Wisconsin Department of Natural Resources

2015 Wisconsin Air Quality Trends Report

Data from 2001-2014

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Contents

Acronyms and Abbreviations

CASAC: Clean Air Scientific Advisory Committee

CO: Carbon monoxide

CBSA: Core Based Statistical Area

EPA: U.S. Environmental Protection Agency

NAAQS: National Ambient Air Quality Standards

NO_2: Nitrogen dioxide

NO_x: Nitrogen oxides

$PM_{2.5}$: Particulate matter 2.5 microns or smaller in size

PM_{10}: Particulate matter 10 microns or smaller in size

PPB: Parts per billion

PPM: Parts per million

SO_2: Sulfur dioxide

TSP: Total suspended particles

UV: Ultraviolet

VOC: Volatile organic compound

WDNR: Wisconsin Department of Natural Resources

Report Summary

The Wisconsin Department of Natural Resources (WDNR) monitors ambient concentrations of several pollutants throughout the state, including ozone, particulate matter, sulfur dioxide, nitrogen dioxide, lead, and carbon monoxide, as well as other toxic compounds. With the exception of toxics, these comprise the set of principal pollutants, called criteria pollutants, which are regulated by the U.S. Environmental Protection Agency (EPA). Monitored levels of these pollutants are compared against the National Ambient Air Quality Standards (NAAQS) set by the EPA to determine whether the levels are sufficiently low. Compliance with the standards, also referred to as attainment of the standards, is usually assessed at the county level.

This report presents Wisconsin monitoring data for the past fifteen years (as data are available) to show trends in pollutant concentrations over time. It addresses all six criteria pollutants regulated by the EPA. The first section of the report provides an overview of the pollutants, their NAAQS regulatory history, and Wisconsin's compliance history. The second section presents the monitoring data for each pollutant, and compares the data to the relevant NAAQS. In some cases, monitoring data are grouped into broader regions to highlight geographic trends.

In general, concentrations of most of the criteria pollutants have been decreasing over the past decade in all regions of the state. In April 2014, three counties in southeastern Wisconsin that had been violating the fine particle NAAQS were redesignated as attaining the standard because of the lower concentrations observed in recent years. The overall decrease in pollutant concentrations is encouraging and is the result of cooperative regulatory control programs reducing emissions from vehicles and stationary sources in Wisconsin and surrounding states.

Two areas – Sheboygan County and a portion of Kenosha County – are currently listed as nonattainment for the 2008 ozone NAAQS. A small area around, and including, the City of Rhinelander in Oneida County is currently listed as nonattainment for the sulfur dioxide standard. The WDNR is committed to working with partners in Wisconsin and other states in the region to improve air quality in those areas.

Annual differences in meteorological conditions can lead to variability in measured concentrations. Relative to the summer of 2012, the summers of 2013 and 2014 were cooler and conditions were not as conducive to ozone formation. While annual data is important to consider, long term trends in air quality guide decisions about management of air quality issues at federal and state levels.

Background

Federal Regulatory History

The Clean Air Act requires the U.S. Environmental Protection Agency (EPA) to set National Ambient Air Quality Standards (NAAQS) for pollutants considered harmful to public health and the environment. The technical basis for the NAAQS is provided through the independent advice of the Clean Air Scientific Advisory Committee (CASAC), as well as EPA staff evaluation.

There are two types of standards – primary and secondary. Primary standards are those set at a level meant to protect general human health, especially for those with respiratory conditions or particular sensitivity to pollutant exposure. Secondary standards are intended to prevent impaired visibility, structural damage, and vegetative/livestock injury. The current standards for the six criteria pollutants regulated by the EPA are shown in Table 1 below.

Table 1. The EPA criteria pollutants and National Ambient Air Quality Standards

Pollutant		Primary/ Secondary	Averaging Time	Level	Definition
Carbon Monoxide		primary	8-hour	9 ppm	Not to be exceeded more than once per year
			1-hour	35 ppm	
Lead		primary and secondary	Rolling 3-month average	0.15 $\mu g/m^3$	Not to be exceeded
Nitrogen Dioxide		primary	1-hour	100 ppb	98th percentile, averaged over 3 years
		primary and secondary	Annual	53 ppb	Annual mean
Ozone*		primary and secondary	8-hour	0.075 ppm	Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years
Particulate Matter	$PM_{2.5}$	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		primary	1-hour	75 ppb	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

Based on the EPA table at < http://epa.gov/air/criteria.html>
***Note: EPA finalized a more stringent ozone standard of 0.070 ppm on October 26, 2015.**

Design Value Calculations

Design values (DVs) are used to assess compliance with the NAAQS and are based on data collected over long periods. Usually, design values are averages of annual values to ensure they represent typical pollutant concentrations rather than isolated spikes in concentrations. The design values for criteria pollutants are calculated using the method specified for each standard, as shown in the "Averaging

Time" and "Definition" columns of Table 1. As examples, the following paragraphs explain how ozone and fine particle design values are calculated.

The metric used to determine compliance with the ozone NAAQS is the annual fourth-highest daily maximum 8-hour concentration, averaged over a period of three years. Individual days are first divided into twenty-four 8-hour periods. Midnight to 8 AM, for example, would be the first period. The average ozone concentration during each period is calculated, and the highest of the 24 average values is selected. Figure 1 shows the highest average value each day during the 2013 ozone season. The fourth-highest value of the year is identified and then averaged with the fourth-highest value from two consecutive years to obtain the design value. For instance, the 2013 design value was calculated by averaging the fourth-highest 8-hour maximum in 2013 with the fourth-highest values for 2012 and 2011. Note that even though the fourth-highest ozone value for 2013 was above the standard, ozone concentrations were below the standard for most days of the season.

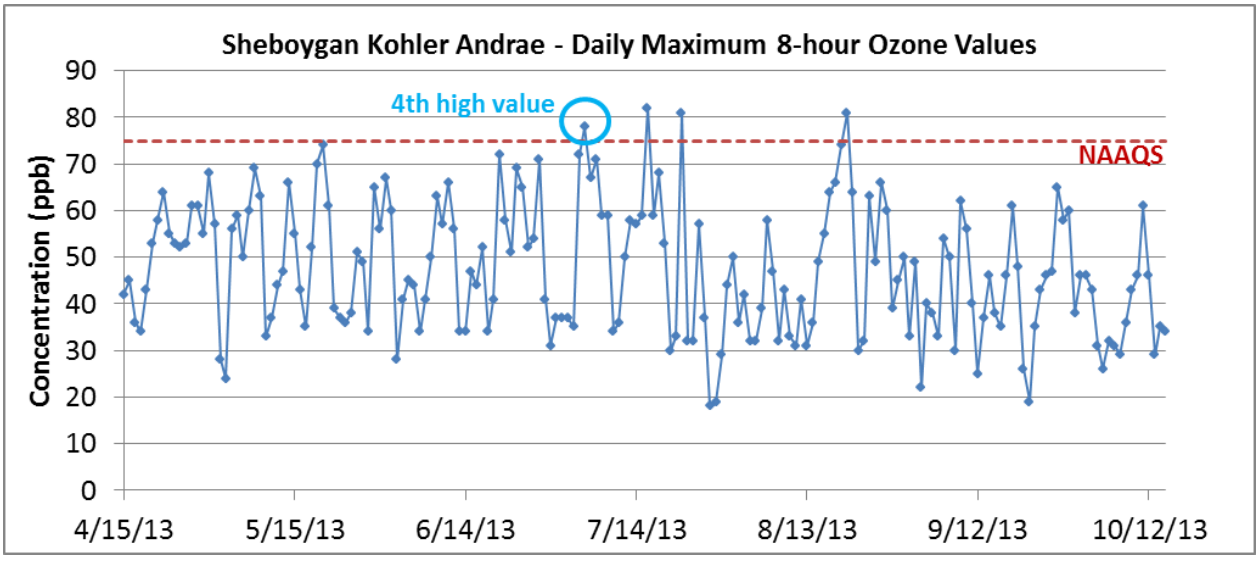


Figure 1. Example of fourth-highest yearly value identified for use in calculating the ozone design value.

For fine particulate matter ($PM_{2.5}$), design values are calculated for comparison with the annual NAAQS and the 24-hour NAAQS. The annual design value for $PM_{2.5}$ is the average of the annual mean from three individual years, where each annual mean is the average of the mean concentration of the four quarters of that year. To obtain 24-hour design values, the observation representing the 98^{th} percentile of daily fine particulate averages is determined (e.g., Figure 2) and averaged over three consecutive years. The 98^{th} percentile value is the observed concentration below which 98 percent of observations fall. Only 2 percent of observed concentrations are higher than this value. In the example shown in Figure 2, the calculated value for 2013 is averaged with values from 2012 and 2011 to derive the official 2013 design value.

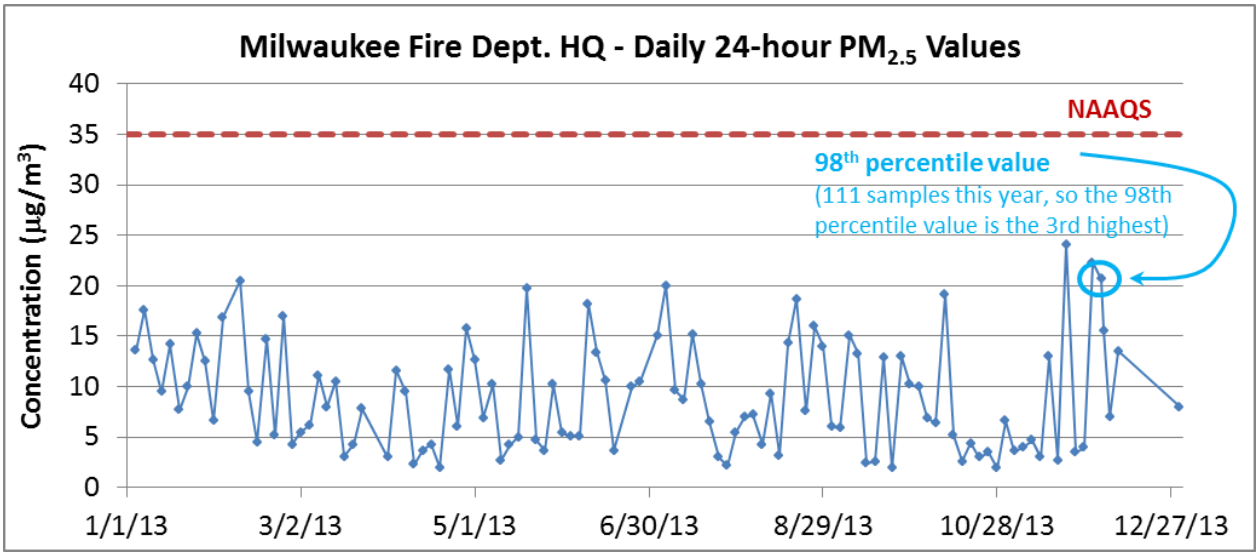


Figure 2. Example of 98th percentile identified for use in calculating the 24-hour $PM_{2.5}$ design value.

Ozone

Ozone is a naturally occurring form of oxygen. While the oxygen molecules predominantly found in the atmosphere contain two atoms, ozone molecules contain three. This form of oxygen is unstable, and is constantly forming and decomposing through a variety of atmospheric reactions. Ozone is present in the Earth's upper atmosphere as well as at ground level. Ozone found at higher levels in the atmosphere (stratospheric ozone) filters out harmful UV rays, while ground-level (tropospheric) ozone can have an adverse impact on health. Monitored values of ozone found in this report represent ground-level ozone.

Ground-level ozone is not directly emitted into the air, but is created by photochemical reactions in the atmosphere. The highest ozone concentrations measured typically occur on hot sunny days downwind of urban areas; ozone can be transported long distances. Ozone concentrations in Wisconsin are significantly higher during the warmer months, and April 15th to October 15th is the state's current ozone monitoring season. Starting in 2017, state monitoring of ozone will start on March 1st.

Ozone exposure can lead to numerous health issues, including respiratory system irritation, reduced lung function, inflammation of and damage to cells in the lungs, aggravation of asthma and chronic lung diseases, increased lung susceptibility to infection, and potential for permanent lung damage. Children are at the greatest risk from exposure to ozone because their lungs are still developing. Research has also shown that at certain levels, ozone can negatively affect vegetation and ecosystems.

Regulatory History

The original hourly ozone standard of 125 ppb was set in 1971. In July 1997, the EPA replaced the hourly standard with an 8-hour standard of 0.08 ppm (84 ppb) to protect the public against longer term exposure. In March 2008, the 8-hour standard was lowered to 0.075 ppm (75 ppb). The 8-hour standard is met when the calculated design value measured at a monitoring site is equal to or less than 75 ppb. On October 26, 2015 the EPA further decreased the 8-hour standard to 0.070 ppm (70 ppb) effective December 28, 2015. The new 2015 standard also includes a change to the number of 8-hour averages to

be calculated per day. Details regarding this change will be provided in the next report. Note that the 2008 standard of 0.075 ppm remains in effect for now.

Wisconsin Non-Compliance History

In 2004, ten counties in eastern Wisconsin were designated as nonattainment for the 1997 ozone standard. Kewaunee County, Door County, Manitowoc County, and the Milwaukee-Racine Area (including Ozaukee, Milwaukee, Racine, Kenosha, Washington, and Waukesha Counties) were redesignated to attainment in 2008, 2010, 2010, and 2012, respectively. When the 1997 standard was rescinded in 2015, the Sheboygan area was still classified as nonattainment. In 2012, Sheboygan County and the eastern part of Kenosha County were also designated nonattainment with the 2008 ozone NAAQS, and nonattainment designations remain in effect for these two areas.

Particulate Matter ($PM_{2.5}$ and PM_{10})

Particulate matter, or particle pollution, is a complex mixture of organic and inorganic materials (primarily nitrates and sulfates) and elemental carbon. It can also include acids, metals, soil or dust, and allergens. For regulatory purposes, particulate matter is divided into two predominant size classes according to diameter: $PM_{2.5}$ or fine particles (2.5 micrometers or smaller) and PM_{10} or inhalable coarse particles (10 micrometers or smaller). Fine particle pollution primarily forms in the atmosphere, but can also be emitted during combustion processes. Coarse particle pollution is primarily formed through mechanical processes such as crushing and grinding.

Fine particles may be categorized as one of two different types. Primary particles are those emitted directly from sources such as vehicles, fires, or combustion smokestacks. Secondary particles are those that form when other pollutants, such as sulfur oxides and nitrogen oxides, react in the atmosphere with ammonia and other gases. Particles created by these types of reactions comprise the vast majority of fine particle pollution.

While all particle pollution poses a health risk according to EPA, $PM_{2.5}$ poses the greatest risk because of its ability to penetrate deep into the respiratory tract. Very small particles may also eventually spread to the bloodstream. Studies have shown an association between fine particle exposure and premature death from heart or lung disease, as well as aggravated respiratory conditions such as asthma and airway irritation. Individuals most sensitive to fine particle exposure include those with heart or lung disease, older adults, and children.

Regulatory History

The EPA's original 1971 standard for particle pollution set a limit for total suspended particles (TSP), which included both $PM_{2.5}$ and PM_{10}, as well as coarser particles up to approximately 20 micrometers in diameter. In 1987, EPA discontinued the standard for TSP and replaced it with two PM_{10} standards: a 24-hour limit of 150 micrograms per cubic meter, and an annual limit of 50 micrograms per cubic meter. The EPA introduced a separate standard for $PM_{2.5}$ in 1997. These separate standards are discussed further in the following sections.

$PM_{2.5}$

The 1997 the annual standard was set by EPA at 15 micrograms per cubic meter, based on the 3-year average of the annual mean $PM_{2.5}$ concentration. The 24-hour $PM_{2.5}$ standard was established the same year at 65 micrograms per cubic meter for the 3-year average of the annual 98th percentile concentrations. In 2006, the 24-hour standard was lowered to 35 micrograms per cubic meter, while in 2012, the annual standard was lowered to 12 micrograms per cubic meter, effective January 2014.

PM_{10}

The original 1987 annual PM_{10} standard of 50 micrograms per cubic meter was revoked in 2006 by EPA, and the 24-hour standard of 150 micrograms per cubic meter remains in effect today.

Wisconsin Non-Compliance History ($PM_{2.5}$)

In 2009, the EPA designated Milwaukee, Racine, and Waukesha counties as not attaining, or non-compliant with, the 2006 24-hour $PM_{2.5}$ NAAQS based on monitoring data from 2006 to 2008. In June 2012, the DNR submitted a request to EPA to redesignate these counties to attainment based on monitoring data collected between 2008 and 2011. Attainment levels have been measured at all sites measuring $PM_{2.5}$ in the state since that time. The EPA proposed redesignation of the three counties to attainment, and the redesignation was finalized on April 22, 2014. As a result of this action, all counties in Wisconsin are currently in attainment of the annual and 24-hour $PM_{2.5}$ NAAQS.

Sulfur Dioxide (SO_2)

Sulfur dioxide (SO_2) is a chemical compound that is one of a group of highly reactive gases known as 'oxides of sulfur'. It is a product of combustion, and the largest emission source of SO_2 is fossil fuel combustion at power plants and other industrial facilities.

Exposure to SO_2 has been shown to cause a range of adverse respiratory effects, including bronchoconstriction and increased asthma symptoms. Further, emission sources that contribute to high concentrations of SO_2 also contribute to the formation of other oxides of sulfur. Some of these oxides can react with other compounds in the atmosphere to form fine particles, which can penetrate deep into the lungs.

Regulatory History

The EPA first set standards for SO_2 in 1971. A 24-hour primary standard was set at 140 ppb and an annual average primary standard at 30 ppb. A 3-hour secondary standard of 500 ppb was also set to protect public welfare. In 1996, the standards were reviewed and the EPA decided not to revise them.

In 2010, the EPA revised the primary SO_2 standards by establishing a new hourly standard at 75 ppb. The EPA revoked the two existing primary standards (24-hour and annual) because the hourly standard is more protective of public health. The 3-hour secondary standard remains in effect.

Wisconsin Non-Compliance History

In 2013, the EPA designated a portion of Oneida County as nonattainment for the 2010 primary SO_2 NAAQS.

Nitrogen Dioxide (NO_2)

Nitrogen dioxide (NO_2) is a reactive byproduct of combustion produced mainly by vehicles, resulting in concentrations that are highest immediately adjacent to roadways. Nitrogen dioxide and nitrogen oxide (NO), collectively referred to as NOx, are important precursors of ozone, which is generated when NOx reacts with volatile organic compounds (VOCs) in the presence of sunlight. In addition, these gases can also react with other pollutants to form airborne particulate matter. Research indicates that direct exposure to NO_2 for short time periods can result in respiratory issues such as airway inflammation and aggravated asthma. Longer term exposure poses a risk of acute respiratory illness and inhibited lung development in children.

Regulatory History

The EPA set the original standard for NO_2 at 53 ppb based on an annual average. This standard is still in effect. In 2010, the EPA established an additional hourly standard of 100 ppb. Historically, Wisconsin has had no NO_2 nonattainment areas.

Lead

Lead can be found in several places in the environment, including the air, water, and soil. Before unleaded gasoline was introduced in 1980, vehicle emissions were the primary source of airborne lead. Today, lead is emitted mainly from industrial metal processing sources, as well as the combustion of leaded aviation fuel.

People can be directly exposed to lead in the air. In addition, deposition onto soil or bodies of water may cause lead to accumulate in natural ecosystems and contaminate drinking water. Health effects of lead exposure in humans are numerous and well-documented. In general, neurological effects and developmental risks are the largest danger for children, whereas cardiovascular effects such as heart disease and high blood pressure commonly affect adults.

Regulatory History

The original lead standard, set by the EPA in 1978, was 1.5 micrograms per cubic meter on a calendar quarterly average basis. In 2008, this standard was phased out and replaced by a rolling three month averaging period; the standard was also lowered to 0.15 micrograms per cubic meter. The design value for lead is determined using the maximum 3-month average over a period of three years.

Wisconsin uses a collection technique that measures lead content as a subset of TSP samples as required by federal rule. During the past decade, no areas in Wisconsin have had levels of lead that exceed the NAAQS.

Carbon Monoxide (CO)

Carbon monoxide (CO) is a toxic gas that is well-known as a potential danger in indoor environments, though it is also emitted into the ambient air primarily by mobile sources. In addition, it reacts under certain conditions to form ground-level ozone.

CO exposure can reduce people's respiration efficiency, resulting in short-term symptoms, or in extremely high concentrations, fatality. People suffering from heart disease face increased risks from exposure to CO because their respiration efficiency is already compromised.

Regulatory History

The EPA originally set standards for CO in 1971: an 8-hour standard of 9 ppm and an hourly standard of 35 ppm. These standards were reviewed in 1994 and 2011 but were not changed, and therefore remain in effect.

Wisconsin Non-Compliance History

In the past, Wisconsin had nonattainment areas for CO in Milwaukee and Oshkosh. Both areas have since been redesignated to attainment.

Regional Pollutant Trends

The following sections present Wisconsin monitoring data for all six criteria pollutants over roughly the last fifteen years. Design values are plotted and compared against the relevant NAAQS to show how the state's air quality has changed over time. The data for some pollutants are also organized regionally to highlight geographic trends. Specifically, different areas of the state are prone to higher concentrations of ozone and fine particles ($PM_{2.5}$) – the main criteria pollutants of concern in Wisconsin.

The data presented are from current ambient air monitoring sites operated by WDNR that have a history of data long enough to create a 3-year design value. The particulate and lead data are collected at WDNR sites using filter-based monitors, which operate at a frequency ranging from daily to once every 12 days. The remaining criteria pollutants are measured using a network of continuously operating monitors, which are the basis for real-time health advisories. Usually, NAAQS attainment is assessed by county. For counties with multiple monitors, the monitor with the highest design value is compared against the NAAQS.

