.S. were centered over parts of Minnesota, Iowa, Wisconsin, Illinois, and Indiana. Due to the regional nature of this event, the MPCA does not believe fine particle pollution associated with silica sand operations caused the exceedance in Winona. This is further illustrated in the charts at the very end of this report.



Winona hourly fine particle results

Health-based standards for fine particles have been established for long term (annual) and short-term (daily) exposures. To date, health-based standards have not been established for very short-term exposures such as one-hour concentrations. Nonetheless, hourly data are useful to identify patterns in air pollution levels throughout the day. The chart below describes the average fine particle concentration measured for each hour of the day by the day of the week. Hourly fine particle concentrations measured in Winona follow the expected hourly pattern for fine particle pollution. Typically, the highest average fine particle levels are measured in the morning hours when wind speeds are relatively calm and emissions from cars, industry, and homes add fresh emissions into the air. As sunlight increases throughout the day, wind speeds and vertical mixing increase. This allows air pollution levels to fall. As the sun sets, this natural mixing of the air slows down, allowing pollutants to build up again. As shown in the chart below, the day of week also impacts the daily pattern of hourly fine particle levels. While all days of the week follow a similar pattern, it appears that fine particle levels on Sundays are less impacted by morning emissions.

Winona average hourly fine particle results by day of the week, January – December 2014



Winona fine particle results compared to wind direction

Comparing air pollution monitoring results to weather data, such as wind speed and direction, can help identify sources of air pollution. A "pollution rose" is a visual tool that describes air pollution levels measured at a monitor based on the direction the wind was blowing from when the measurement was made.

A pollution rose shows three types of information:

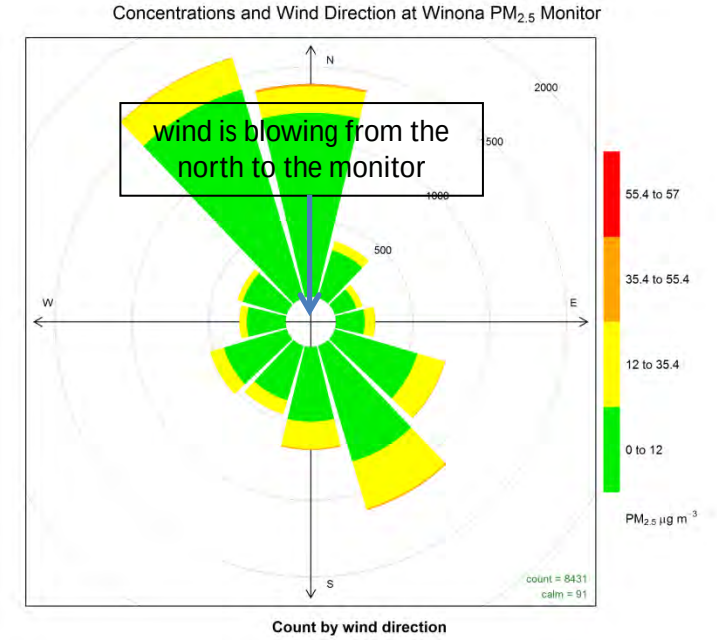
1. Wind direction – The monitor is located in the center of the rose and the location of the wedges show the direction the wind is blowing from.
2. Pollutant concentration – The pollutant concentration is represented by the color of the wedge (red = highest concentration measured, green = lowest).
3. Frequency: The length of the wedge shows the number of times the pollutant came from that wind direction by concentration category (red, yellow, green). The longer the wedge, the more times that pollutant concentration range was measured coming from that wind direction.

The graphic was created using the same color scale as the MPCA's Air Quality Index.

1. Green or Good: 0 to 12.0 µg/m3
2. Yellow or Moderate: 12.1 to 35.4 µg/m3
3. Orange or Unhealthy for Sensitive Groups: 35.5 to 55.4 µg/m3

The pollution rose included below describes the daily average fine particle concentrations measured in Winona as a function of the average wind direction that day. As is common in the winter months, on the majority of days, the wind in Winona was blowing from the north, northwest, or the south.

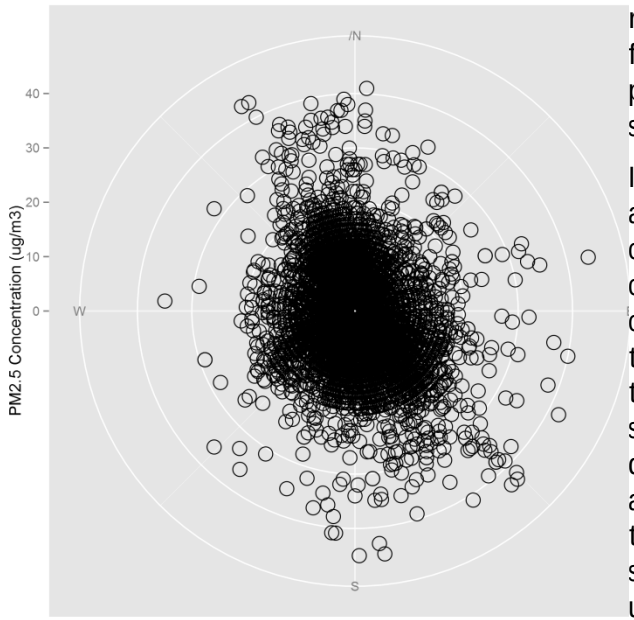
Daily fine particle pollution rose for Winona January 1, 2014 – December 31, 2014



This pollution rose describes daily average fine particle concentrations measured at the monitor in Winona as a function of the direction the wind was blowing when the measurement was made.

In a pollution rose, the center of the chart represents the location of the monitor and the placement of the wedges represents the direction the wind is blowing from. The length of the wedge describes how often the wind blew from that direction -- and the color describes the level of the pollutant measured.

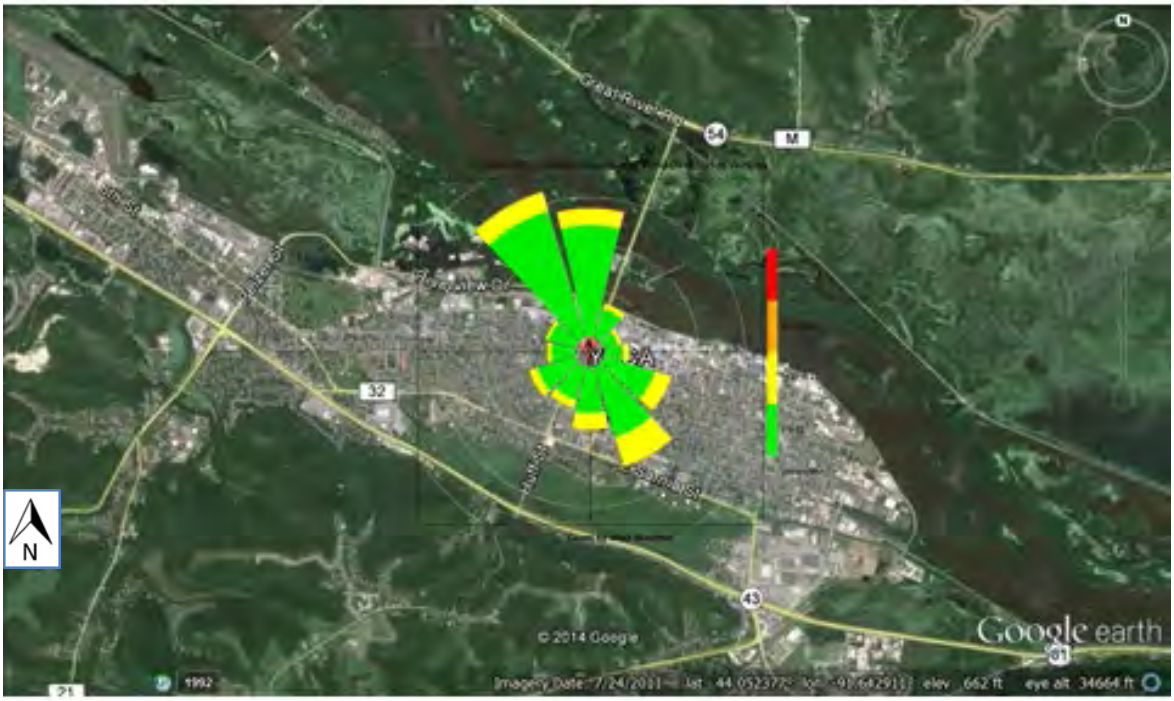
For example, the orange wedge shown on the rose shows the average fine particle concentration for that 24-hour period was between 35 and 55 µg/m^3. On this day, the wind was blowing from the northeast.



The data on the polar plot to the left represent the un-summarized data from above. These same data are presented above, but in a count summary.

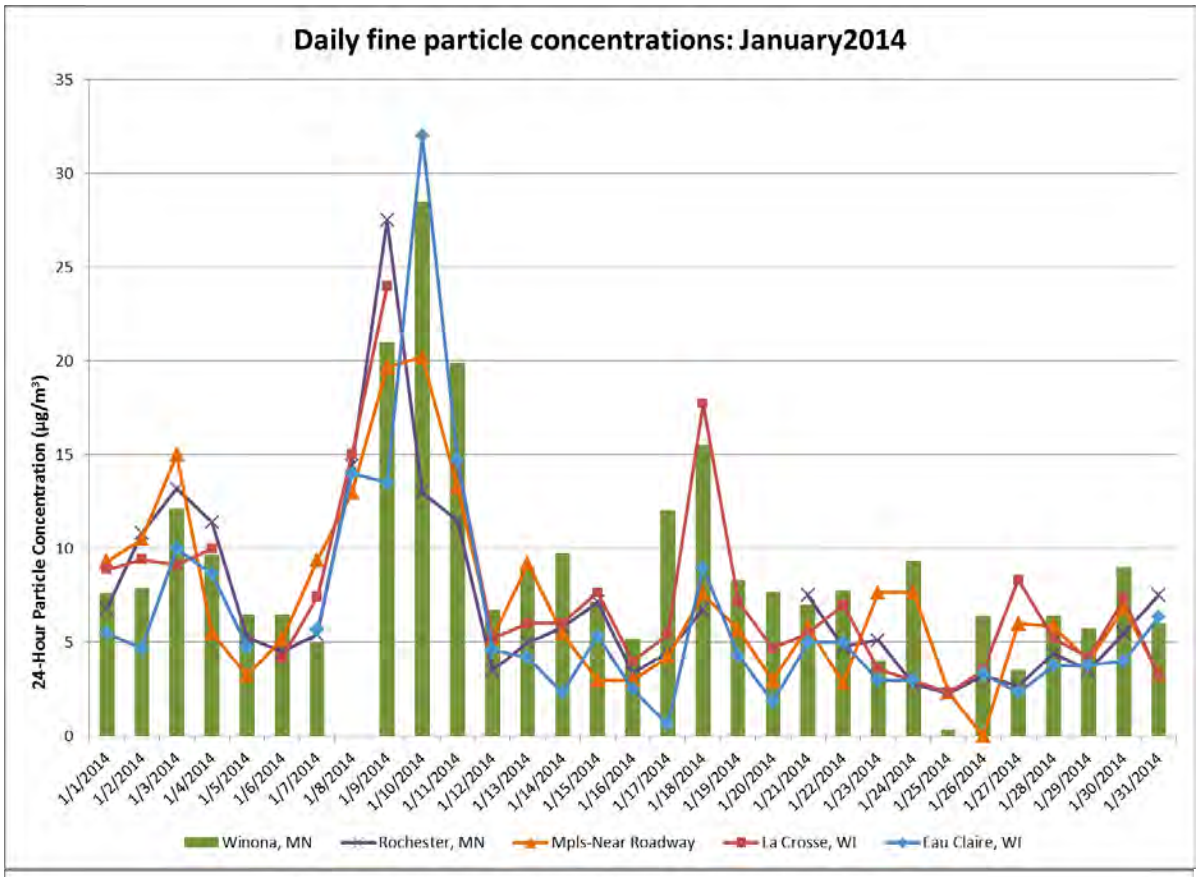
In this type of plot, the concentrations are higher towards the outside of the circles, and lower at the center of the circle. If there is a cluster of high concentrations in one area of the circle, this would be one piece of information to suggest a localized air pollution source blowing from that wind direction. If the data circles are spread around the circle somewhat randomly, this is one piece of information to suggest that the pollutant is more ubiquitous in nature.