Ozone

Ozone forms primarily as the result of reactions in the atmosphere between VOCs and nitrogen oxides (NO_x, which consists of NO and NO_2). Significant amounts of the ozone precursors that affect Wisconsin originate out of state, particularly from the south. These precursors react to form ozone over Lake Michigan. Ozone formation is greatest on hot, sunny, and humid days. On these days, temperature gradients from the shoreline to the lake create pressure differences which cause an on-shore or lake breeze in the afternoon. Wisconsin counties along Lake Michigan experience the highest ozone concentrations on days with a southerly breeze, which transports ozone precursors north to Wisconsin. This transport, in combination with the lake breeze, pushes ozone formed over the lake onshore. For this reason, ozone concentrations in Wisconsin are closely correlated with distance from the Lake Michigan shoreline, as demonstrated when design values are compared across three distinct regions:

1) **Lakeshore -** counties between Illinois and Green Bay which border Lake Michigan
2) **Inland** - counties in central and western Wisconsin
3) **Far North** – counties in the northern part of the state near the Upper Peninsula of Michigan

Figure 3 shows the most recently available ozone design values for each region for the period 2012 to 2014. Four of eleven monitoring sites in the Lakeshore region observed design values greater than the 75 ppb NAAQS for ozone. No sites in the other two regions had design values exceeding the 2008 standard, and sites in western and northern Wisconsin recorded the lowest ozone concentrations.

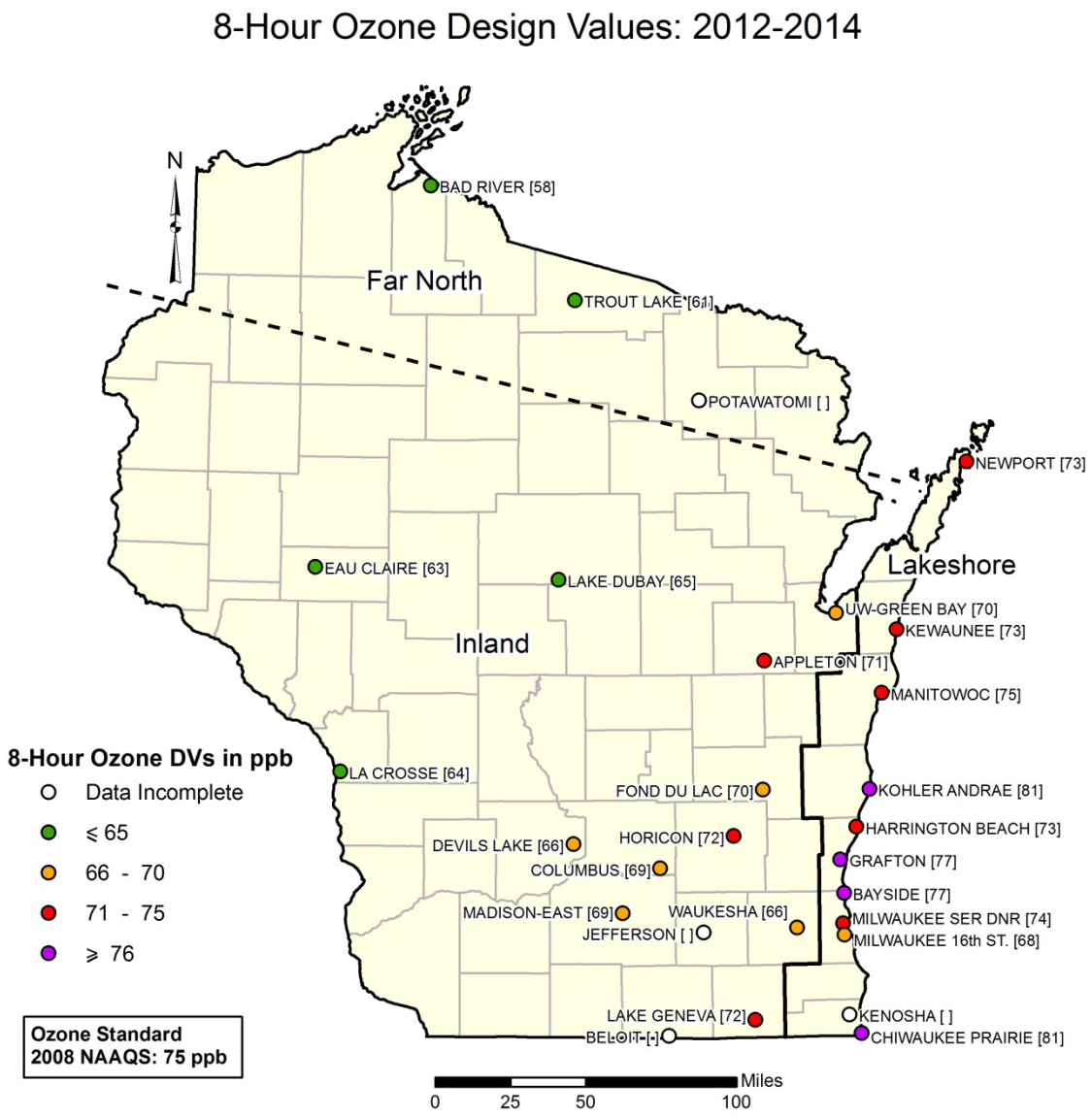


Figure 3 .Ozone design values (8-hr averages) for each monitoring site based on data from 2012 to 2014. Note that the Far North region includes the three sites shown, but its boundaries are not clearly defined.

Figure 4 shows a plot of design values for the Lakeshore region over the period 2003 to 2014. These design values are compared with the NAAQS to assess compliance with the federal standard. The relationship between design values from different monitoring sites was generally consistent over time (e.g., the values from the Milwaukee SER DNR site were consistently greater than the values from the Milwaukee 16th Street site). The design values collectively demonstrated a downward trend over the period, with the lowest average values for the region recorded in the 2010 design value year (which represents data from 2008 to2010). The summer of 2012 was extraordinarily hot, with accordingly high ozone concentrations. Design values for the last three years were higher than the previous period due to the inclusion of 2012. Over the past seven years, the site located in Kohler-Andrae State Park in

Sheboygan County generally showed the highest design values in the region, and consistently exceeded the NAAQS. A number of other sites have also exceeded the NAAQS in some years (Figure 4).

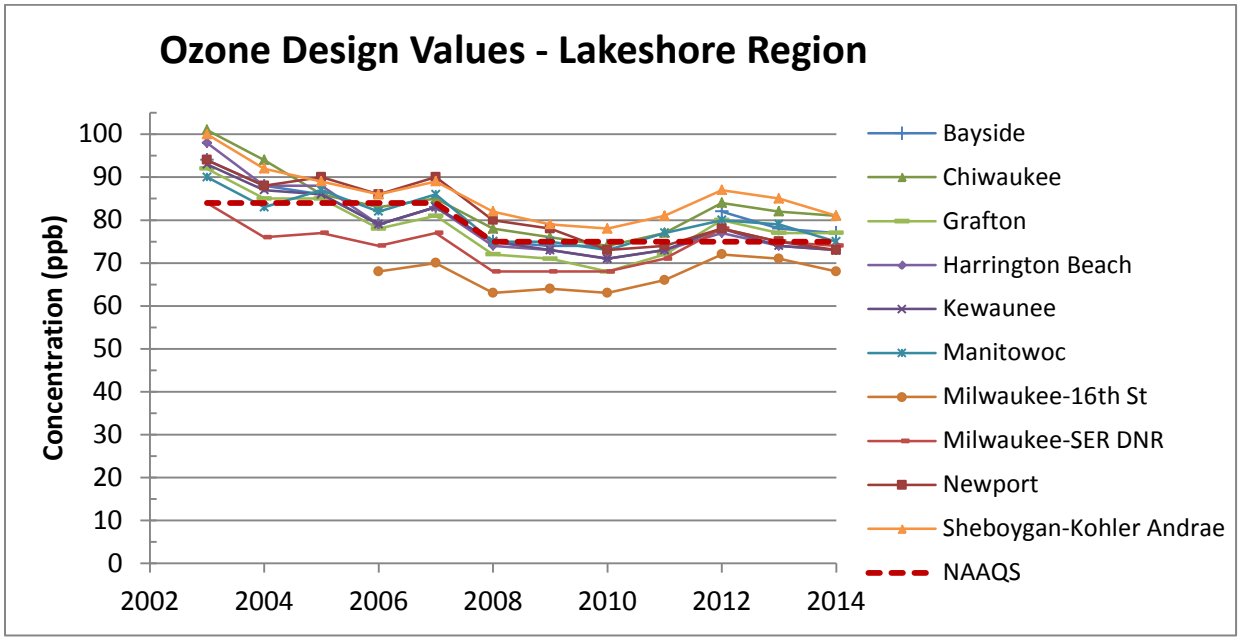


Figure 4. Ozone design values for the Lakeshore region, 2003 - 2014. Note that the standard was lowered from 84 ppb to 75 ppb in 2008.

Figure 5 shows design values for the Inland region over the period 2003 to 2014. Like the Lakeshore region, the design values for each of these monitoring sites generally decreased over time. The lowest design values in this region, 61 ppb, was observed in both La Crosse and Lake DuBay in the 2010 design

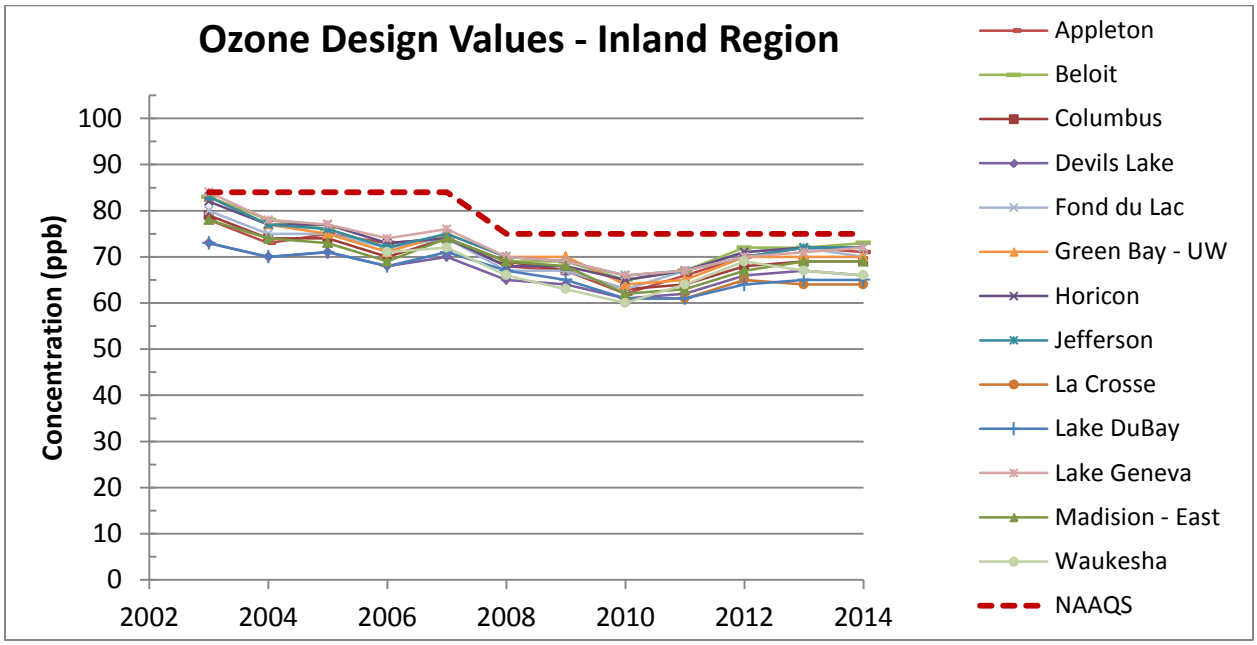


Figure 5. Ozone design values for the Inland region, 2003 - 2014. Note that the standard was lowered from 84 ppb to 75 ppb in 2008.

value year. Design values were higher for the last three years due to high ozone concentrations in 2012. No design value in this region exceeded the NAAQS between 2003 and 2014.

Overall, the design values in the Inland region were more similar between sites than those in the Lakeshore region. This finding suggests that while ozone concentrations are subject to variation at local scales in the Lakeshore region due to the impact of the lake breeze effect, Inland region concentrations are buffered from this effect because they are farther from the shoreline. Because onshore ozone transport is less of a factor at Inland locations, the ozone concentrations at the Inland sites were both more uniform throughout the region and generally lower than concentrations at the Lakeshore sites.

Figure 6 shows ozone design values over the period 2006 to 2014 for the three monitoring sites in the Far North region. Data were incomplete prior to 2006 for the Potawatomi site in Forest County, while data were available starting in 2007 and 2009 for the Bad River and Trout Lake sites in Ashland and Vilas Counties, respectively. All sites were consistently below the NAAQS and represented the overall lowest concentrations of ozone in the state. Minimum levels for the region were observed in design value years 2010 and 2011; the Bad River site observed the lowest concentrations among the three sites.

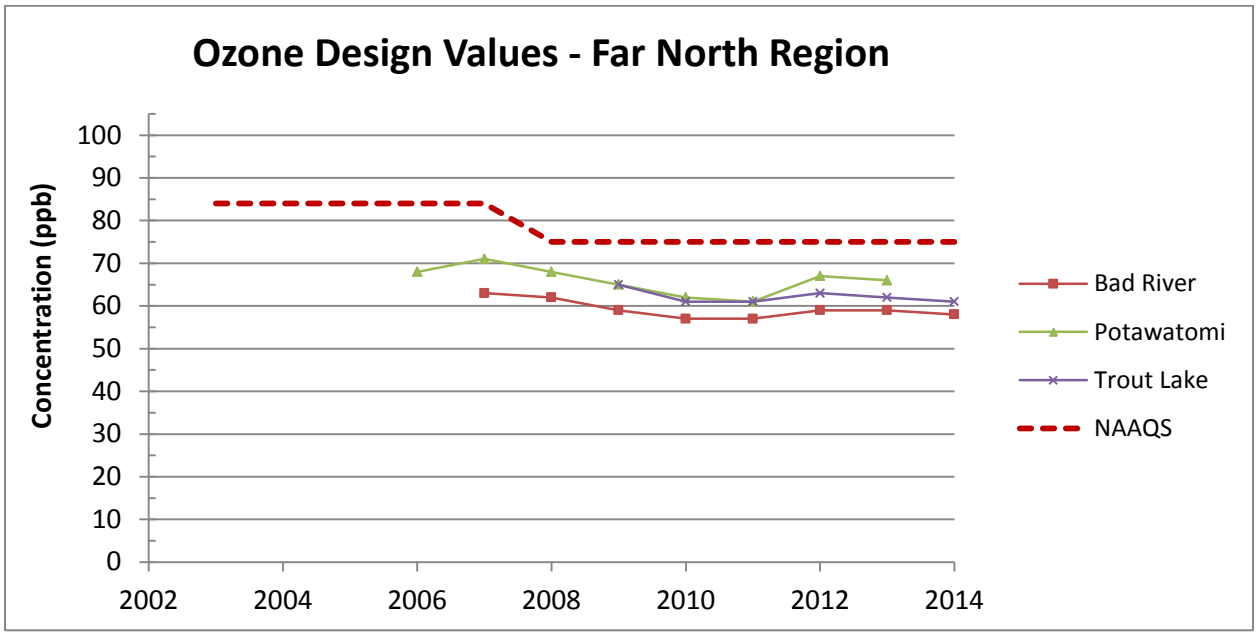


Figure 6. Ozone design values for Far North region, 2003 - 2014. Note that the standard was lowered from 84 ppb to 75 ppb in 2008.

Fine Particles ($PM_{2.5}$)

The WDNR maintains a robust network of fine particle ($PM_{2.5}$) monitoring sites throughout the state and currently measures attainment of the annual and 24-hour standards at all sites. Fine particulate matter may be transported long distances and may affect air quality over large geographical areas. The pollutant's ambient concentrations are strongly influenced by weather, so it is possible to forecast conditions. Local topography may also influence particulate patterns. Specifically, low-lying areas may exhibit elevated particulate levels during a period of localized air stagnation.

To highlight geographic trends in $PM_{2.5}$ concentrations, design values are grouped by the following regions:

1) Southeast
2) Inland
3) Far North

Figure 7 shows annual $PM_{2.5}$ design values for the period 2012 to 2014, while Figure 8 shows 24-hour design values for the same period. For both sets of design values, the highest values were observed in the Milwaukee and Madison areas, though no sites exceeded either standard.

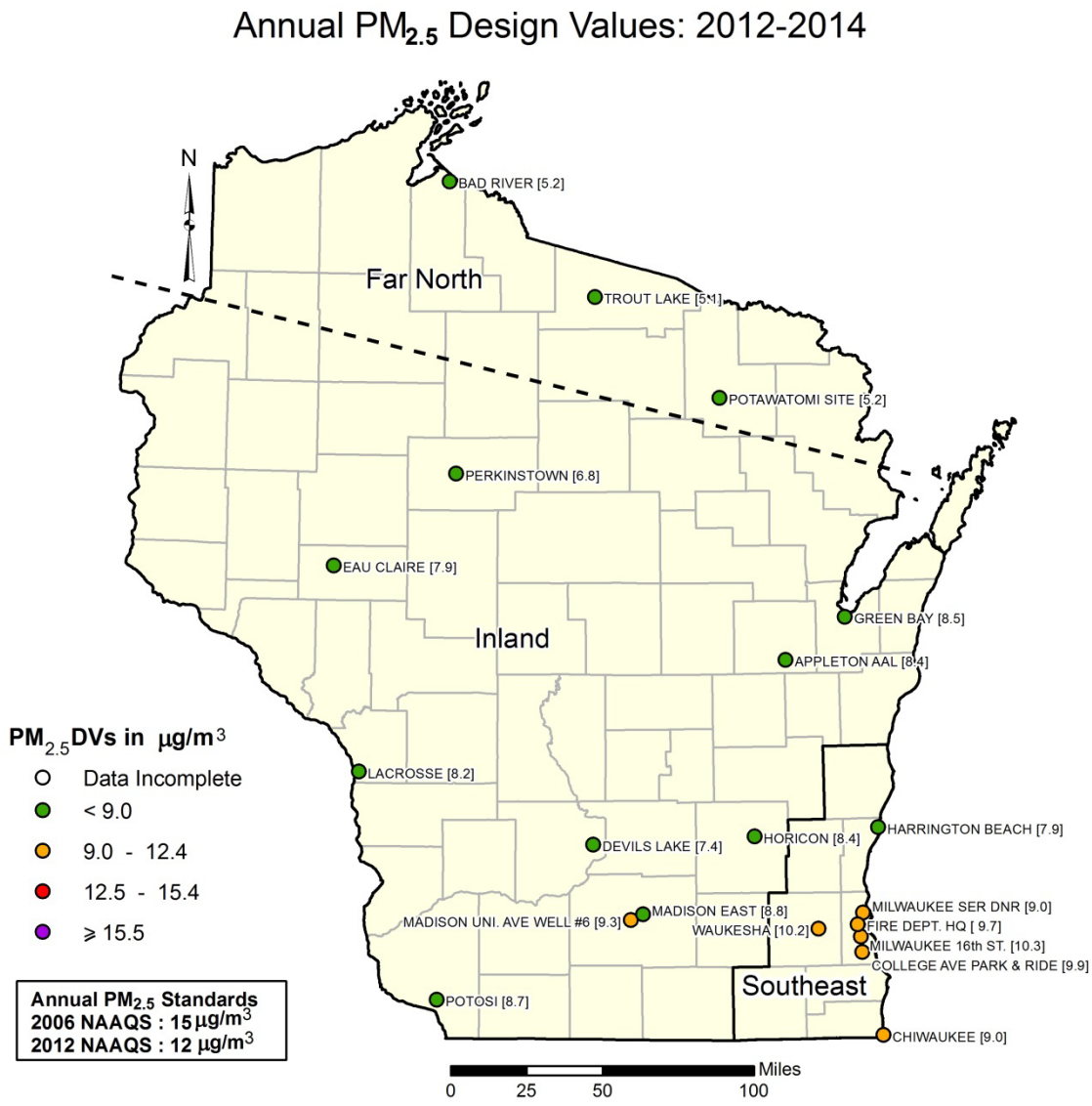


Figure 7. Annual $PM_{2.5}$ design values for each monitoring site based on data from 2012 to 2014. The NAAQS is 12 µg/m^3. Note that the Far North region includes the three sites shown, but its boundaries are not clearly defined.