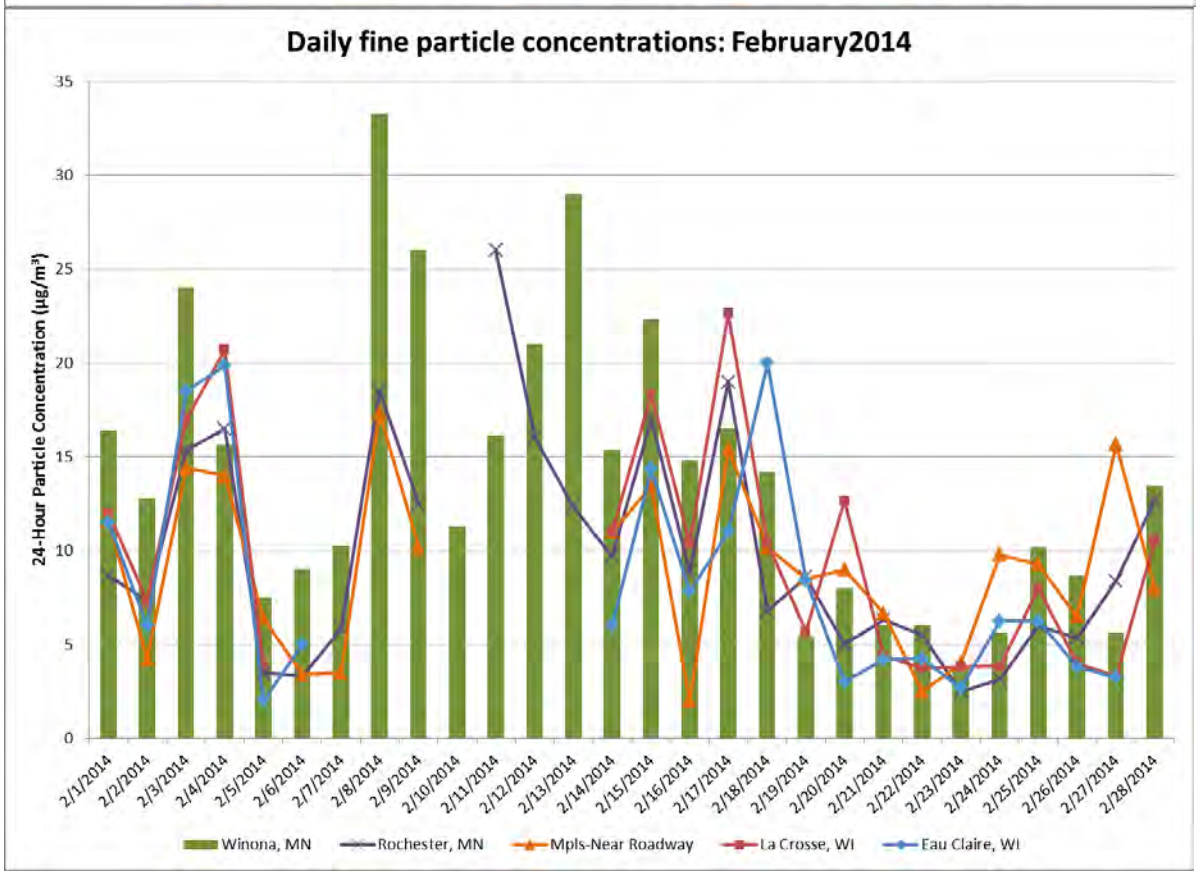
Daily fine particle pollution rose for Winona overlaid on Google Earth image of Winona

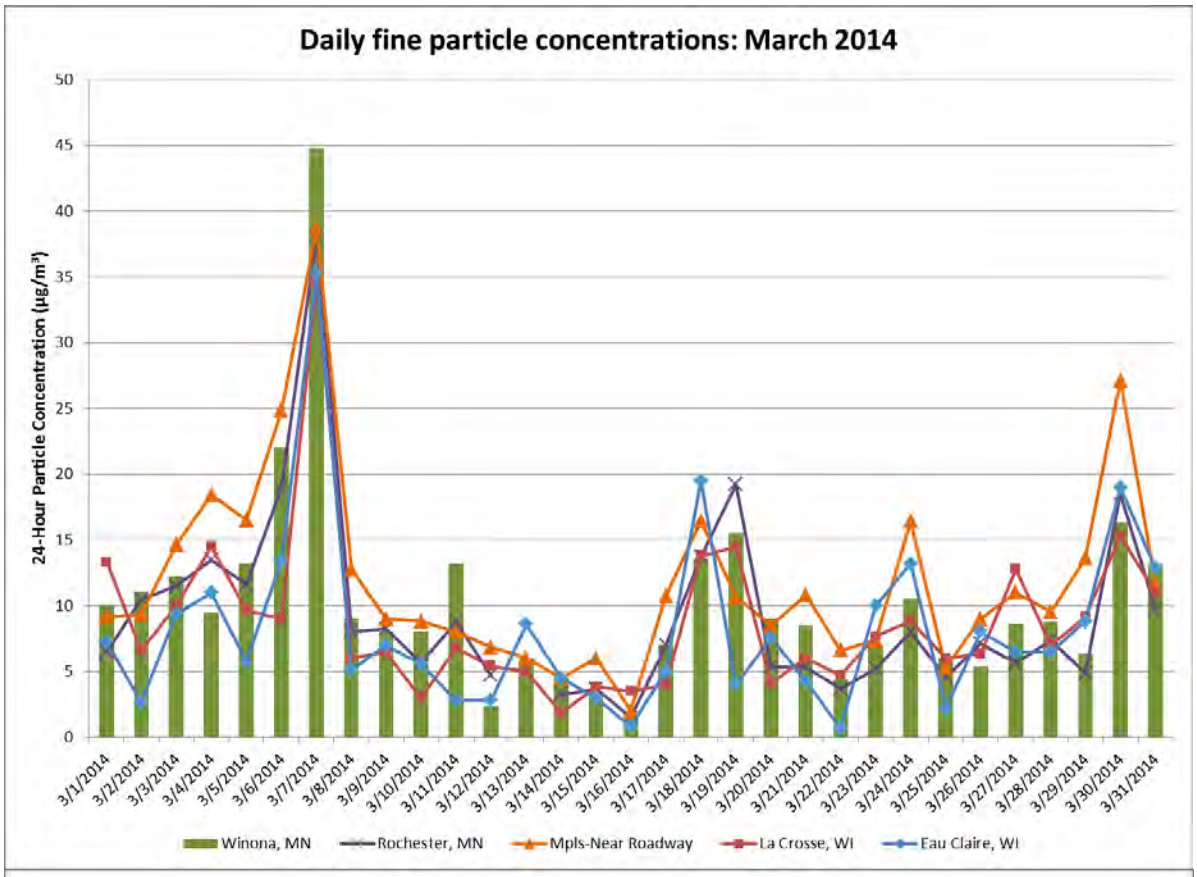


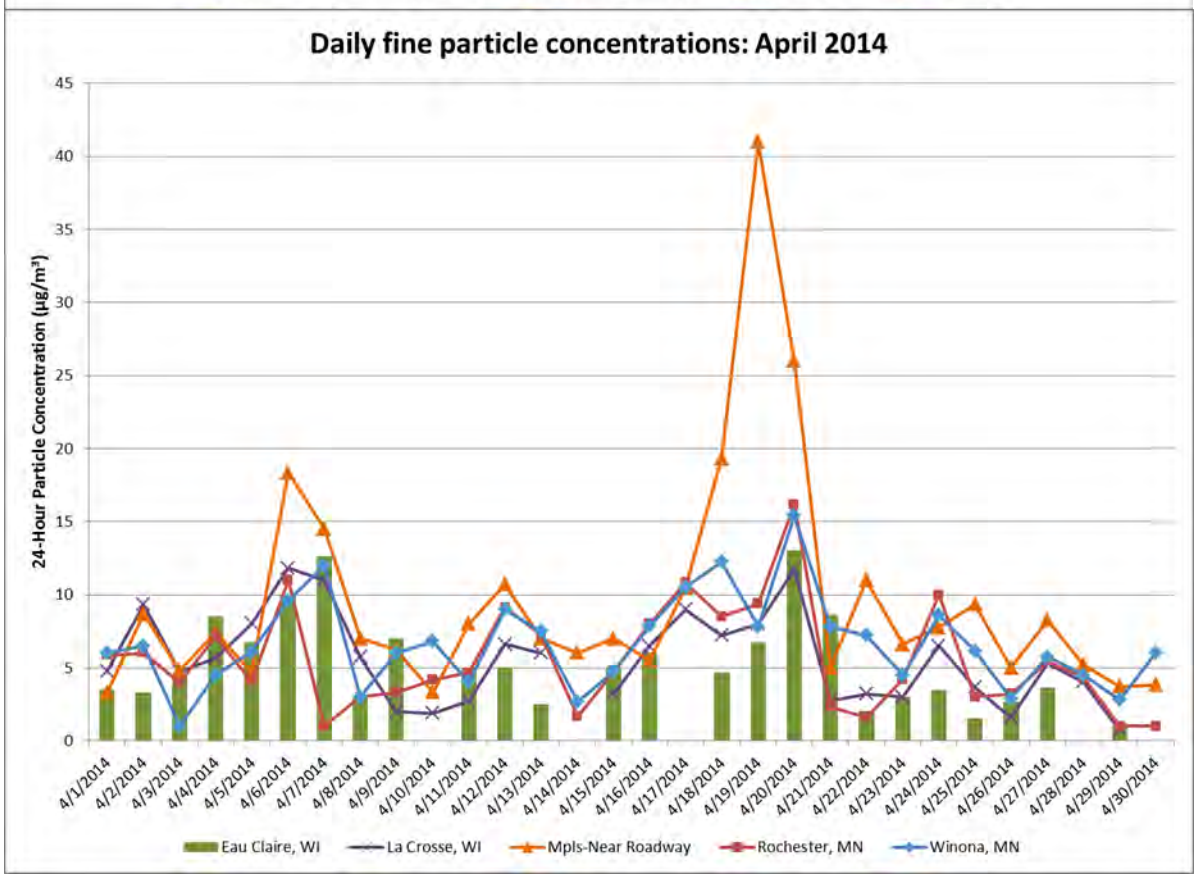
Winona fine particle results compared to other monitoring sites in Minnesota

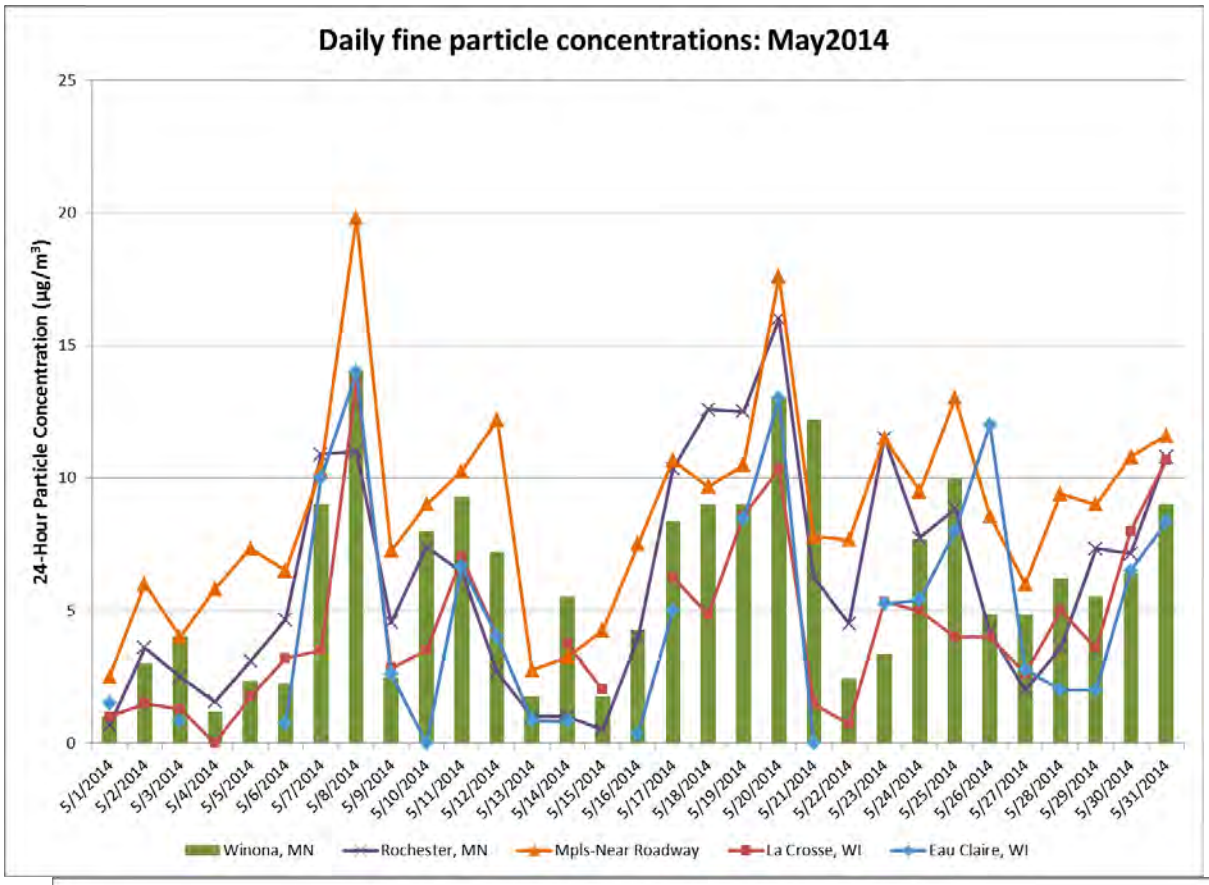
The data summarized on the preceding pages are specific to the geographic area immediately surrounding Winona, Minnesota. The MPCA operates a statewide network of ambient fine particle monitors. The data the MPCA collects from that network are representative of wider geographic areas. Nonetheless, it can be useful to compare the Winona data to air concentrations measured at other ambient monitoring locations. Below is a series of charts of daily average fine-particle air concentrations for 2014. The sites chosen for comparison are Rochester, Minnesota; La Crosse, Wisconsin; Eau Claire, Wisconsin; and the Minneapolis Near Roadway monitoring site which is located along I-94 and I-35W in downtown Minneapolis.