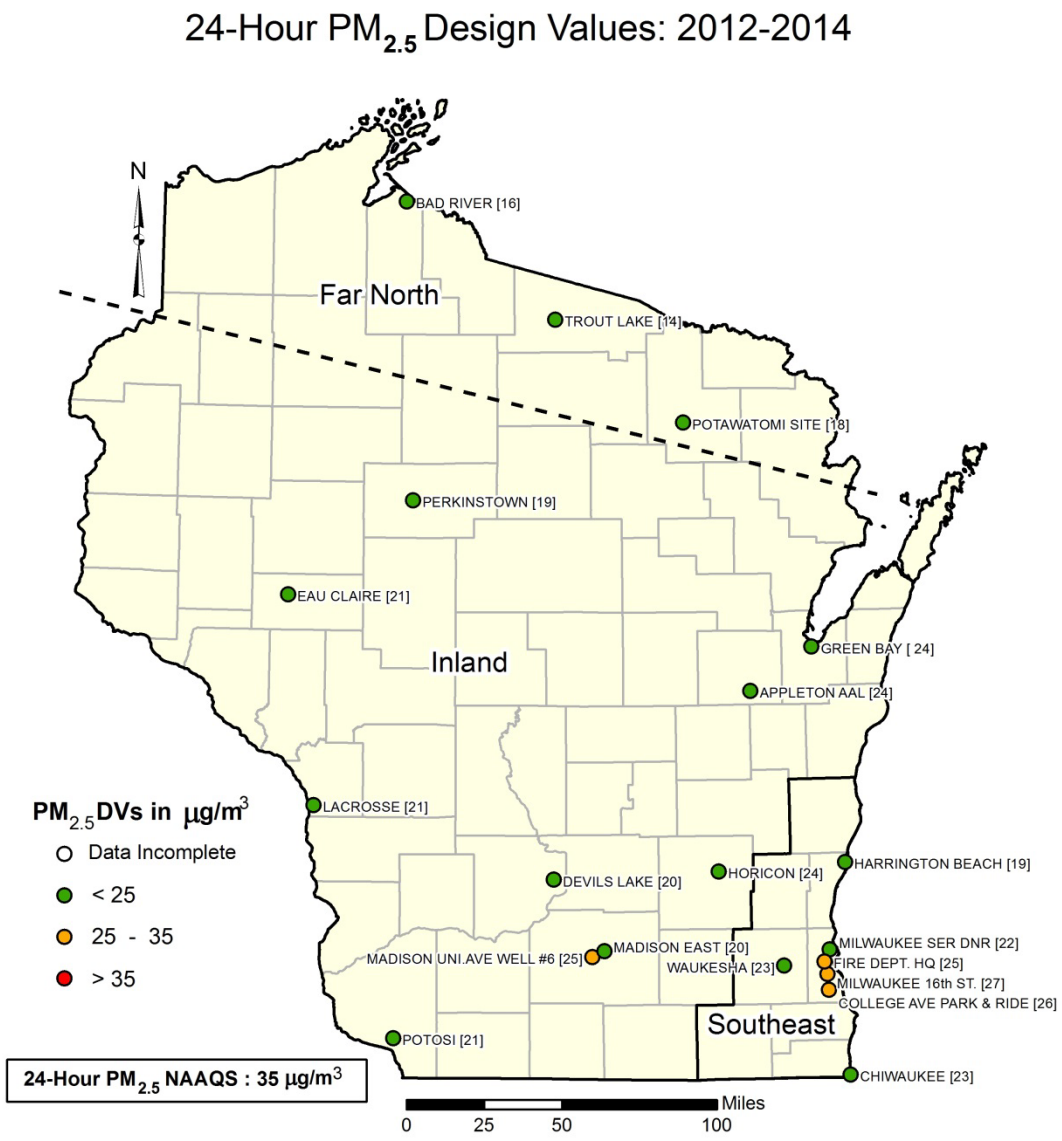


Figure 8. The 24-hour $PM_{2.5}$ design values for each monitoring site based on data from 2012 to 2014. The NAAQS is 35 µg/m^3. Note that the Far North region includes the three sites shown, but its boundaries are not clearly defined.

Figure 9 shows annual and 24-hour design values for six of the seven monitoring sites in the Southeast region over the period 2001 to 2014. Design values are reported starting in 2004 for the Harrington Beach site. No values are shown for the Milwaukee College Avenue site because there were insufficient data due to a combination of invalid design values for some years and no data from 2010 and 2011 when monitoring at this site was paused.

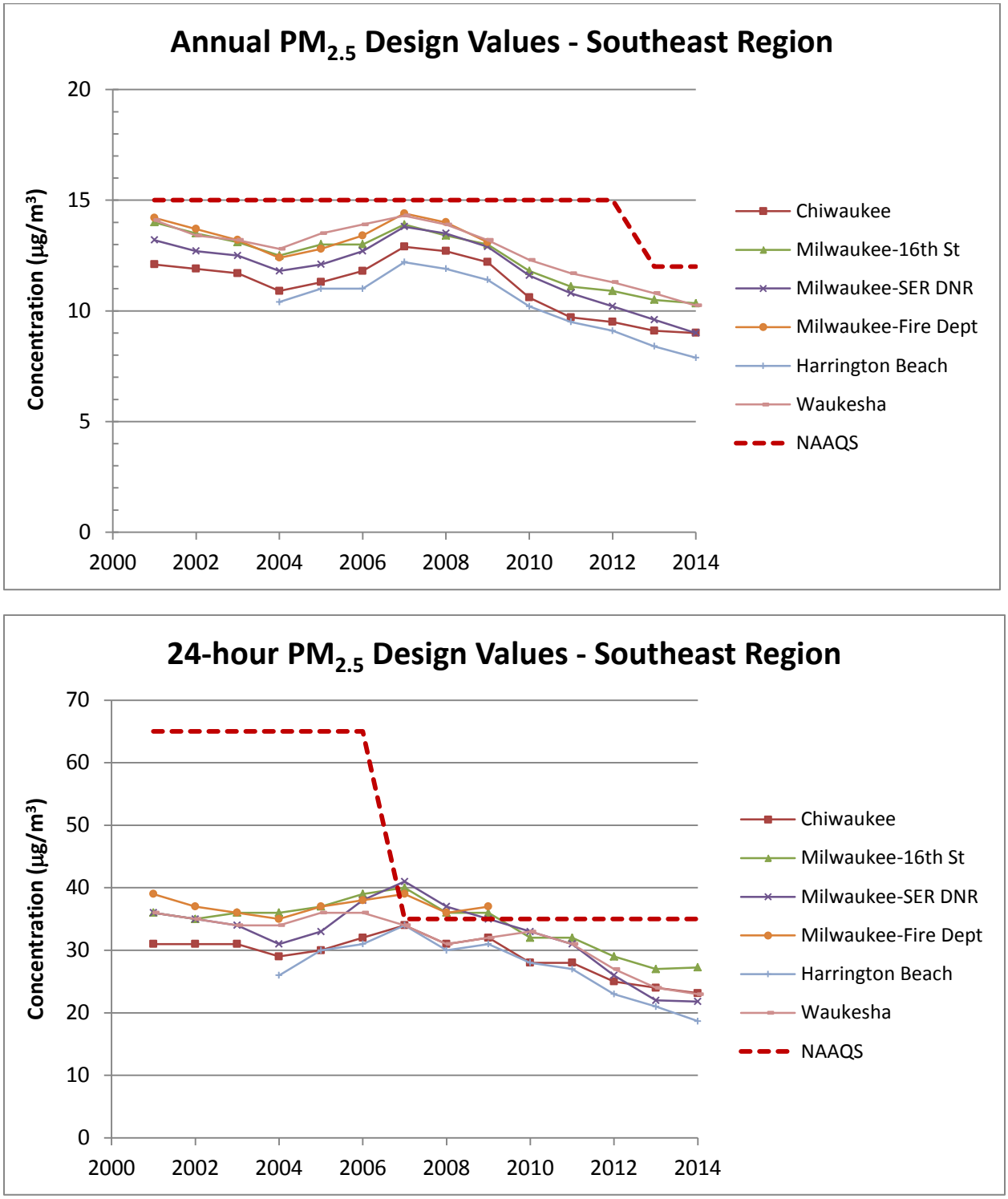


Figure 9. Annual (top) and 24-hour (bottom) $PM_{2.5}$ design values in the Southeast region for the period 2001 to 2014. Note that the annual standard was lowered from 15 to 12 µg/m^3 in 2013, and the 24-hour standard was lowered from 65 to 35 µg/m^3 in 2006.

The relationships between design values at different sites were relatively consistent for both the annual and 24-hour design values. For both metrics, monitoring sites measured a steady decrease in concentrations over the past seven years, generally reaching the lowest overall concentrations in 2014.

The Harrington Beach site generally had the lowest annual and 24-hour design values. The Waukesha site generally recorded the highest annual value, and the Milwaukee 16th St. Health Center site often measured the highest 24-hour design values.

While none of the sites ever measured an annual design value exceeding the relevant NAAQS (the 2006 annual standard of 15 μg/m^3 or the 2012 annual standard of 12 μg/m^3), the decrease in the 24-hour standard from 65 to 35 μg/m^3 in 2006 resulted in design values at some sites exceeding the standard during subsequent years.

Figure 10 shows annual and 24-hour design values for the eight monitoring sites in the Inland region over the period 2001 to 2014. Similar to the Southeastern region, the relationships between annual design values at different sites in the Inland region were consistent over time. The annual design values decreased consistently at all sites after 2008. The lowest annual design values in this region were observed at the Perkinstown site in Taylor County.

Trends over time were less consistent across sites for the 24-hour design values prior to 2008, and the values generally decreased after 2008. Immediately after the lower standard went into effect in 2007, the Green Bay East and Madison University sites measured exceedances of the NAAQS, though no sites did in subsequent years.

Figure 11 shows annual and 24-hour design values for the three monitoring sites in the Far North region over the period 2001 to 2014, though values are not reported for the Bad River and Potawatomi sites until 2004 and 2006, respectively. Sites in this region showed the lowest concentrations of particle pollution in the state, and the annual design values decreased consistently after 2008. Agreement between sites was much stronger for the annual design values than the 24-hour values.

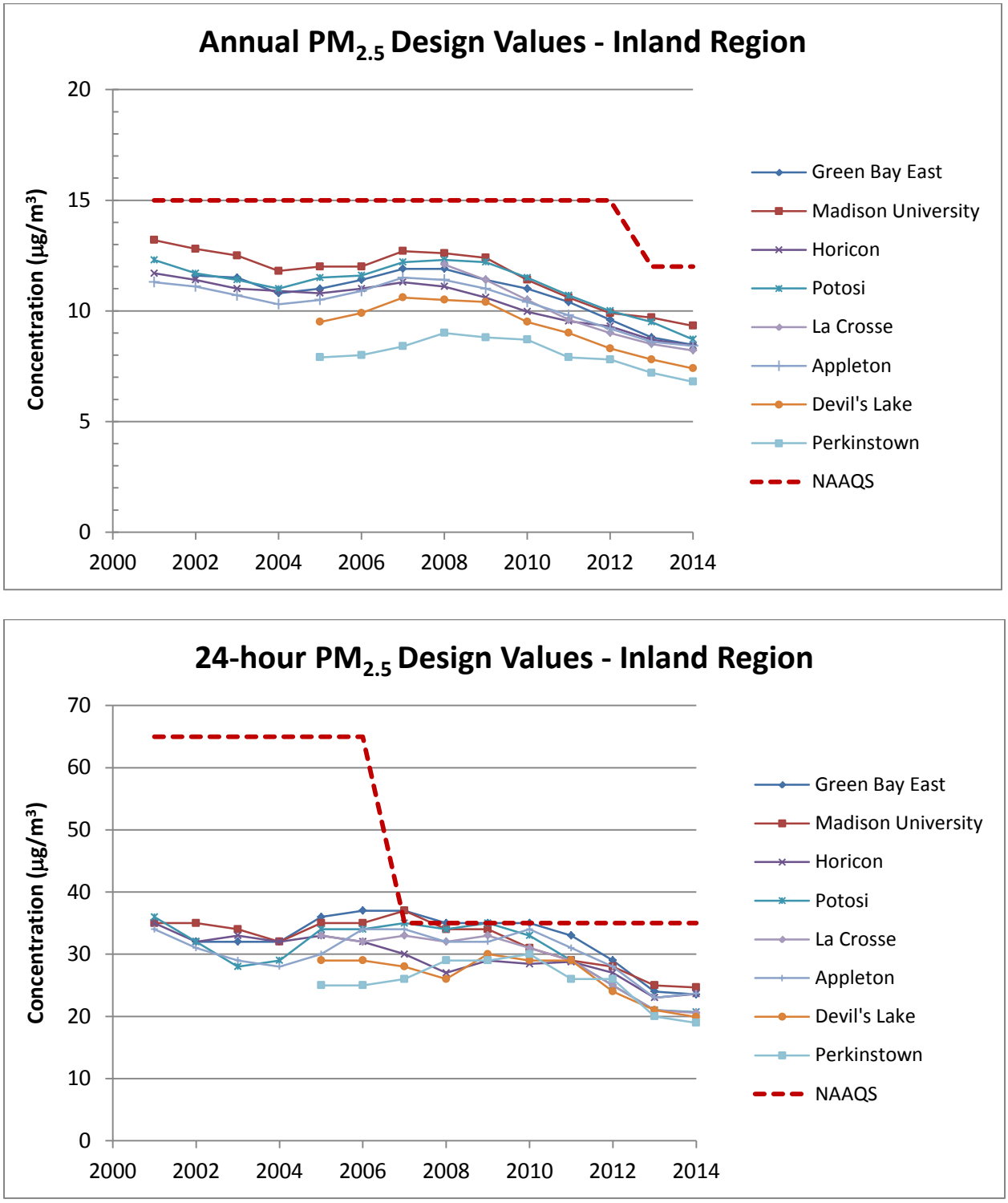


Figure 10. Annual (top) and 24-hour (bottom) $PM_{2.5}$ design values in the Inland region for the period 2001 to 2013. Note that the annual standard was lowered from 15 to 12 µg/m³ in 2013, and the 24-hour standard was lowered from 65 to 35 µg/m³ in 2006.

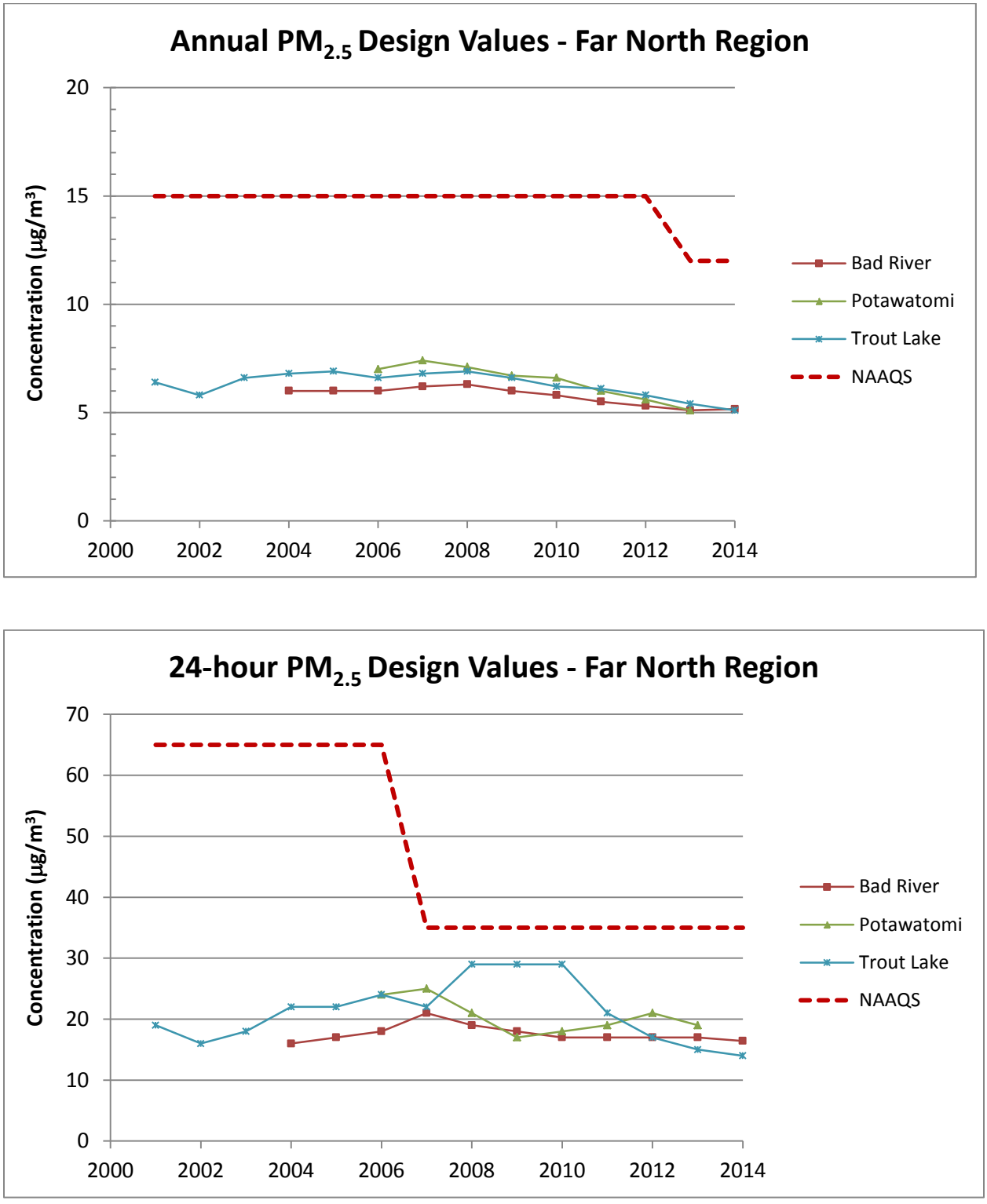


Figure 11. Annual (top) and 24-hour (bottom) $PM_{2.5}$ design values in the Far North region for the period 2001 to 2014. Note that the annual standard was lowered from 15 to 12 µg/m^3 in 2013, and the 24-hour standard was lowered from 65 to 35 µg/m^3 in 2006.

Inhalable Coarse Particles (PM_{10})

Inhalable coarse particles are monitored at seven sites in the WDNR network (Figure 12) which includes both filter-based and continuous monitors. Values shown in the map below are the maximum daily averages from 2014 which contribute to the determination of the PM_{10} design value. The highest PM_{10} concentrations are measured in urban areas.

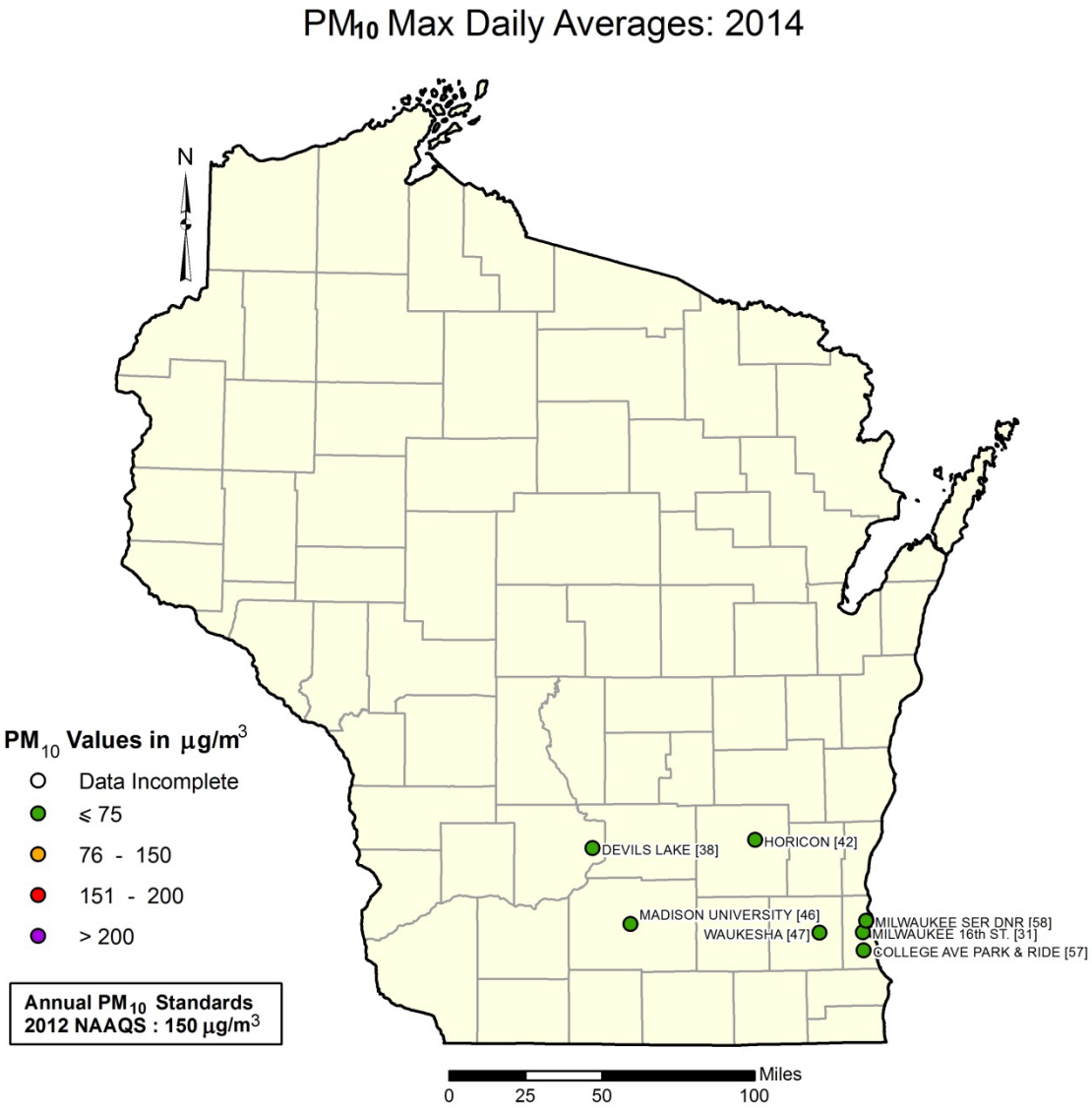


Figure 12. Maximum daily averages of PM_{10} in 2014.

Figure 13 shows maximum daily averages for each PM_{10} monitoring site for the period 2001 to 2014. These maxima are compared to the NAAQS. The standard is violated at a site if the daily average PM_{10} values at that site exceed the standard, 150 µg/m^3, more than once per year on average over three years. Concentrations of PM_{10} generally decreased over time, although values were somewhat variable. Annual daily maxima for all sites fell well below the NAAQS.