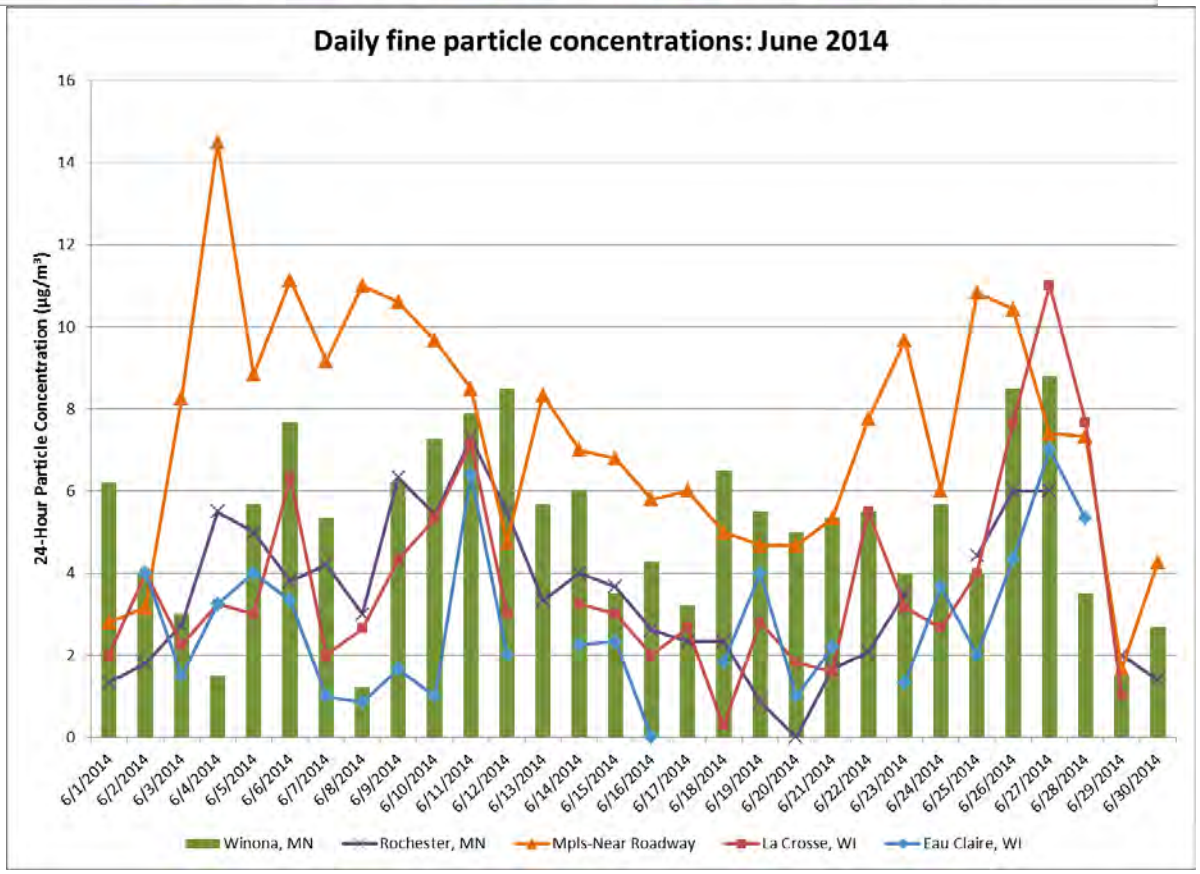

Daily fine particle concentrations: January2014
24-Hour Particle Concentration (µg/m³)
Winona, MN
Rochester, MN
Mpls-Near Roadway
La Crosse, WI
Eau Claire, WI

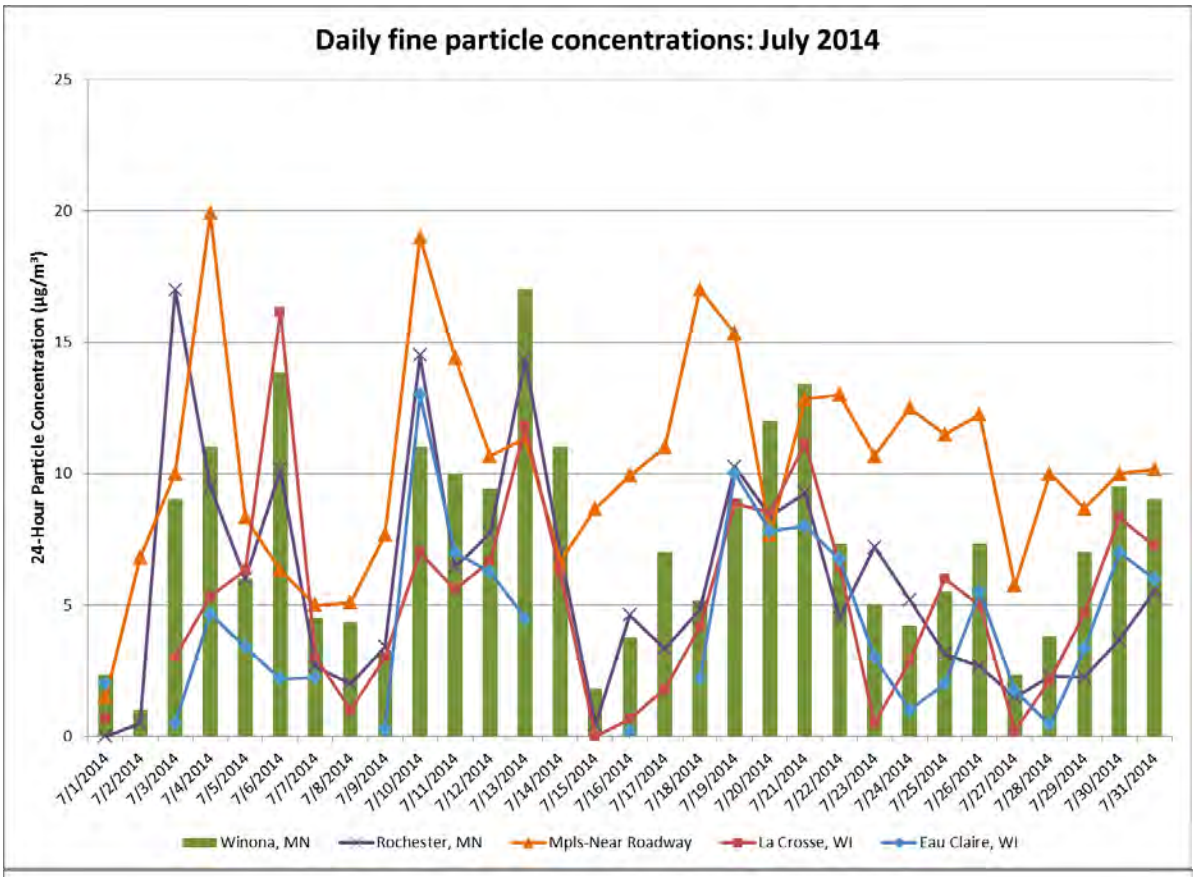

Daily fine particle concentrations: February2014
24-Hour Particle Concentration (µg/m³)
Winona, MN
Rochester, MN
Mpls-Near Roadway
La Crosse, WI
Eau Claire, WI