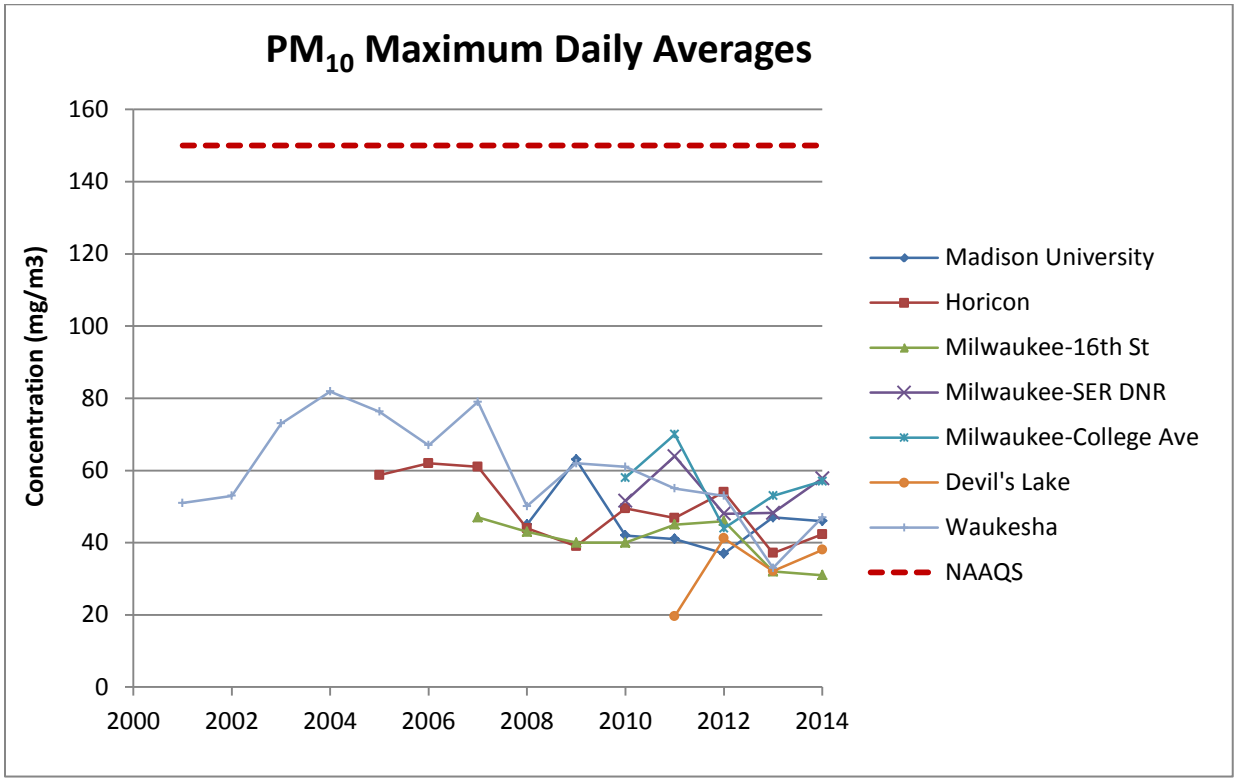


Figure 13. Maximum 24-hour averages of PM_{10} for the period 2001 to 2014.

Some industrial sources in Wisconsin have a requirement in their permit to monitor for particulate matter. The majority of the industrial sources in Wisconsin with such a requirement are industrial sand facilities monitoring for PM_{10}. The WDNR quality assures this data and places it on a webpage for viewing (http://dnr.wi.gov/topic/Mines/AQSandMap.html).

Sulfur Dioxide (SO_2)

The WDNR operates six sites that measure sulfur dioxide (SO_2), as shown in Figure 14 along with annual design values. These data are compared against the hourly NAAQS of 75 ppb. In Wisconsin, most SO_2 is produced from combustion at power plants and industrial boilers, while secondary sources include industrial processes such as pulp and paper production.

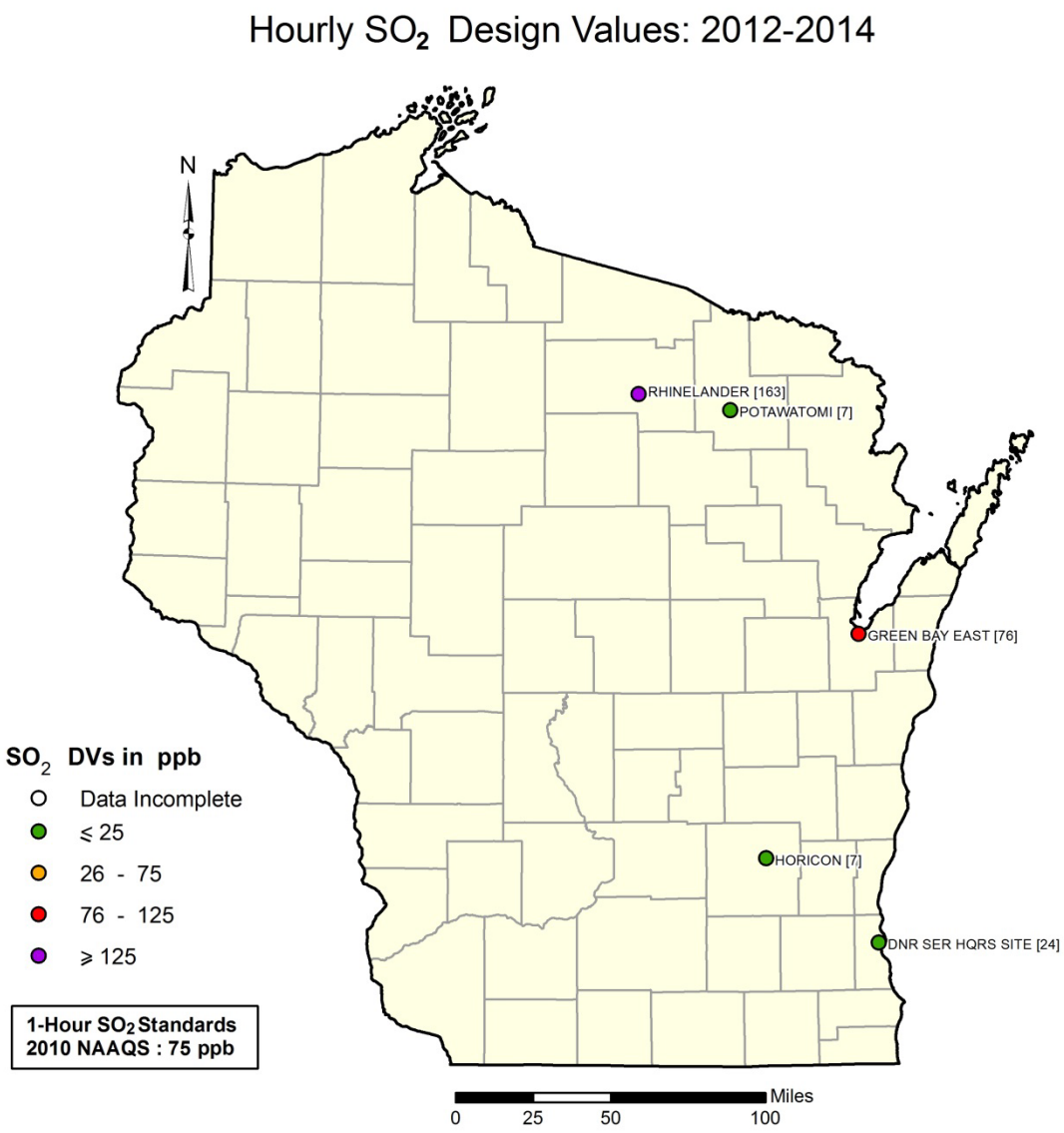


Figure 14. Hourly SO_2 design values for each monitoring site based on data from 2012 to 2014.

Figure 15 shows hourly design values for SO_2 since 2004 at five of the six monitoring sites where data are available. The Madison East monitoring site in Dane County is not shown because it began monitoring in 2013, and thus has not collected sufficient data to calculate a 3-year design value.

It is important to note that the annual and 24-hour SO_2 standards were replaced with an hourly standard in 2010. To provide a clearer picture of trends in SO_2 concentrations over time, hourly design values were calculated for years prior to 2010, even though the design values preceding 2010 were not used to assess NAAQS compliance.

Very low concentrations of SO_2 were generally observed at the Horicon and Potawatomi sites. In 2013 and 2014 low concentrations were seen at the Milwaukee SER HQ site as well. Design values from the Green Bay East site were all close to the 2010 hourly NAAQS and just exceeded the standard in 2014 with a design value of 76 ppb. The Rhinelander site design values have exceeded the NAAQS since the

site was established, and as a result, a portion of Oneida County is in nonattainment for the 2010 SO_2 standard.

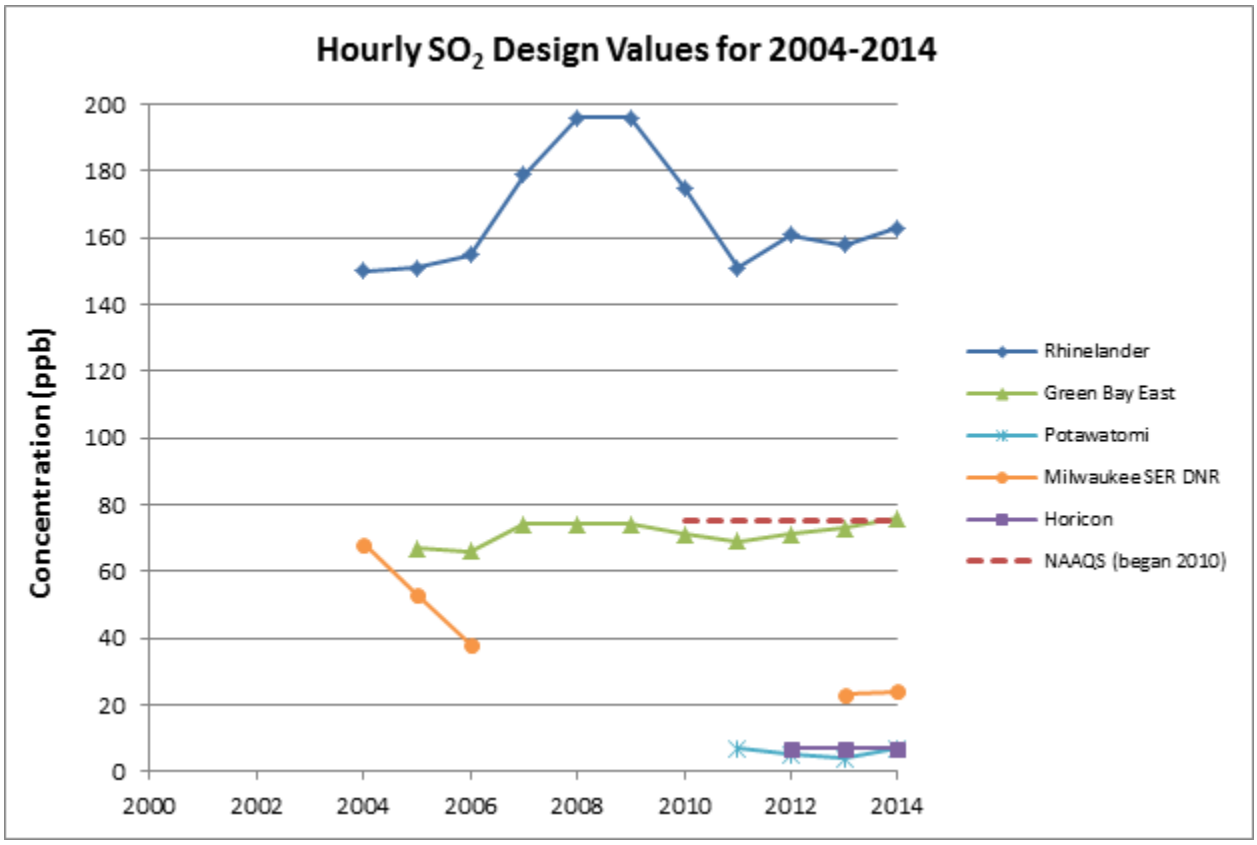


Figure 15. Hourly SO_2 design values for the period 2004 to 2014. Note that the 75 ppb hourly NAAQS was established in 2010, replacing the annual and 24-hour standards.

Nitrogen Dioxide (NO_2)

Three sites measure nitrogen dioxide (NO_2) in the WDNR network and design values are compared against annual and hourly NAAQS. Figures 16 and 17 show monitoring sites for NO_2, along with annual and hourly design values, respectively. Nitrogen dioxide is emitted by all combustion sources, including vehicles, home and commercial heating systems, and power plants.

WDNR also monitors NO_2 at the Manitowoc site during the summer months (June-August) as part of the Photochemical Assessment Monitoring Stations (PAMS) network. However, because of the shorter monitoring period, these values cannot be used to determine compliance with the NAAQS and thus are not included in this document.

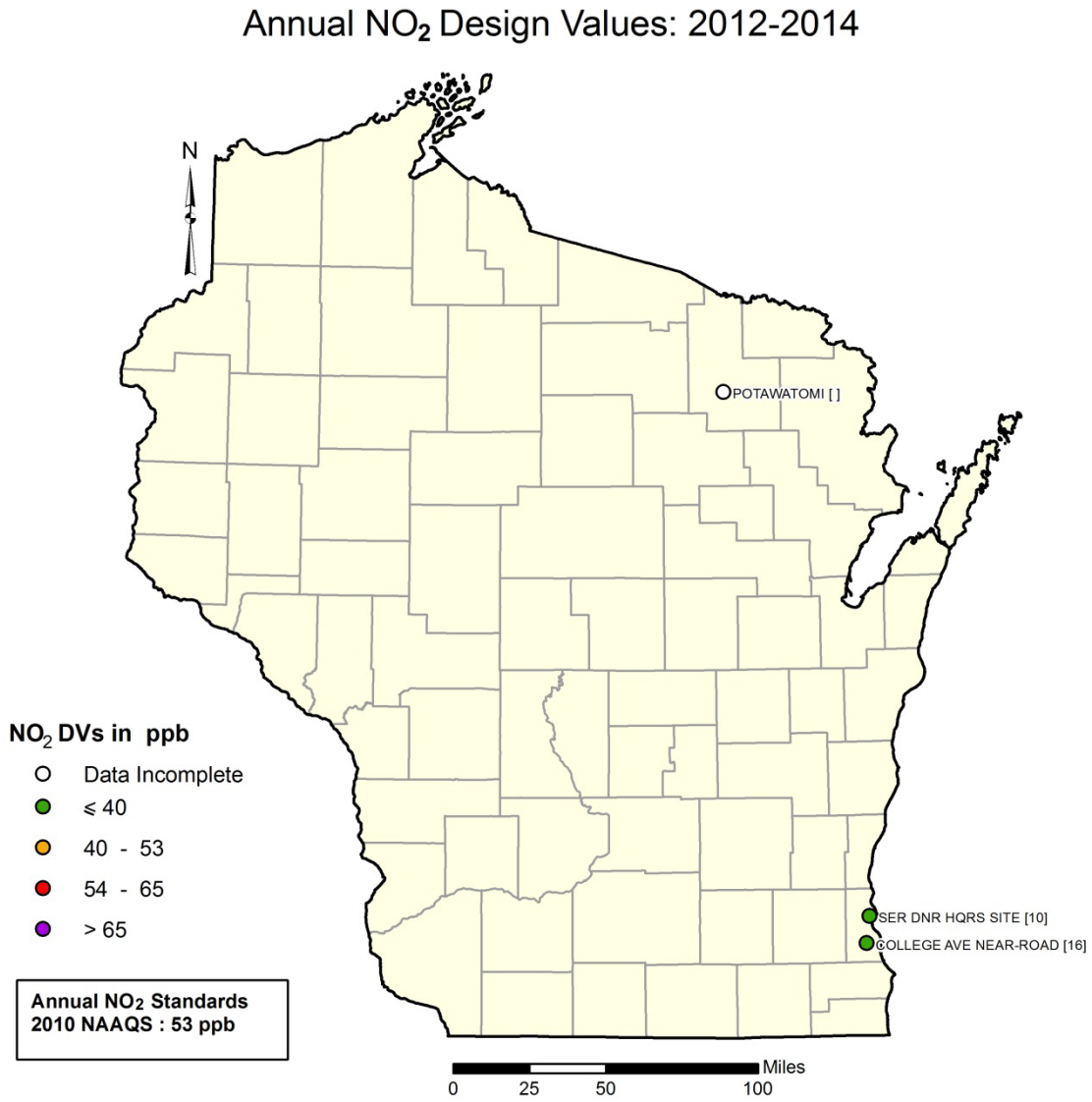


Figure 16. Annual NO_2 design values for each monitoring site based on data from 2012 to 2014.

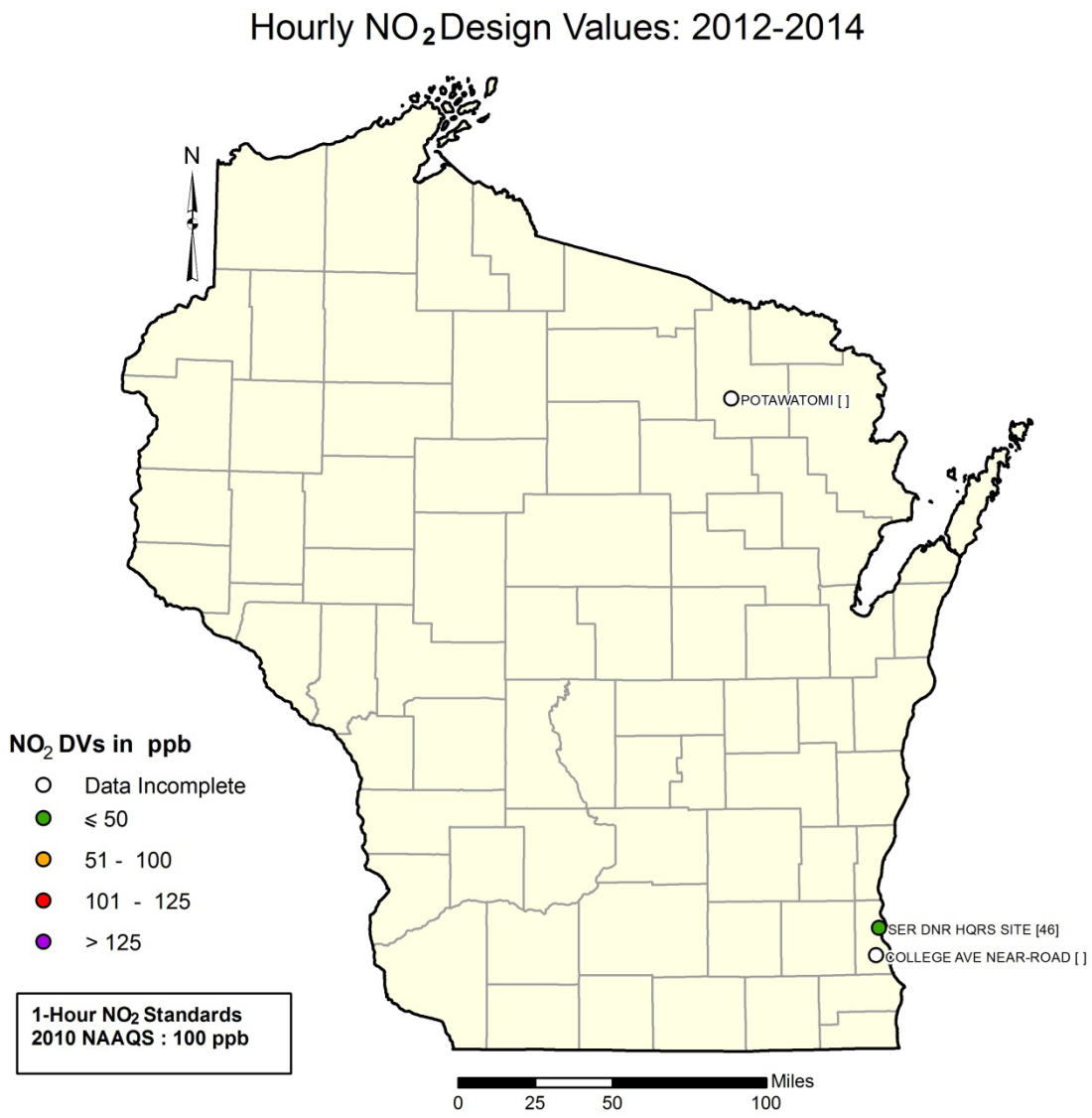
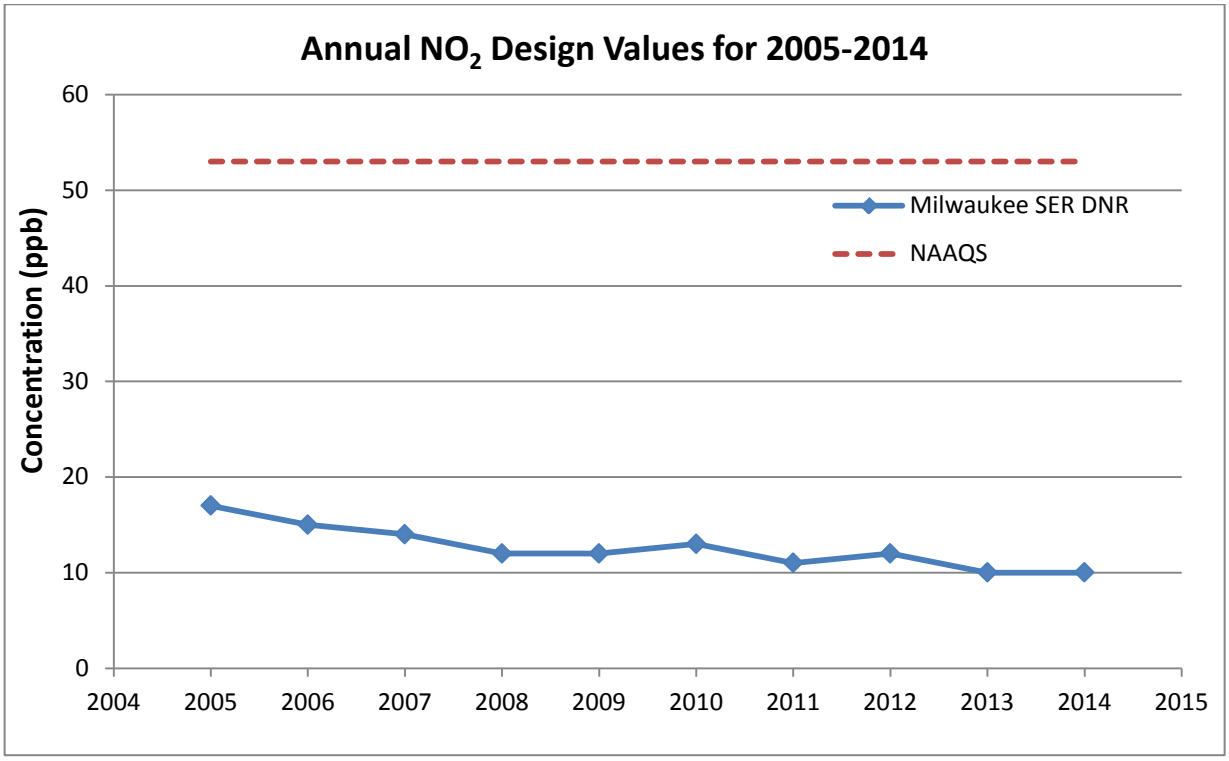


Figure 17. Hourly NO_2 design values for each monitoring site based on data from 2012 to 2014.

Figure 18 shows annual and hourly NO_2 design values for the Milwaukee SER site. The Milwaukee College Ave – NR site is not included because it only began monitoring in 2014, and values for Potawatomi are not shown because this site only had two valid design values (2012 and 2013).

Monitored levels of NO_2 were very low, and the annual design values at the Milwaukee SER site decreased over time. Hourly design values remained steady for the past few years at Milwaukee SER.



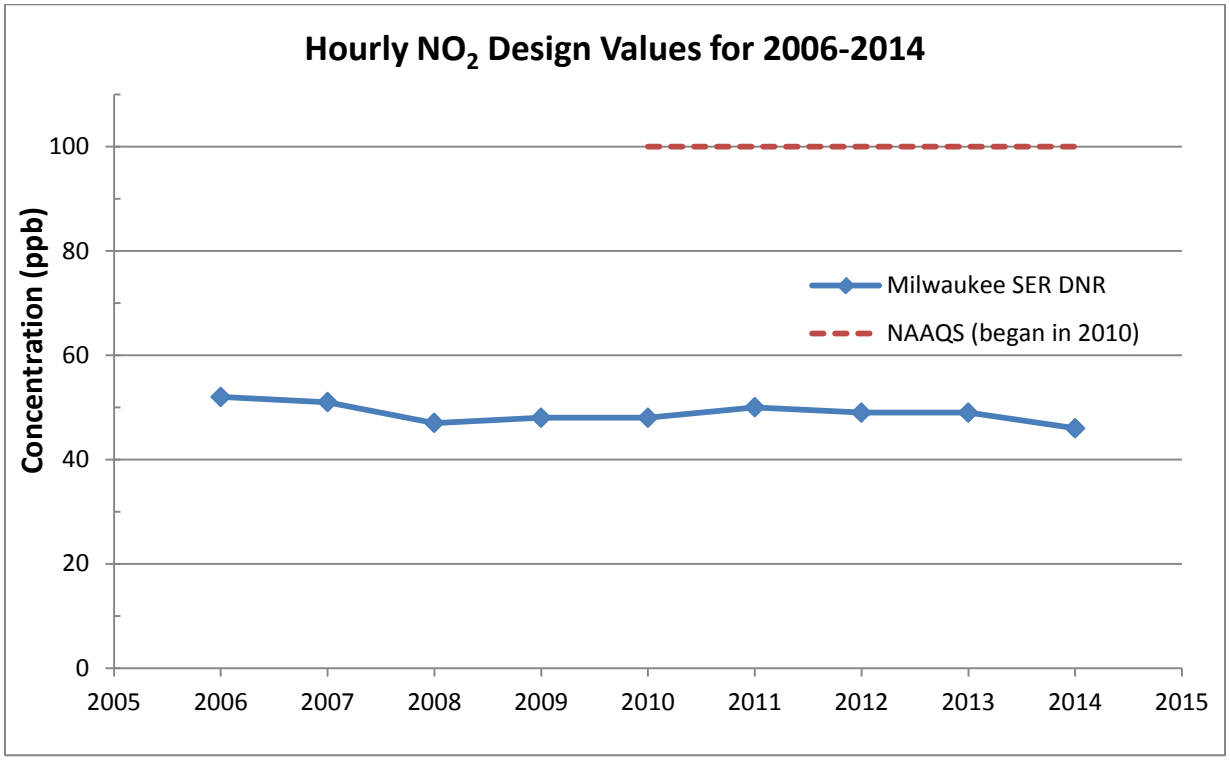


Figure 18. Annual (top) and hourly (bottom) design values for NO_2 for the period 2004 to 2014.

Lead

By federal rule, lead is measured for comparison to the NAAQS at the Kohler monitoring site in Sheboygan County (Figure 19). Lead is emitted primarily as the result of industrial processes such as metallic processing, power plants, and waste incinerators. The NAAQS is based on a rolling 3-month average, which is not to exceed 0.15 µg/m^3, and the design value is expressed as the maximum 3-month average over a 3-year period. All 3-month average values at the Kohler site meet the lead NAAQS. While the design value for Kohler could be computed for 2014 (Figure 19), values from previous years were not valid. As a result, we do not show a trend line for this site.

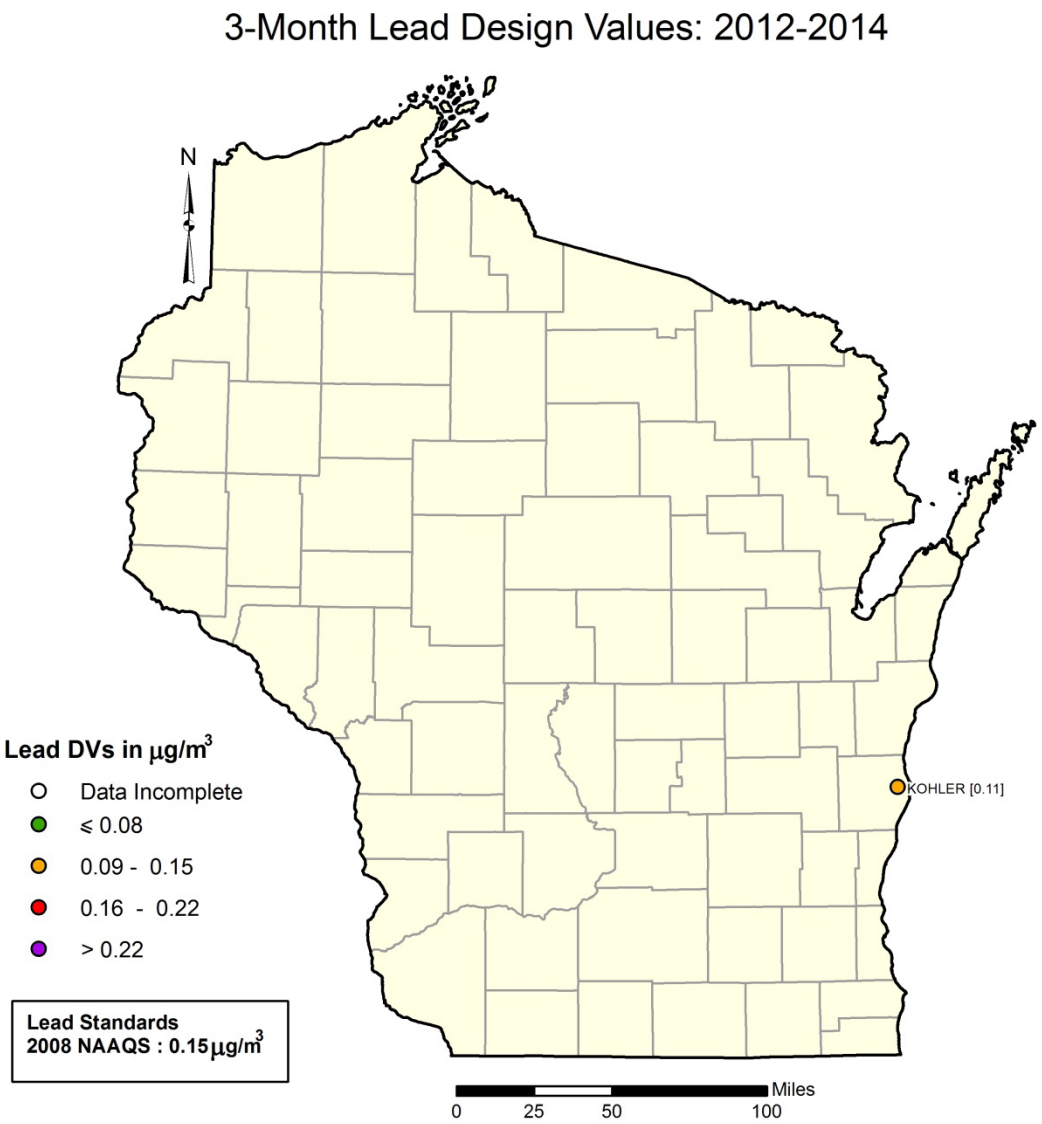


Figure 19. Three-month lead design values for each monitoring site based on data from 2012 to 2014.

The WDNR also monitors lead at the Horicon and Milwaukee 16th Avenue Health Center sites as part of the National Air Toxics Trends Stations (NATTS) network. The fraction of particulate matter monitored for lead at the NATTS sites (i.e., PM_{10}), however, differs from that required for lead criteria pollutant

monitoring (i.e., total suspended particles, TSP). As a result of this difference, the NATTS lead data cannot be used to determine compliance with the NAAQS and are not included in this document.

Carbon Monoxide (CO)

Carbon monoxide (CO) is monitored at two sites in the WDNR network, and design values are compared against 8-hr and hourly NAAQS (Figures 20 and 21, respectively). The main source of this pollutant is motor vehicle emissions, and as a result, higher concentrations will be observed in urban areas. Nationwide, levels of CO have decreased over the past two decades with the help of emission control technologies, and as a result no areas currently violate federal standards. Standards for CO are expressed in 8-hour and hourly averages.

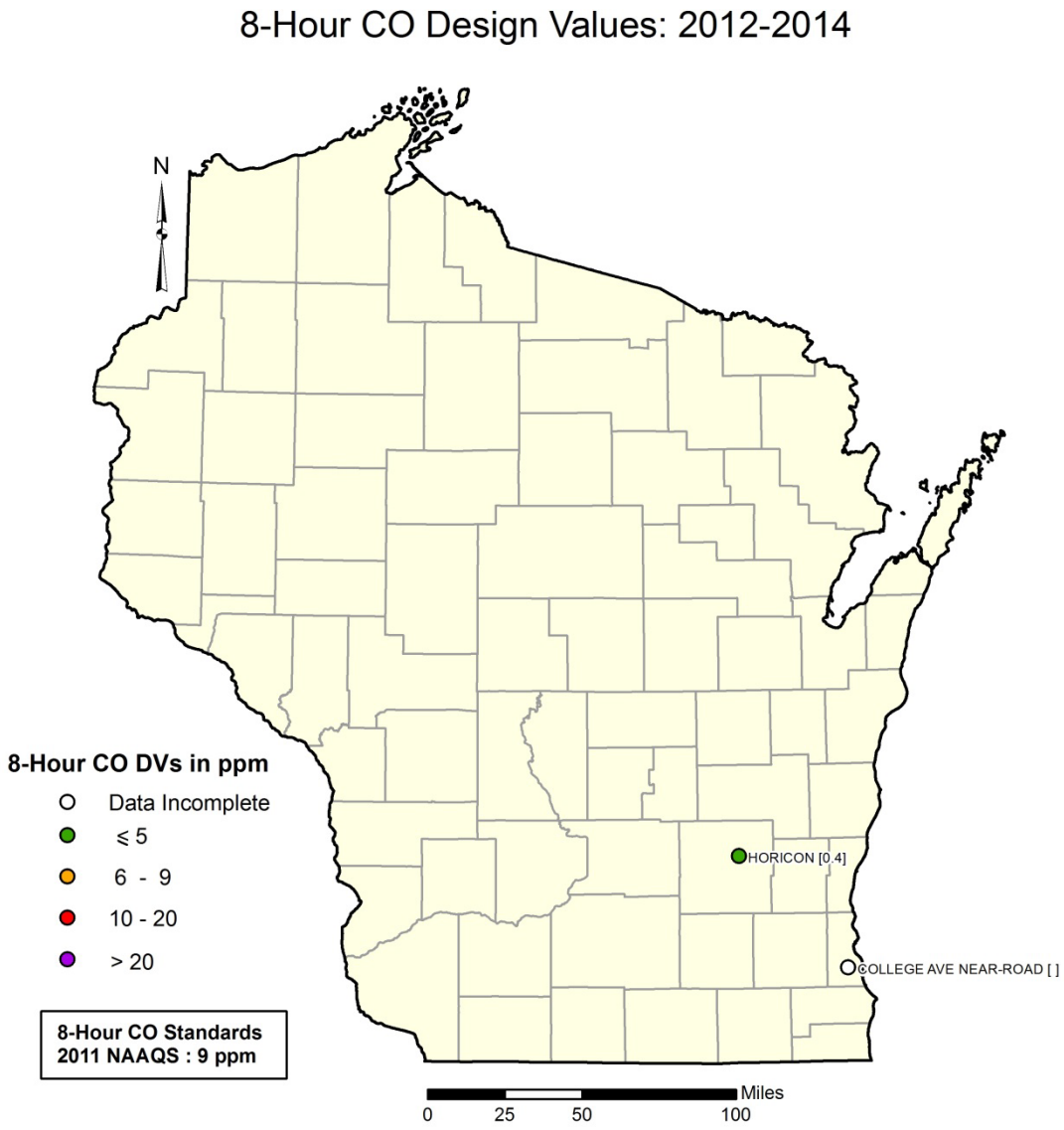


Figure 20. Eight-hour CO design values for each monitoring site based on data from 2012 to 2014

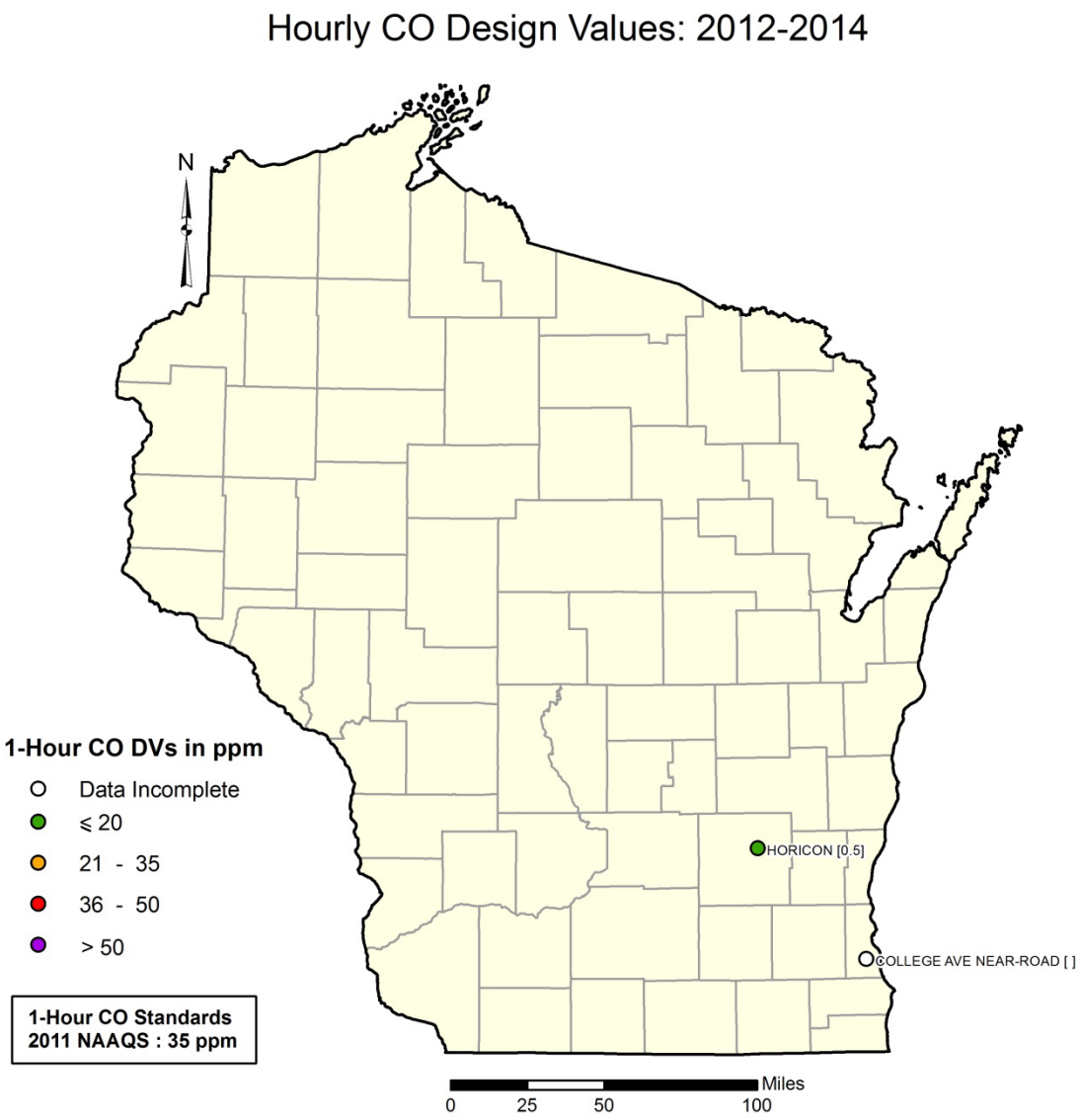


Figure 21. Hourly CO design values for each monitoring site based on data from 2012 to 2014.

Figure 22 shows 8-hr and hourly CO design values at the Horicon monitoring site over the period 2010 to 2014. The values were extremely low, almost indistinguishable from zero. Values from the Milwaukee College Ave – Near Road site are not shown, because the site only began collecting data in 2014, as required by federal rule.

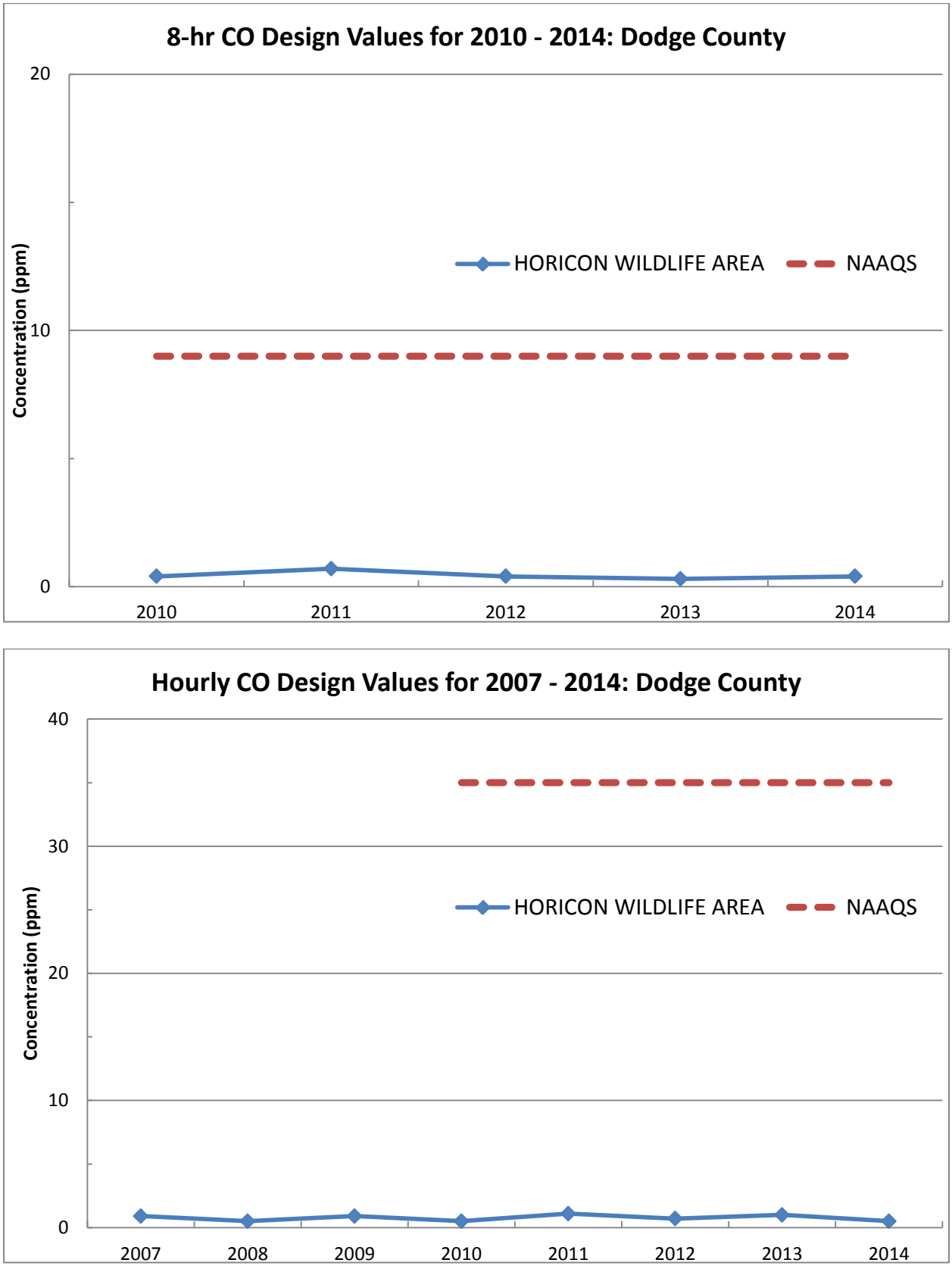
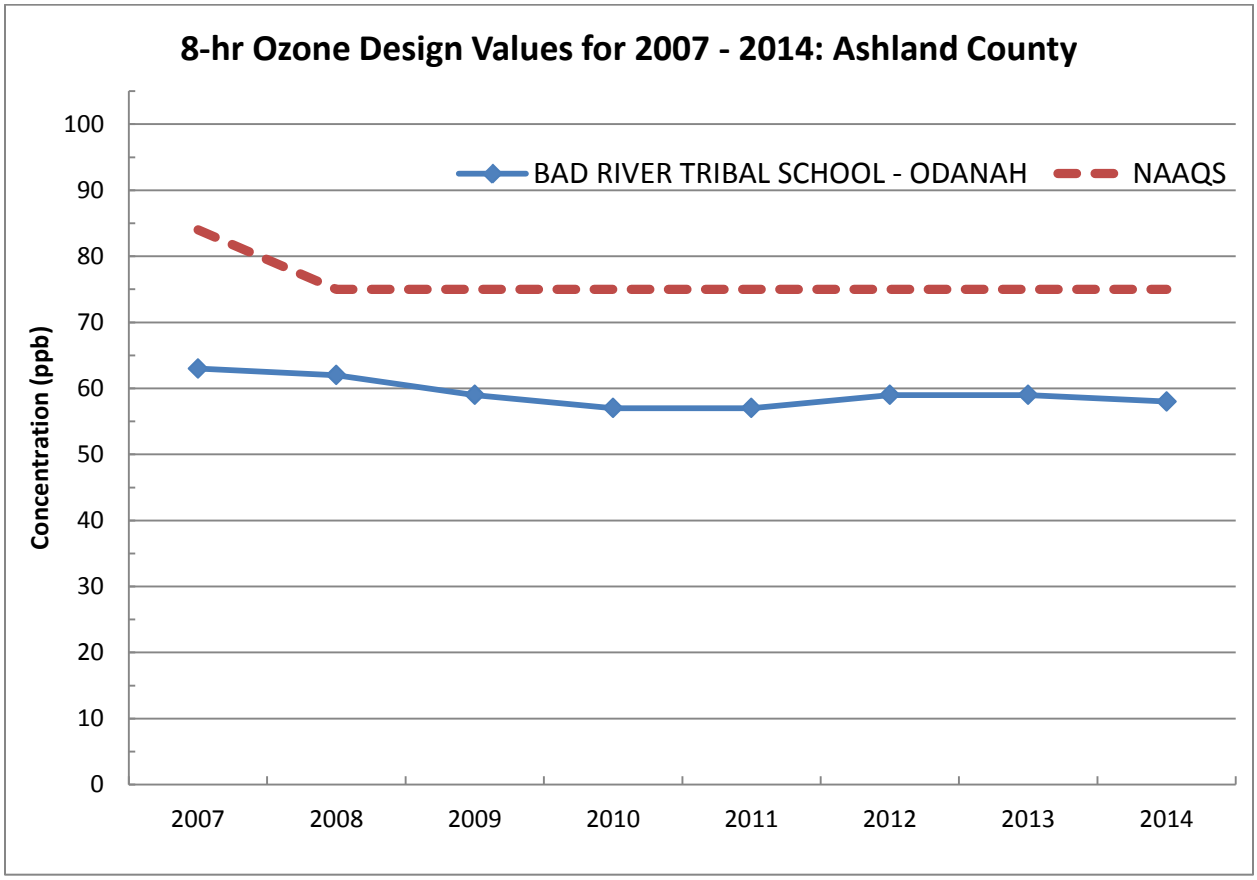