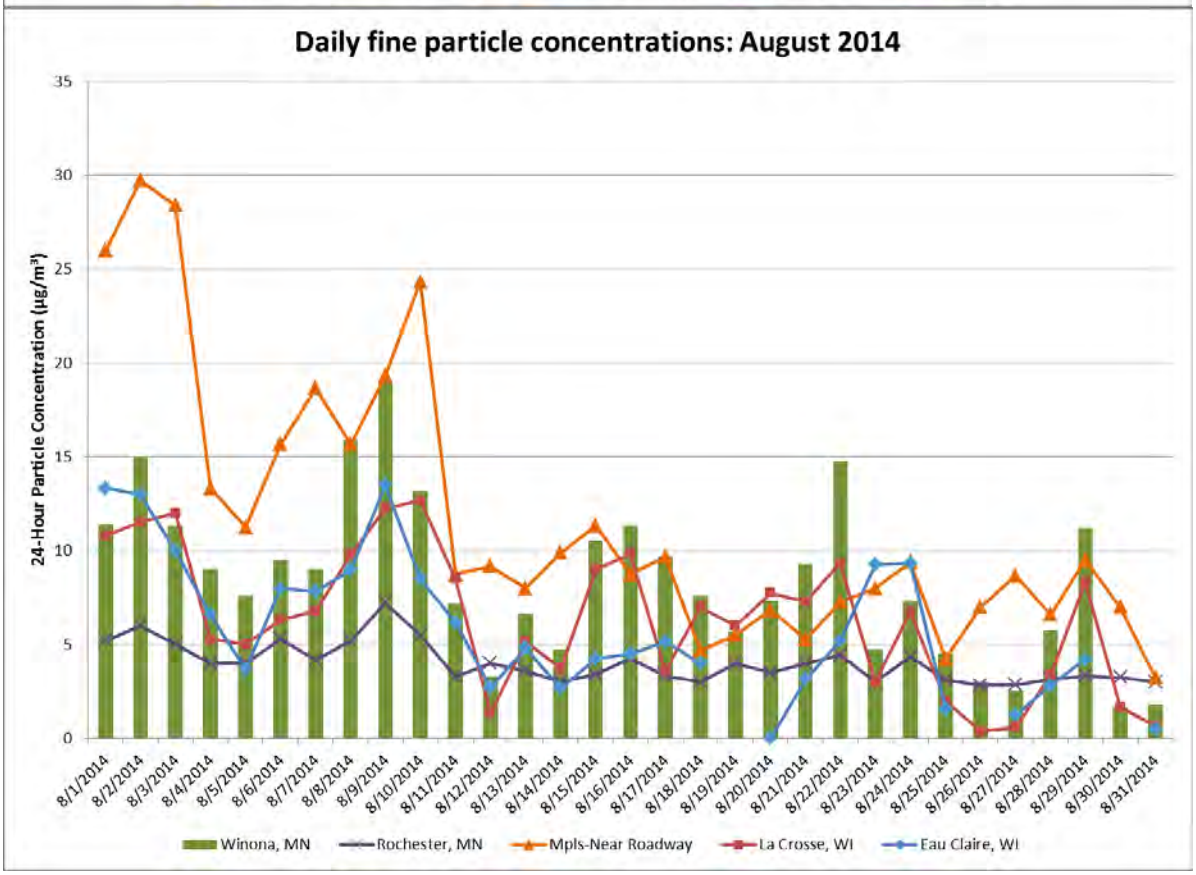

Daily fine particle concentrations: March 2014
24-Hour Particle Concentration (µg/m³)
Winona, MN
Rochester, MN
Mpls-Near Roadway
La Crosse, WI
Eau Claire, WI

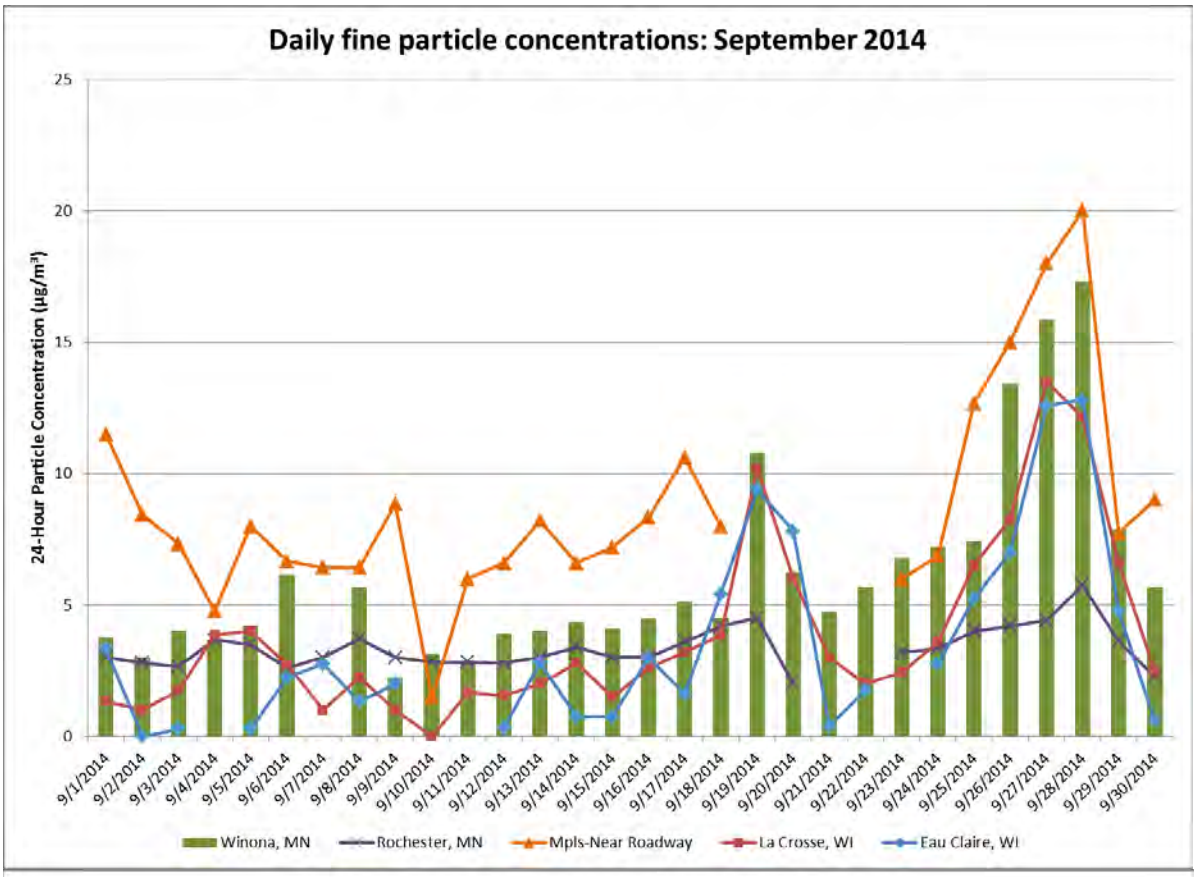

Daily fine particle concentrations: April 2014
24-Hour Particle Concentration (µg/m³)
Eau Claire, WI
La Crosse, WI
Mpls-Near Roadway
Rochester, MN
Winona, MN


Daily fine particle concentrations: May2014
24-Hour Particle Concentration (µg/m³)
25
20
15
10
5
0
5/1/2014
5/2/2014
5/3/2014
5/4/2014
5/5/2014
5/6/2014
5/7/2014
5/8/2014
5/9/2014
5/10/2014
5/11/2014
5/12/2014
5/13/2014
5/14/2014
5/15/2014
5/16/2014
5/17/2014
5/18/2014
5/19/2014
5/20/2014
5/21/2014
5/22/2014
5/23/2014
5/24/2014
5/25/2014
5/26/2014
5/27/2014
5/28/2014
5/29/2014
5/30/2014
5/31/2014
Winona, MN
Rochester, MN
Mpls-Near Roadway
La Crosse, WI
Eau Claire, WI


Daily fine particle concentrations: June 2014
24-Hour Particle Concentration (µg/m³)
16
14
12
10
8
6
4
2
0
6/1/2014
6/2/2014
6/3/2014
6/4/2014
6/5/2014
6/6/2014
6/7/2014
6/8/2014
6/9/2014
6/10/2014
6/11/2014
6/12/2014
6/13/2014
6/14/2014
6/15/2014
6/16/2014
6/17/2014
6/18/2014
6/19/2014
6/20/2014
6/21/2014
6/22/2014
6/23/2014
6/24/2014
6/25/2014
6/26/2014
6/27/2014
6/28/2014
6/29/2014
6/30/2014
Winona, MN
Rochester, MN
Mpls-Near Roadway
La Crosse, WI
Eau Claire, WI


Daily fine particle concentrations: July 2014
24-Hour Particle Concentration (µg/m³)
Winona, MN
Rochester, MN
Mpls-Near Roadway
La Crosse, WI
Eau Claire, WI


Daily fine particle concentrations: August 2014
24-Hour Particle Concentration (µg/m³)
Winona, MN
Rochester, MN
Mpls-Near Roadway
La Crosse, WI
Eau Claire, WI


Daily fine particle concentrations: September 2014
24-Hour Particle Concentration (µg/m³)
0
5
10
15
20
25
9/1/2014
9/2/2014
9/3/2014
9/4/2014
9/5/2014
9/6/2014
9/7/2014
9/8/2014
9/9/2014
9/10/2014
9/11/2014
9/12/2014
9/13/2014
9/14/2014
9/15/2014
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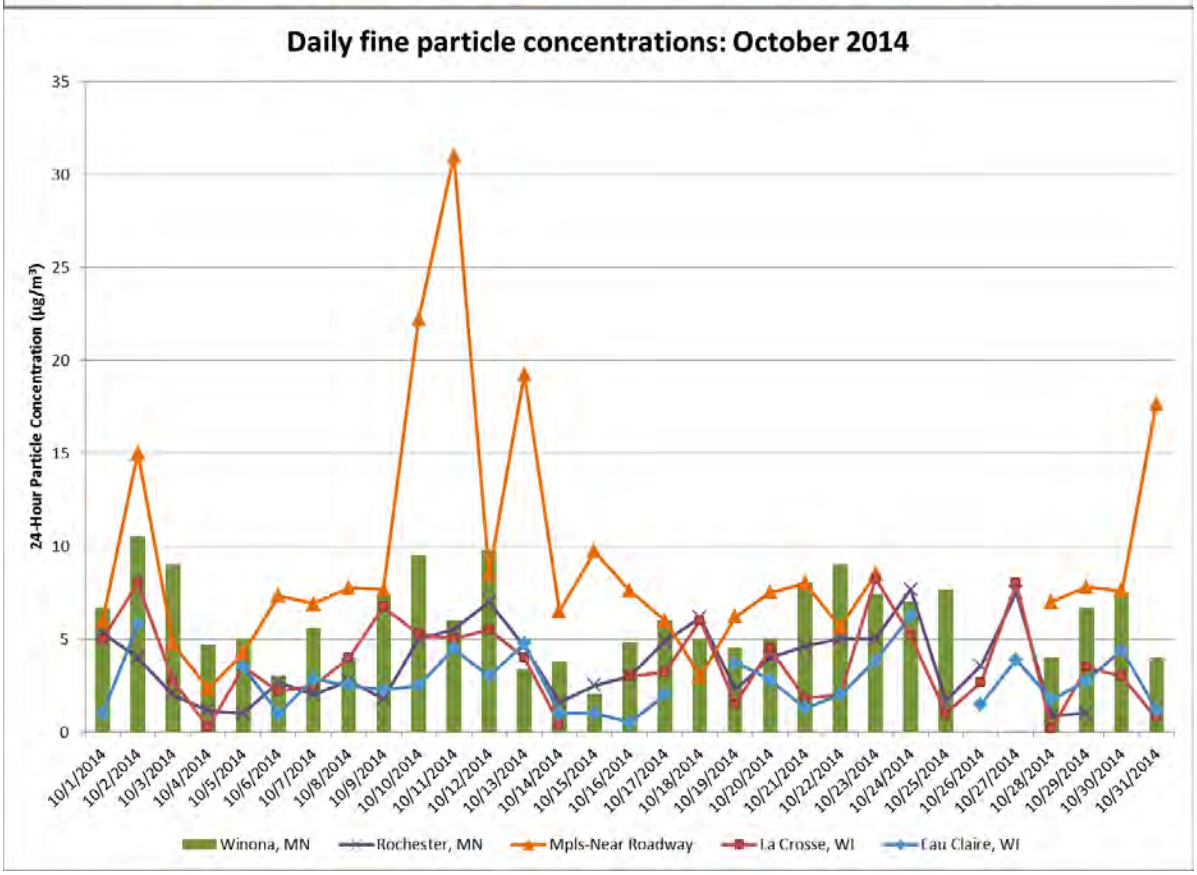
9/21/2014
9/22/2014
9/23/2014
9/24/2014
9/25/2014
9/26/2014
9/27/2014
9/28/2014
9/29/2014
9/30/2014
Winona, MN
Rochester, MN
Mpls-Near Roadway
La Crosse, WI
Eau Claire, WI