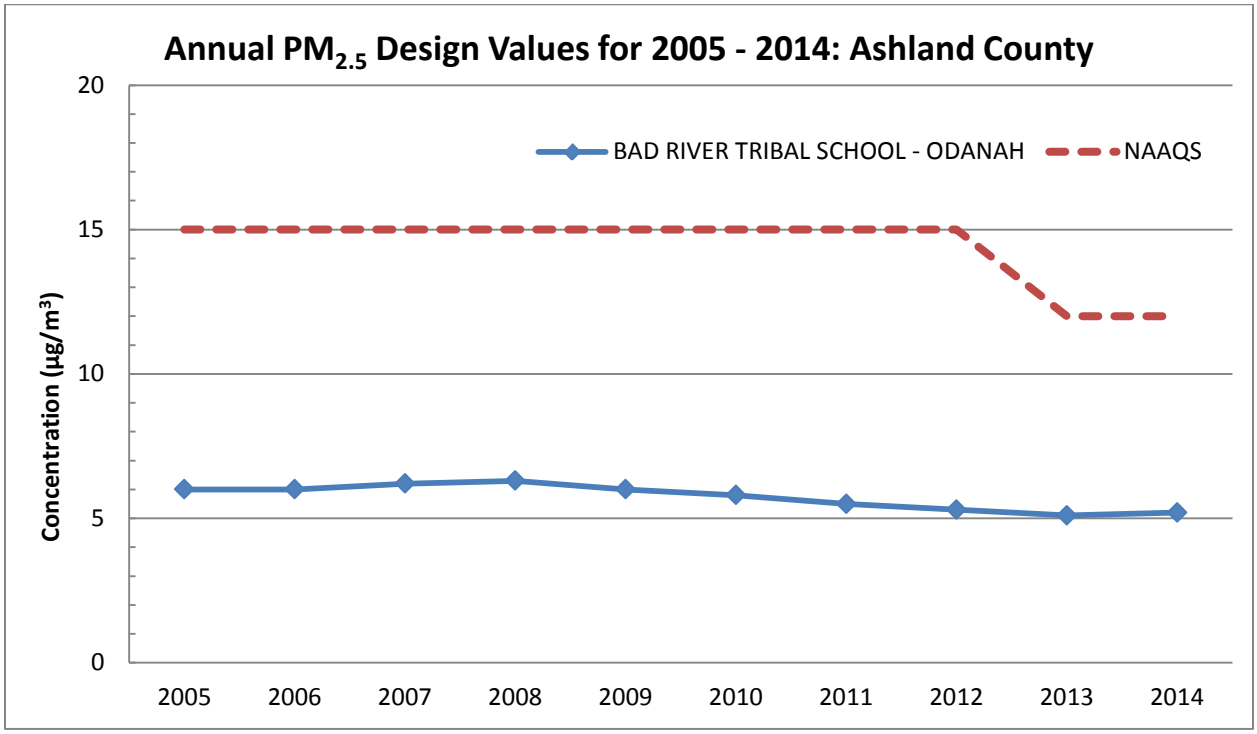
Figure 22. Eight hour (top) and hourly (bottom) design values for CO at the Horicon monitoring site over the periods 2010 to 2014 and 2007 to 2014, respectively.

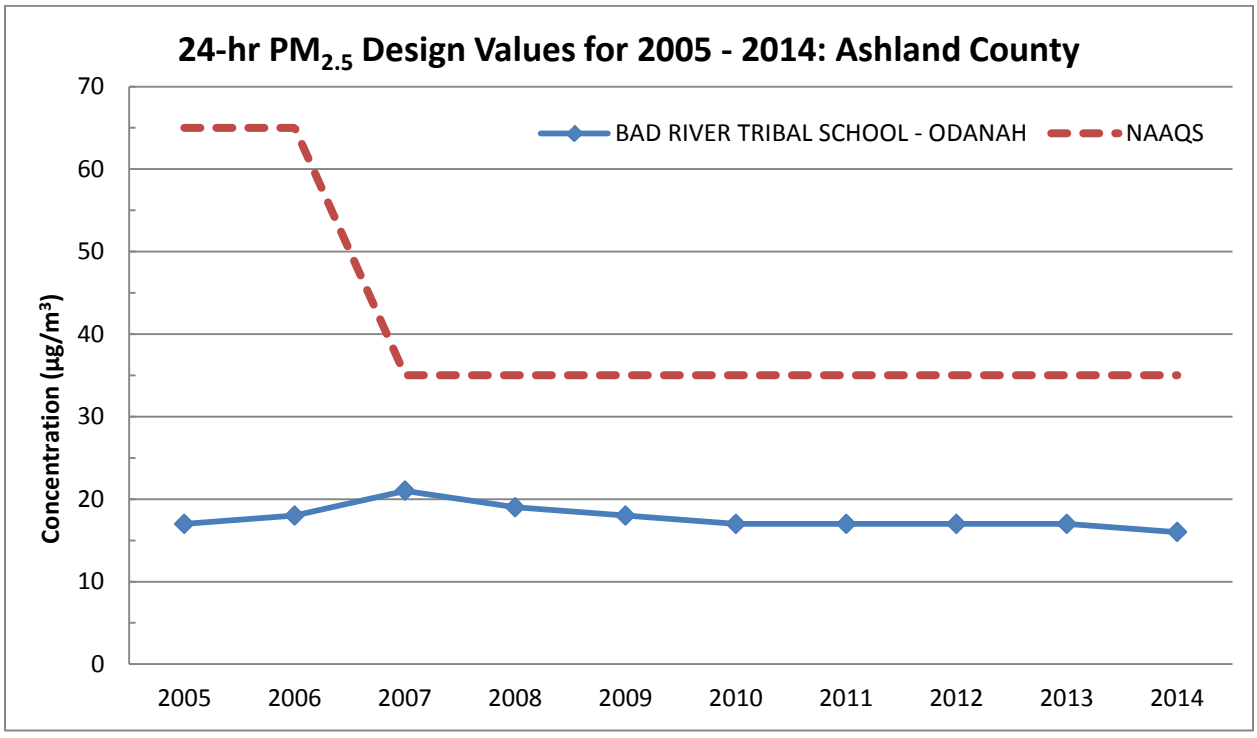
Appendix A. – Air Quality by County

Ashland County

Sampling for ozone and $PM_{2.5}$ is conducted at the Bad River Tribal School in Odanah.

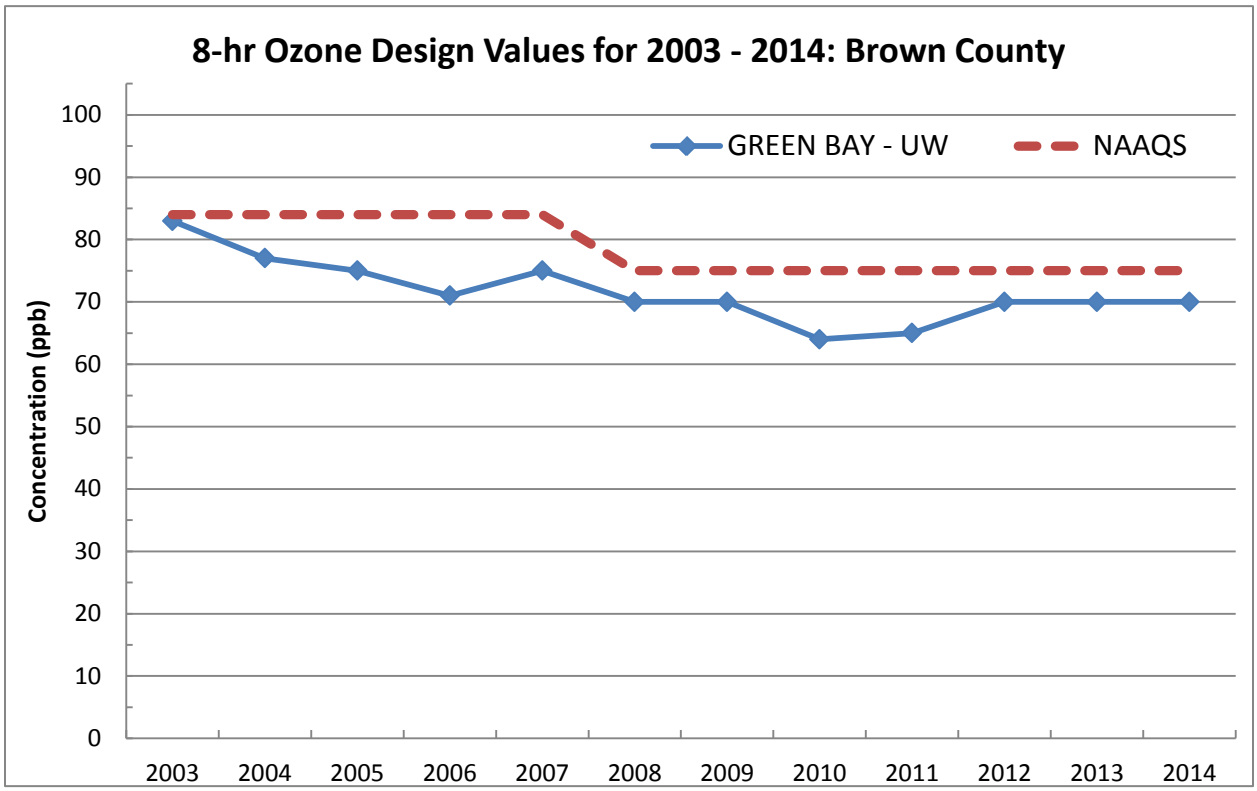


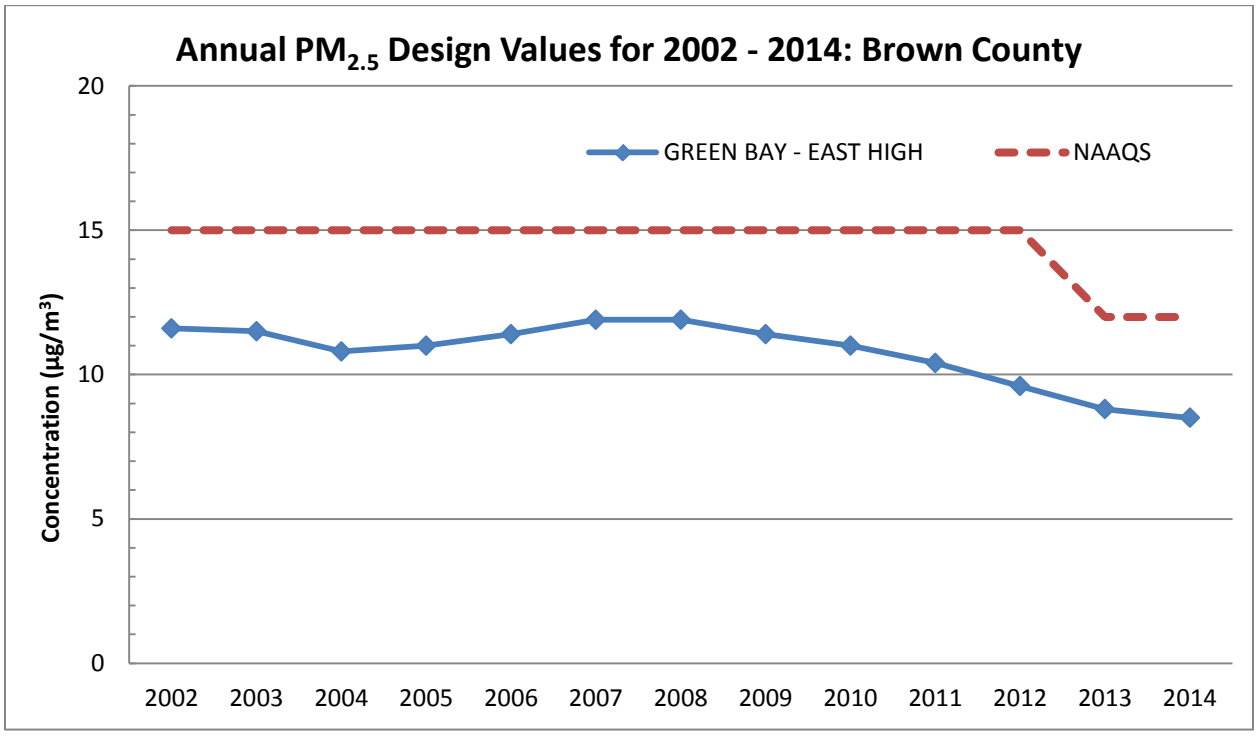

Annual PM2.5 Design Values for 2005 - 2014: Ashland County
BAD RIVER TRIBAL SCHOOL - ODANAH
NAAQS
Concentration (µg/m³)
20
15
10
5
0
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014

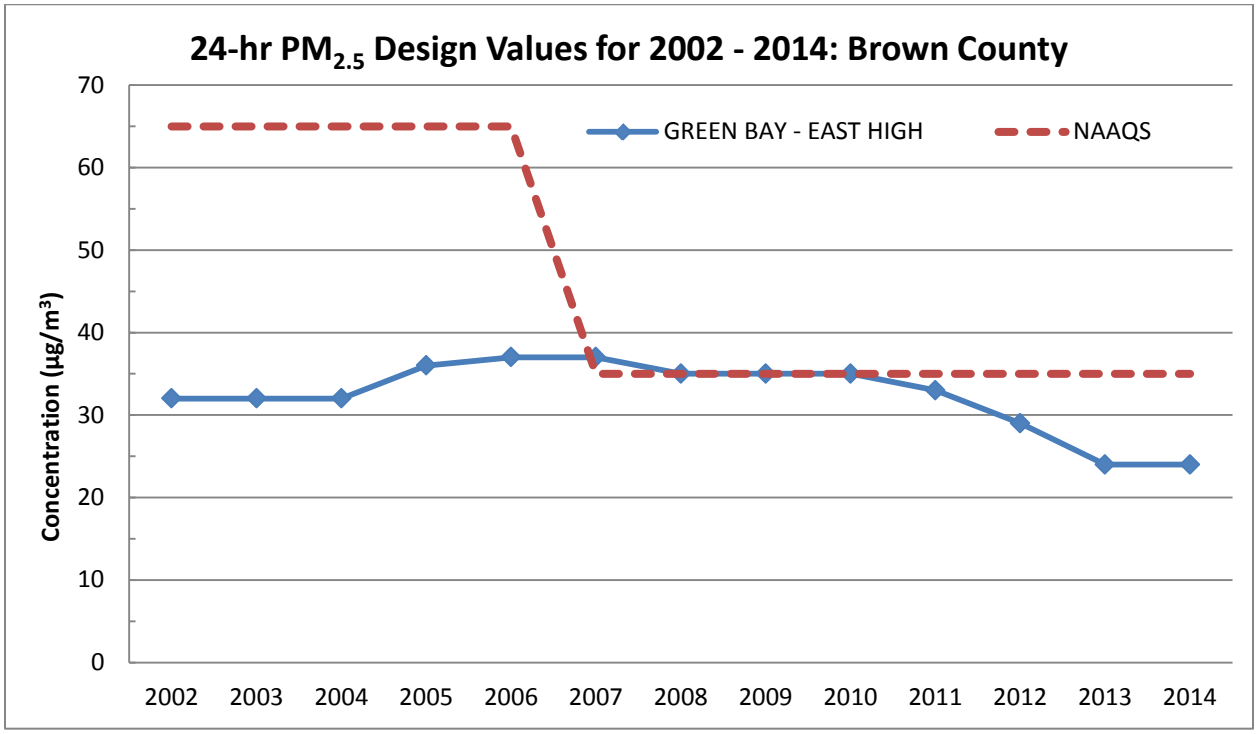

24-hr PM2.5 Design Values for 2005 - 2014: Ashland County
BAD RIVER TRIBAL SCHOOL - ODANAH
NAAQS
Concentration (µg/m³)
70
60
50
40
30
20
10
0
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014

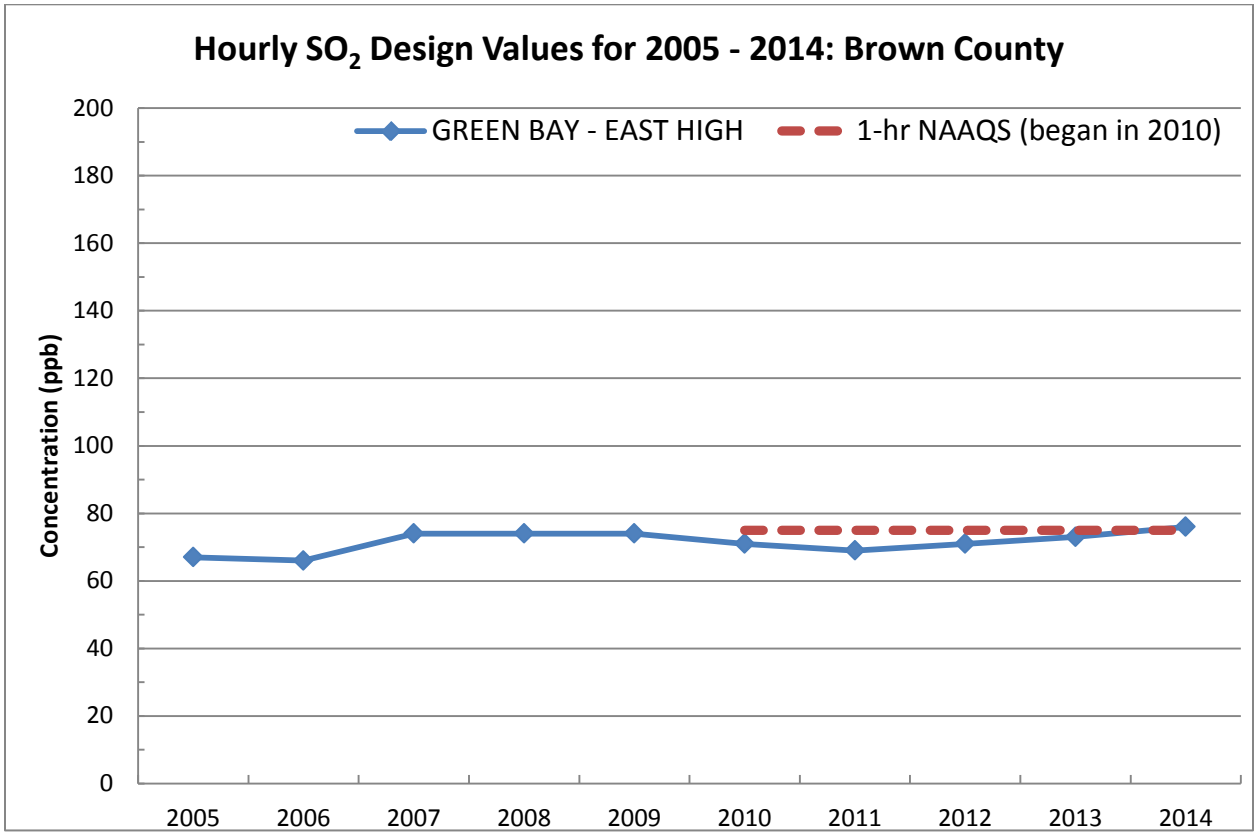
Brown County

Ozone monitoring in Brown County takes place at the University of Wisconsin – Green Bay. Sampling for $PM_{2.5}$ and SO_2 in Brown County is conducted at Green Bay East High School, located at 1415 East Walnut Street.





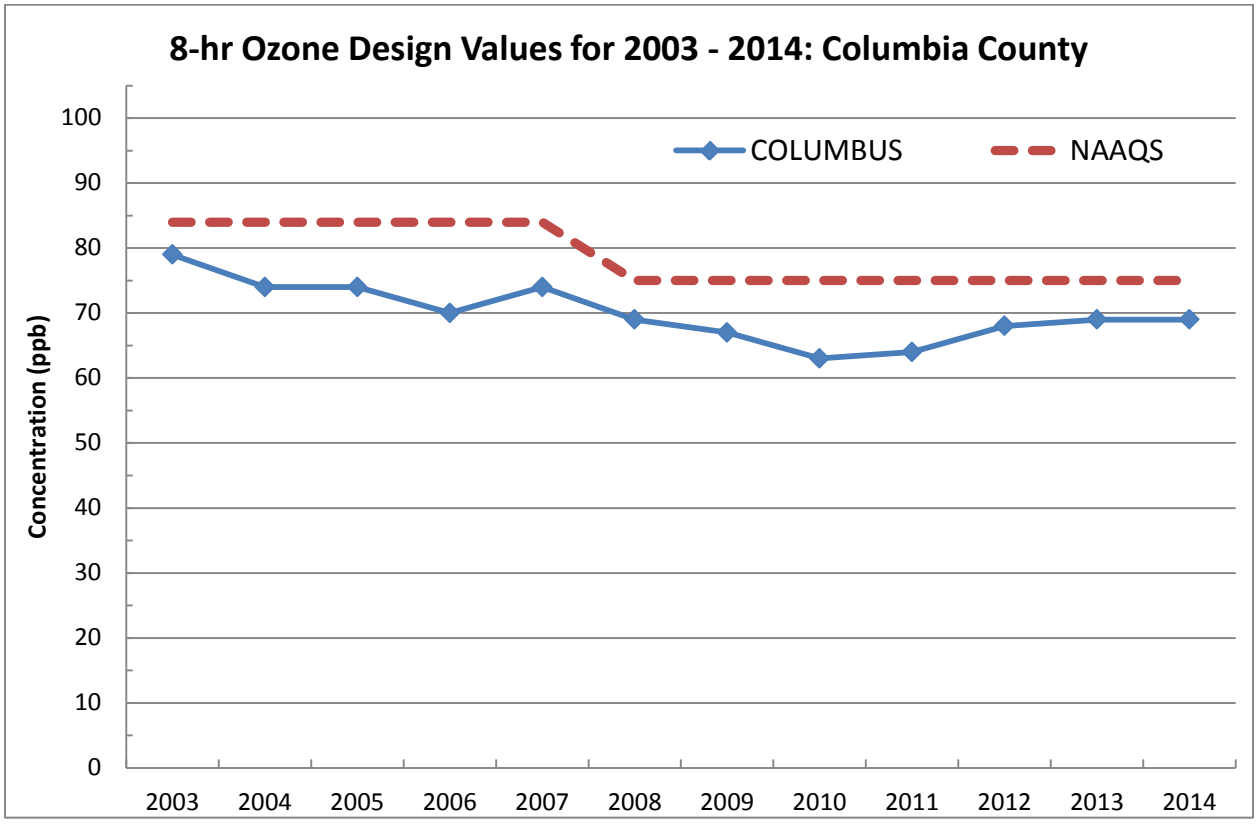




The EPA established an hourly SO_2 standard in 2010 that replaced the previous 24-hour and annual standards.

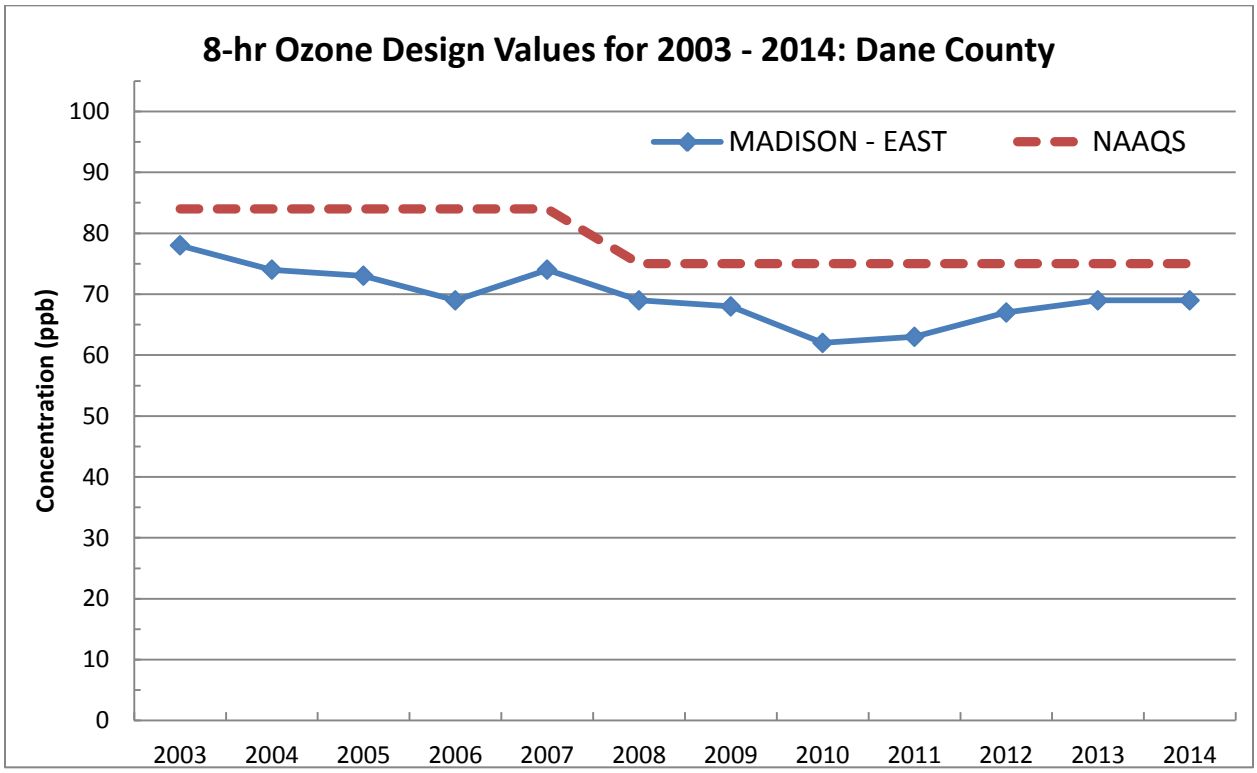
Columbia County

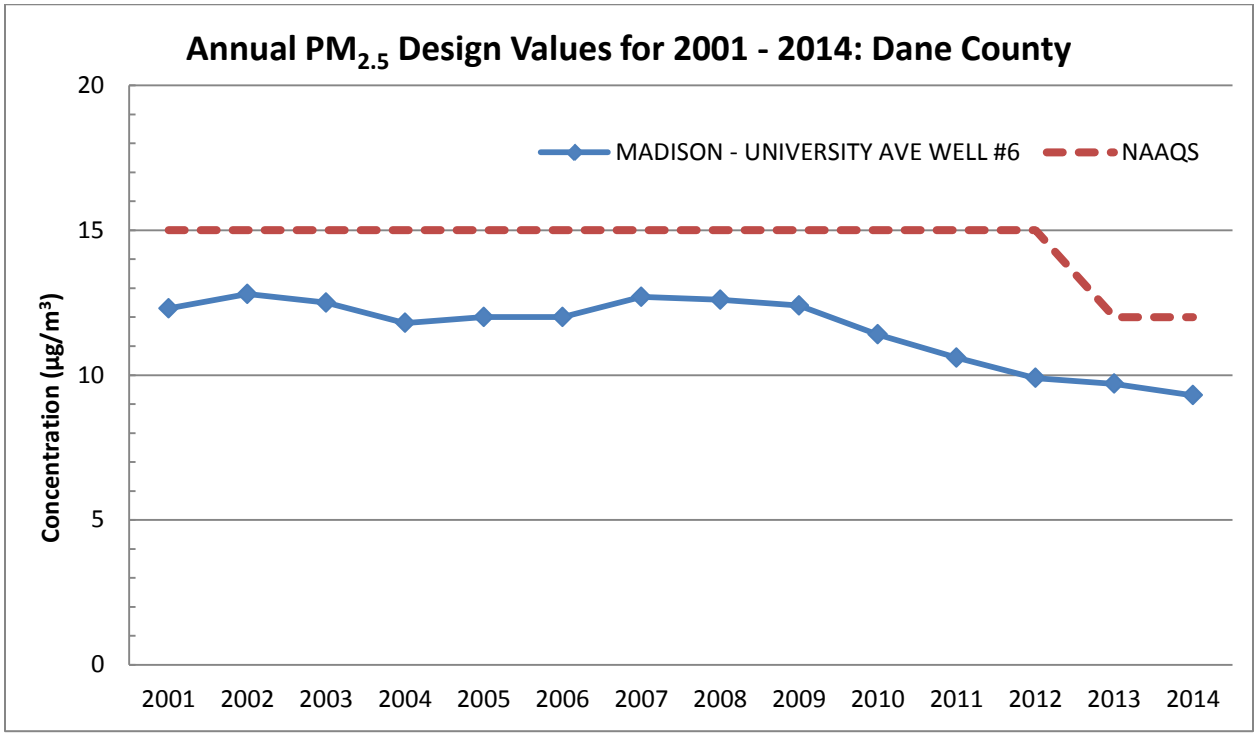
Ozone monitoring in Columbia County takes place at a rural location on Wendt Road in Columbus Township. The ozone monitor serves as the downwind ozone instrument in the Madison CBSA.

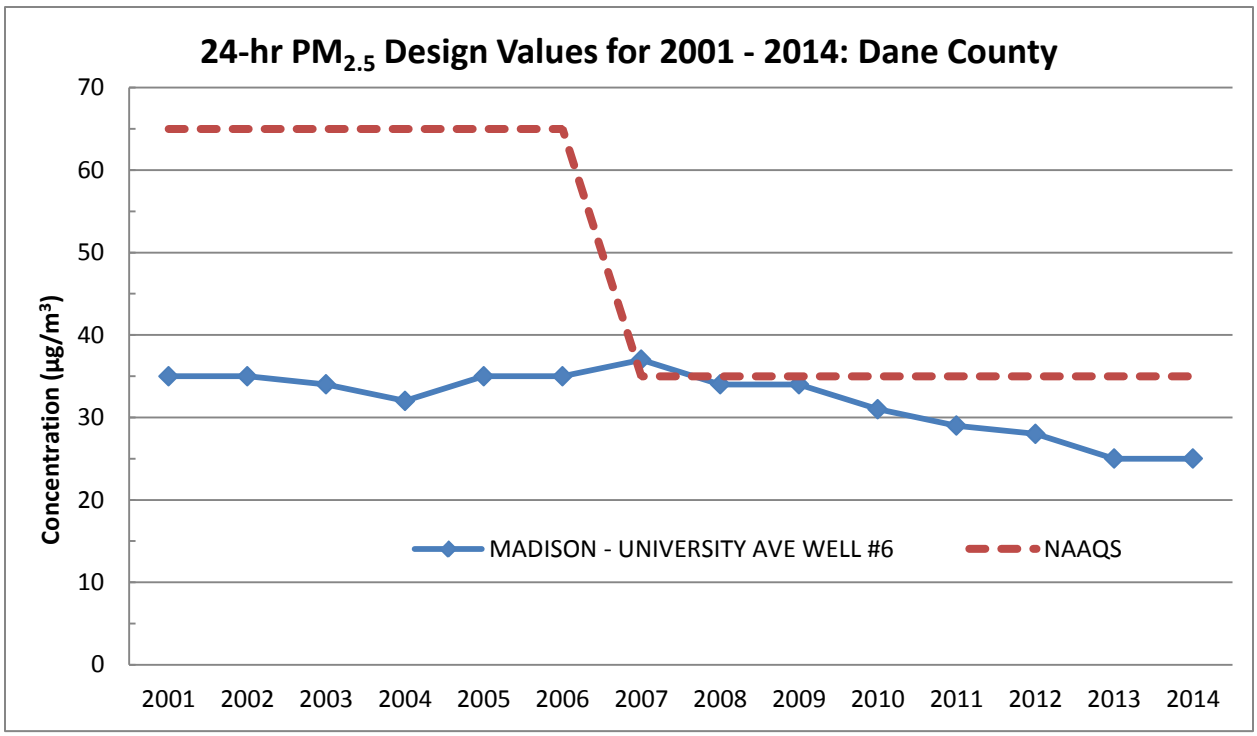


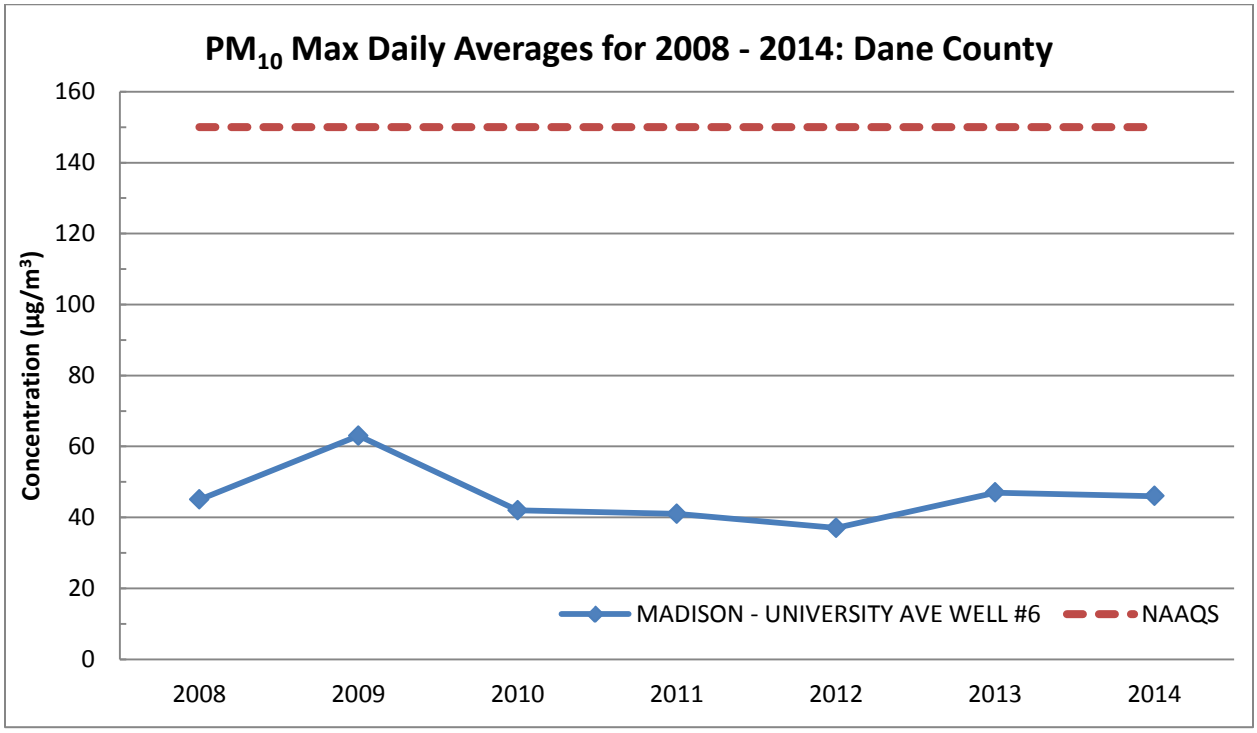
Dane County

Ozone monitoring in Dane County takes place at Madison East High School located at 2302 North Hoard Street next to the Madison East High School Sports Field. Monitoring of $PM_{2.5}$ is done at Madison East High School and Madison – University Avenue, located at 2757 University Avenue. The Madison-East site does not currently have enough data to meet the criteria for $PM_{2.5}$ design value calculation. Monitoring of PM_{10} takes place at the Madison – University Avenue site.



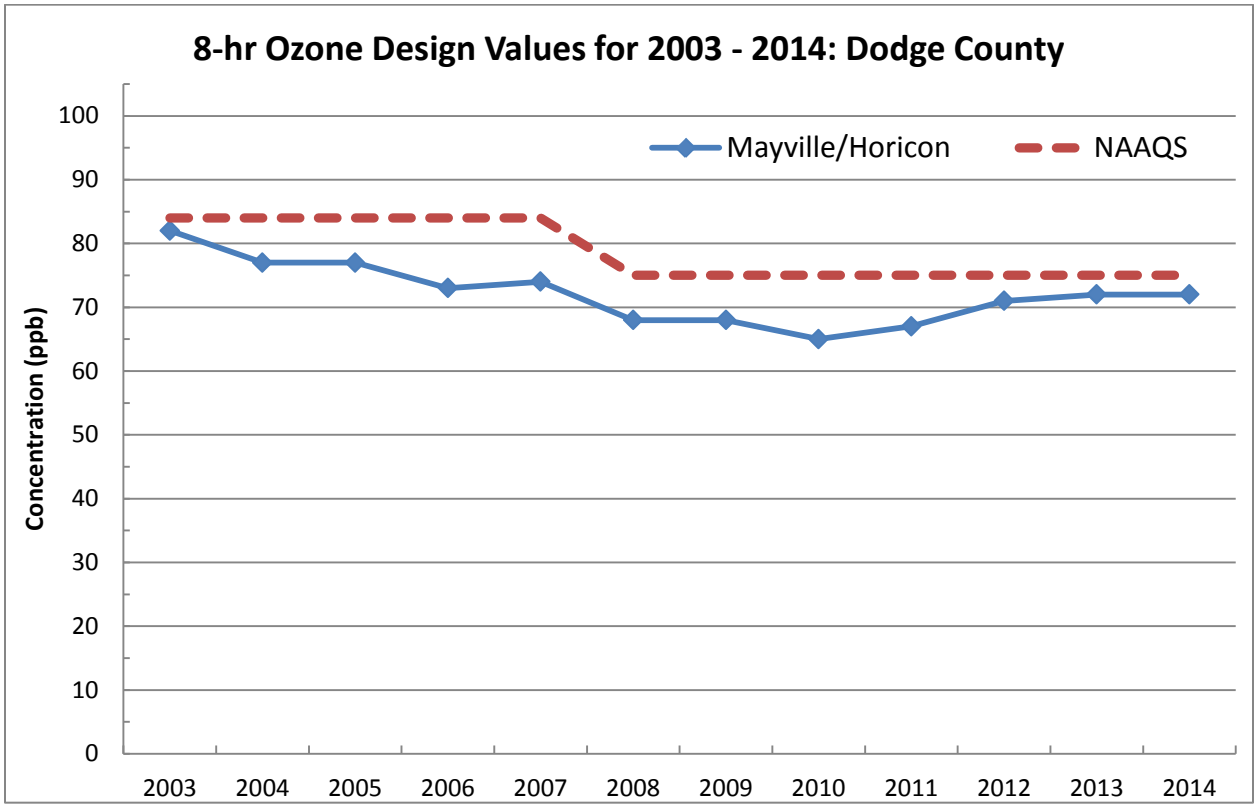

Annual PM2.5 Design Values for 2001 - 2014: Dane County
Concentration (µg/m³)
20
15
10
5
0
MADISON - UNIVERSITY AVE WELL #6
NAAQS
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014

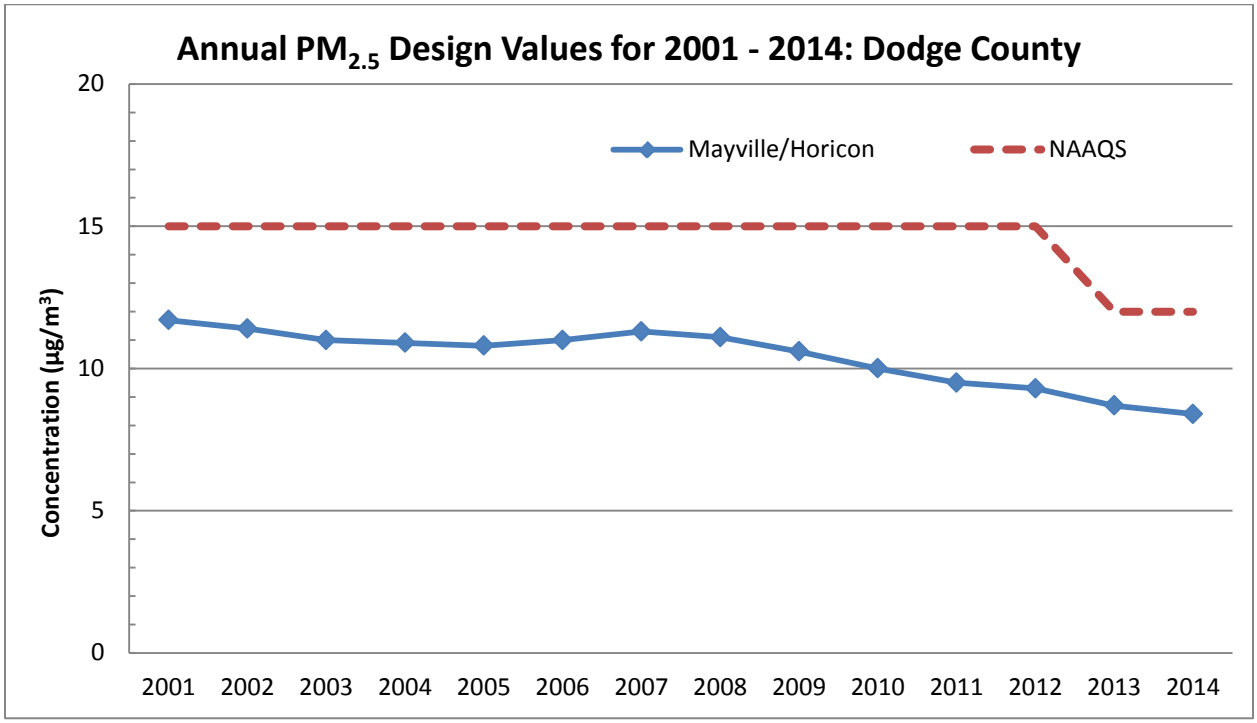

24-hr PM2.5 Design Values for 2001 - 2014: Dane County
Concentration (µg/m³)
70
60
50
40
30
20
10
0
MADISON - UNIVERSITY AVE WELL #6
NAAQS
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014