Daily fine particle concentrations: October 2014
24-Hour Particle Concentration (µg/m³)
0
5
10
15
20
25
30
35
10/1/2014
10/2/2014
10/3/2014
10/4/2014
10/5/2014
10/6/2014
10/7/2014
10/8/2014
10/9/2014
10/10/2014
10/11/2014
10/12/2014
10/13/2014
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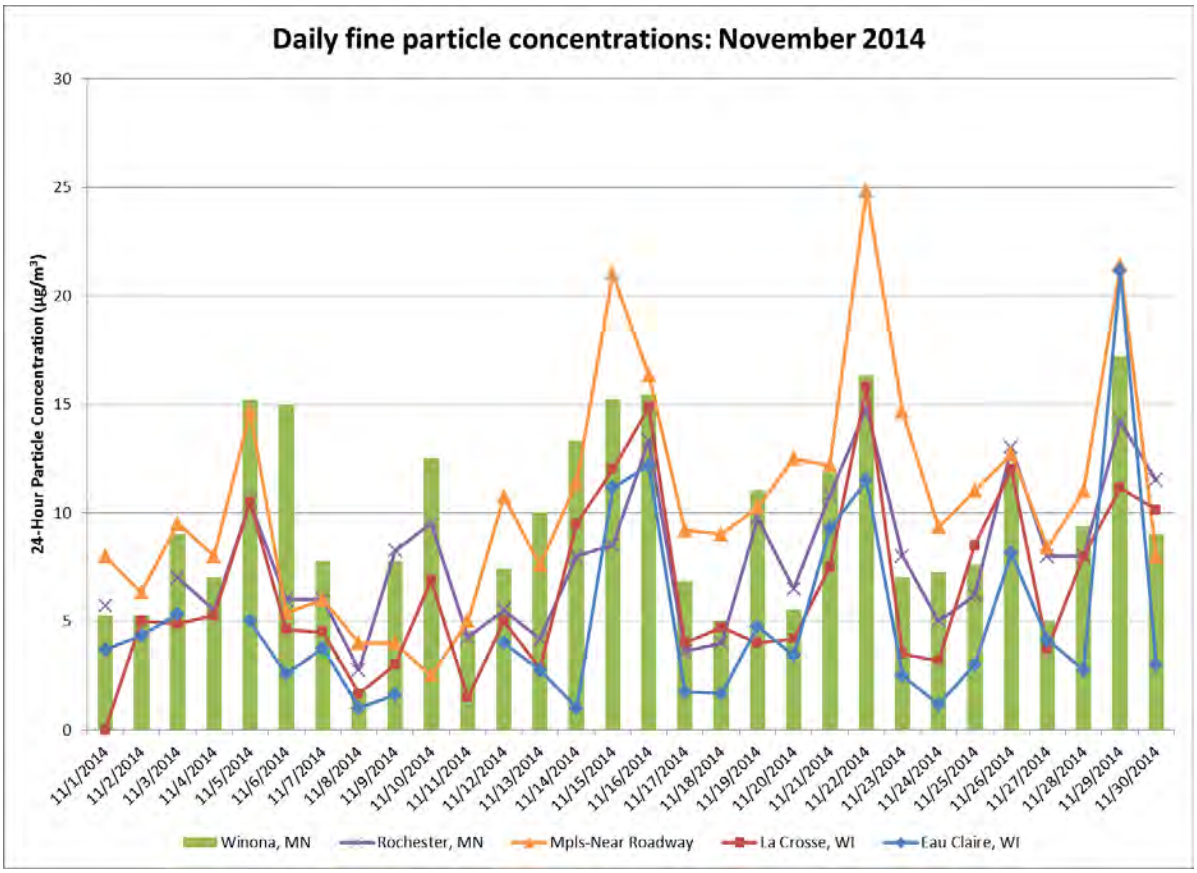
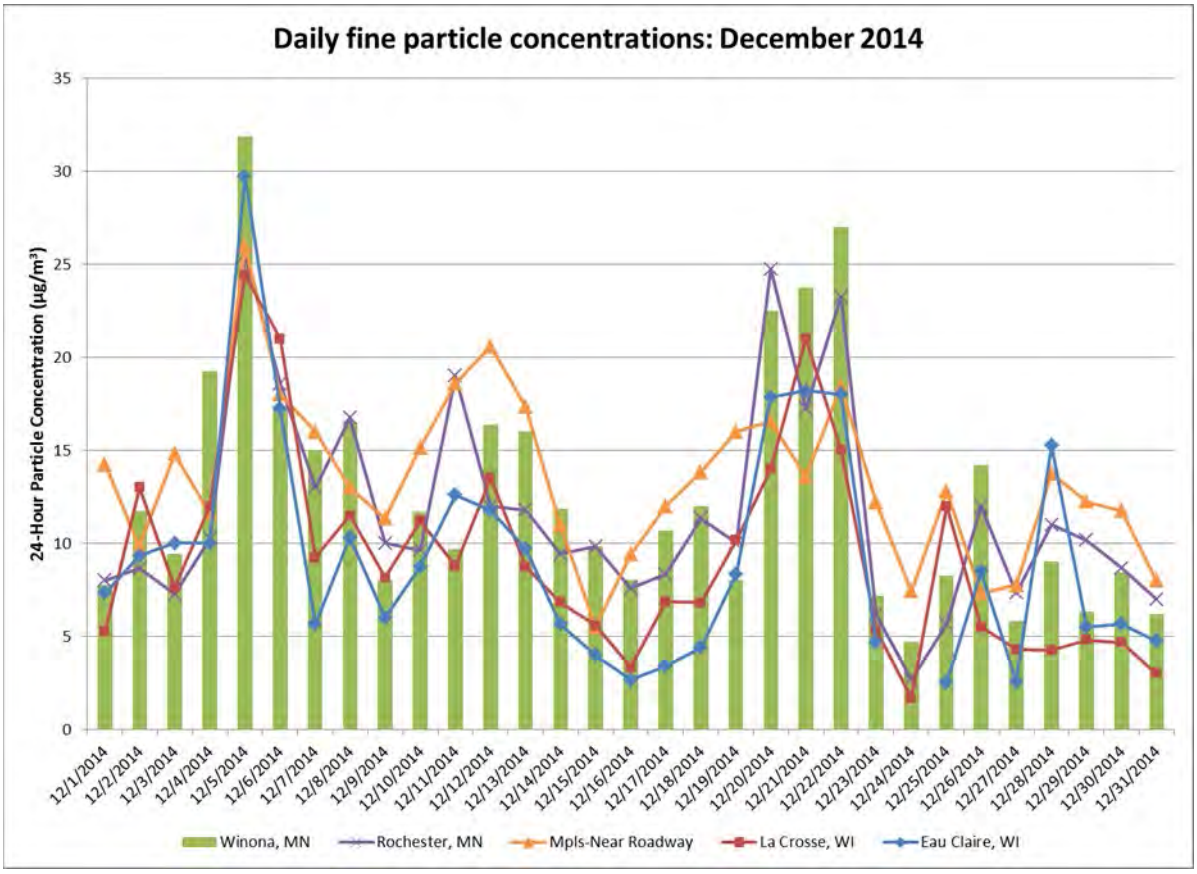
10/22/2014
10/23/2014
10/24/2014
10/25/2014
10/26/2014
10/27/2014
10/28/2014
10/29/2014
10/30/2014
10/31/2014
Winona, MN
Rochester, MN
Mpls-Near Roadway
La Crosse, WI
Eau Claire, WI


Daily fine particle concentrations: November 2014
24-Hour Particle Concentration (µg/m³)
Winona, MN
Rochester, MN
Mpls-Near Roadway
La Crosse, WI
Eau Claire, WI


Daily fine particle concentrations: December 2014
24-Hour Particle Concentration (µg/m³)
Winona, MN
Rochester, MN
Mpls-Near Roadway
La Crosse, WI
Eau Claire, WI