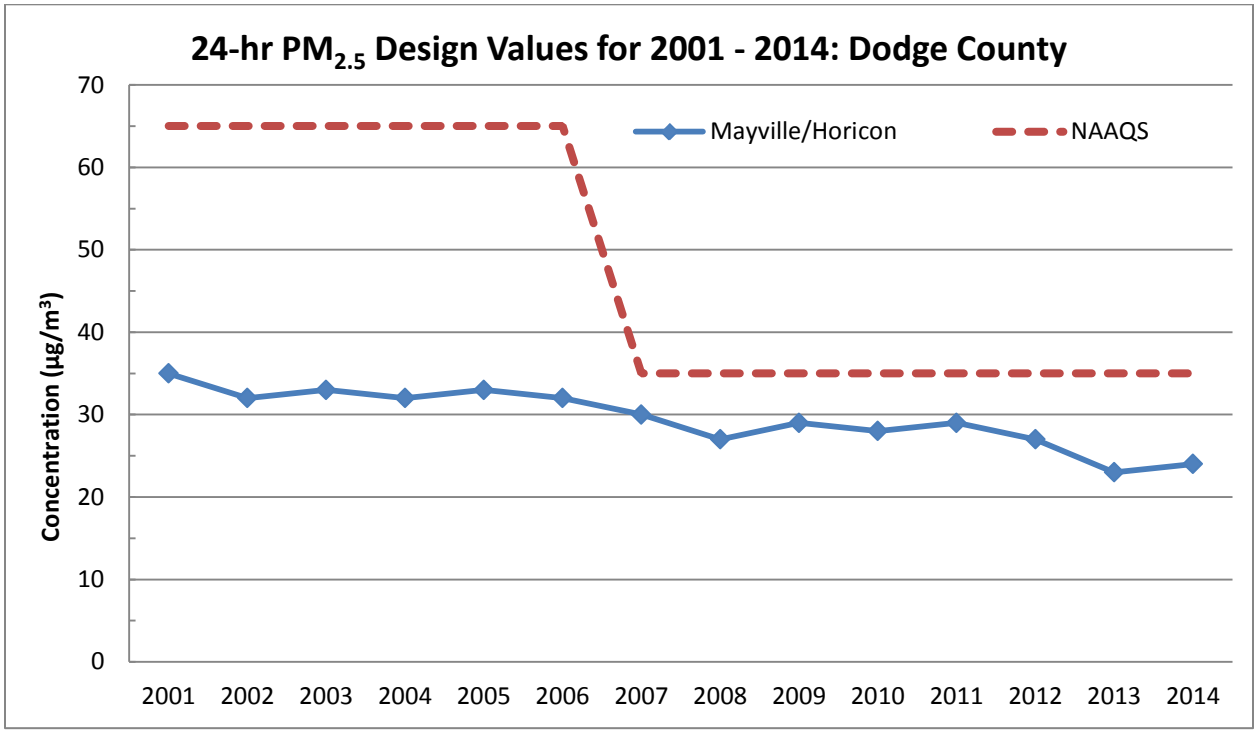

PM10 Max Daily Averages for 2008 - 2014: Dane County
Concentration (µg/m³)
160
140
120
100
80
60
40
20
0
2008
2009
2010
2011
2012
2013
2014
MADISON - UNIVERSITY AVE WELL #6
NAAQS

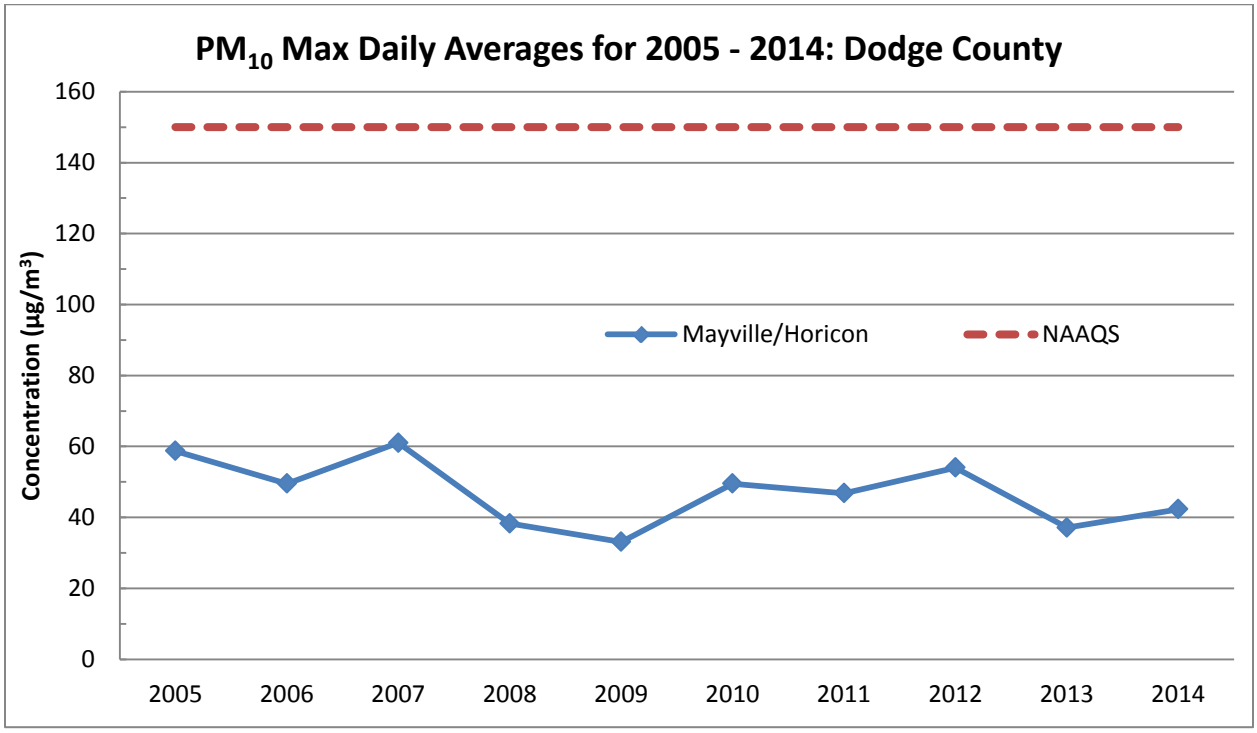
Dodge County

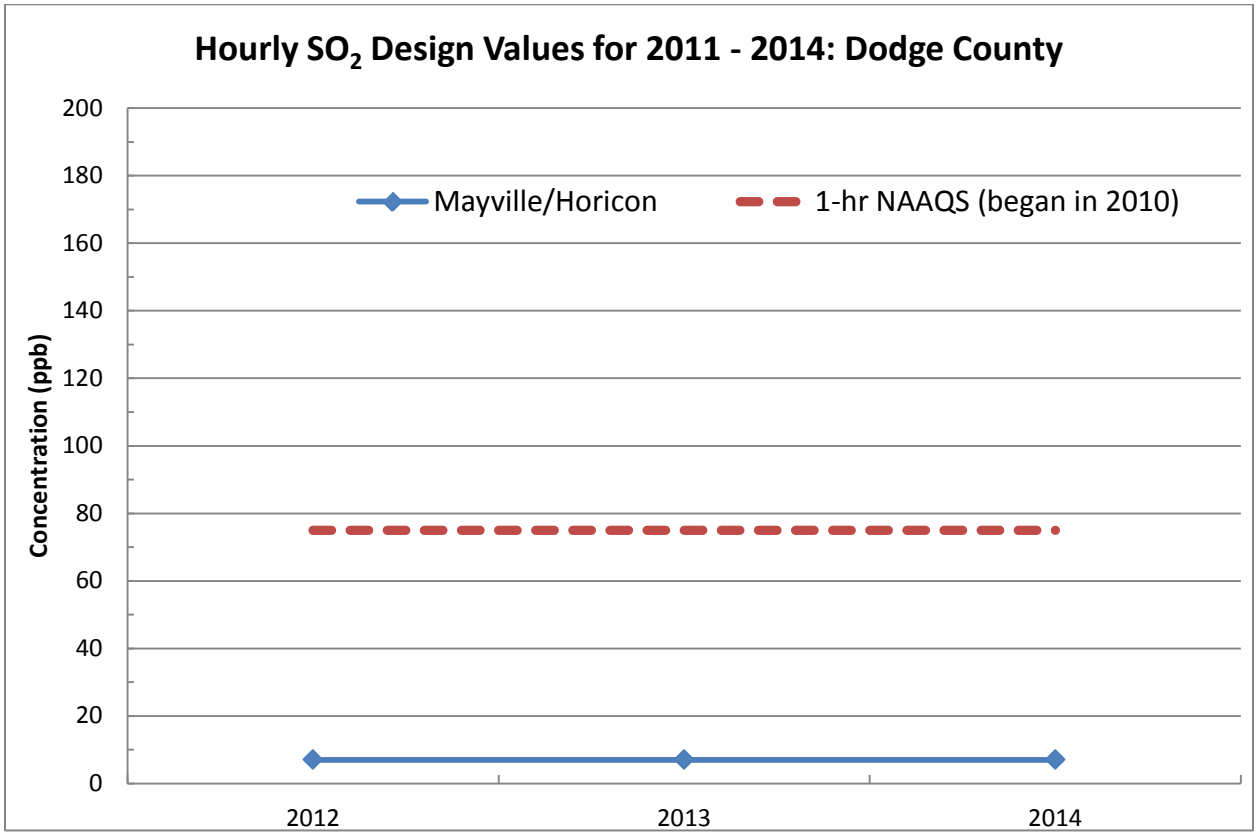
Ozone, $PM_{2.5}$, PM_{10}, SO_2, and CO monitoring in Dodge County is conducted at the Horicon Wildlife Area monitoring site located at 1210 North Palmatory Street. The Horicon site began sampling for ozone on January 22, 2010 and for 24-hour $PM_{2.5}$ on December 18, 2009. Prior to these dates, sampling in Dodge County was performed at a site near Mayville. Data from both sites are used to calculate design values for 2010, 2011, and 2012.

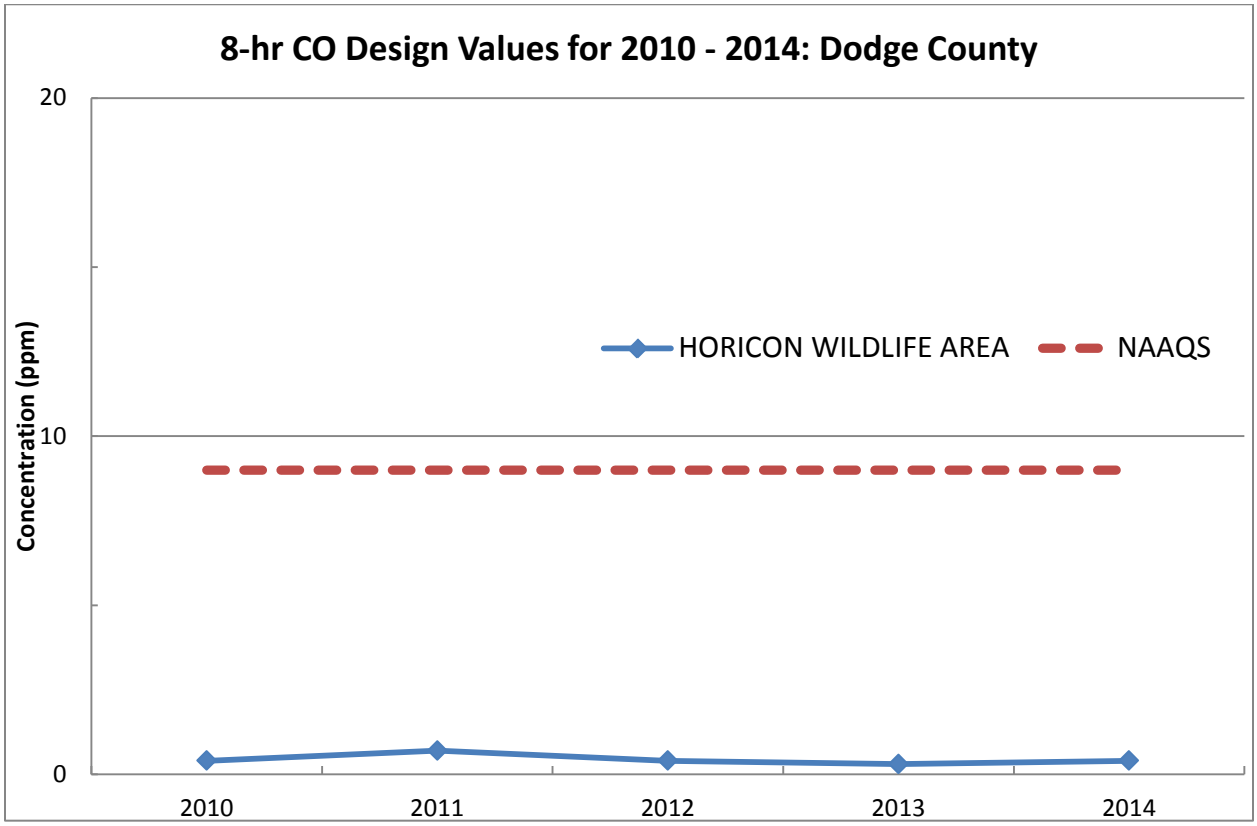


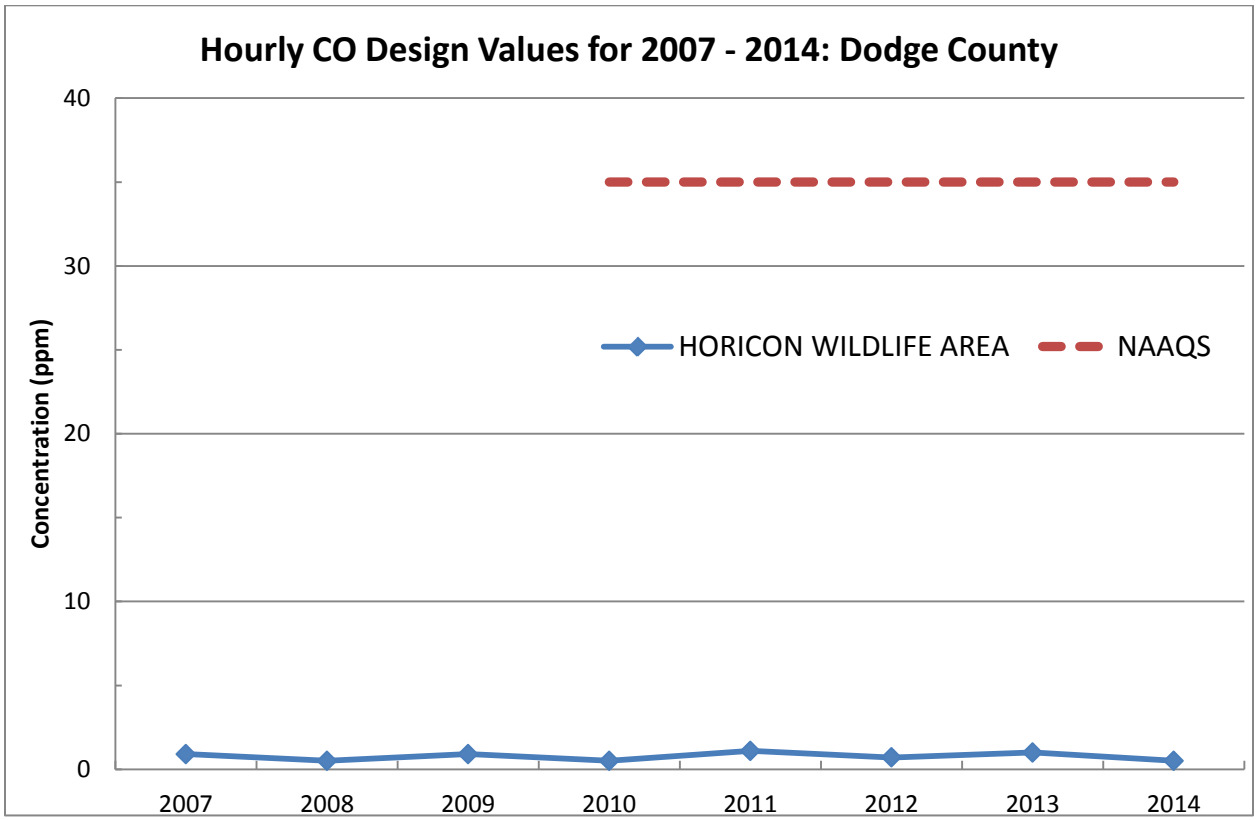

Annual PM2.5 Design Values for 2001 - 2014: Dodge County
Concentration (µg/m³)
20
15
10
5
0
Mayville/Horicon
NAAQS
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014


24-hr PM2.5 Design Values for 2001 - 2014: Dodge County
Concentration (µg/m³)
70
60
50
40
30
20
10
0
Mayville/Horicon
NAAQS
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014


PM10 Max Daily Averages for 2005 - 2014: Dodge County
Concentration (µg/m³)
160
140
120
100
80
60
40
20
0
Mayville/Horicon
NAAQS
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014

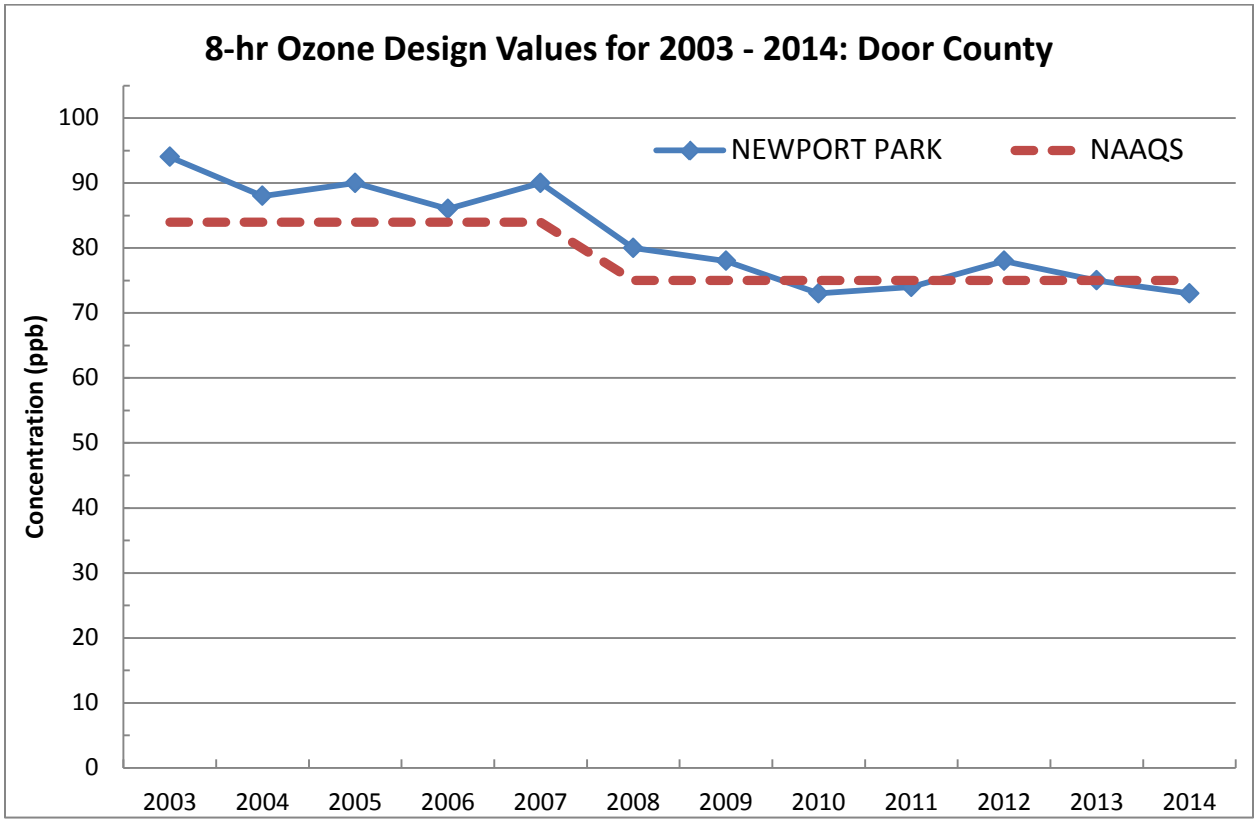

Hourly SO2 Design Values for 2011 - 2014: Dodge County
Concentration (ppb)
200
180
160
140
120
100
80
60
40
20
0
Mayville/Horicon
1-hr NAAQS (began in 2010)
2012
2013
2014


8-hr CO Design Values for 2010 - 2014: Dodge County
Concentration (ppm)
20
10
0
HORICON WILDLIFE AREA
NAAQS
2010
2011
2012
2013
2014


Hourly CO Design Values for 2007 - 2014: Dodge County
Concentration (ppm)
40
30
20
10
0
HORICON WILDLIFE AREA
NAAQS
2007
2008
2009
2010
2011
2012
2013
2014

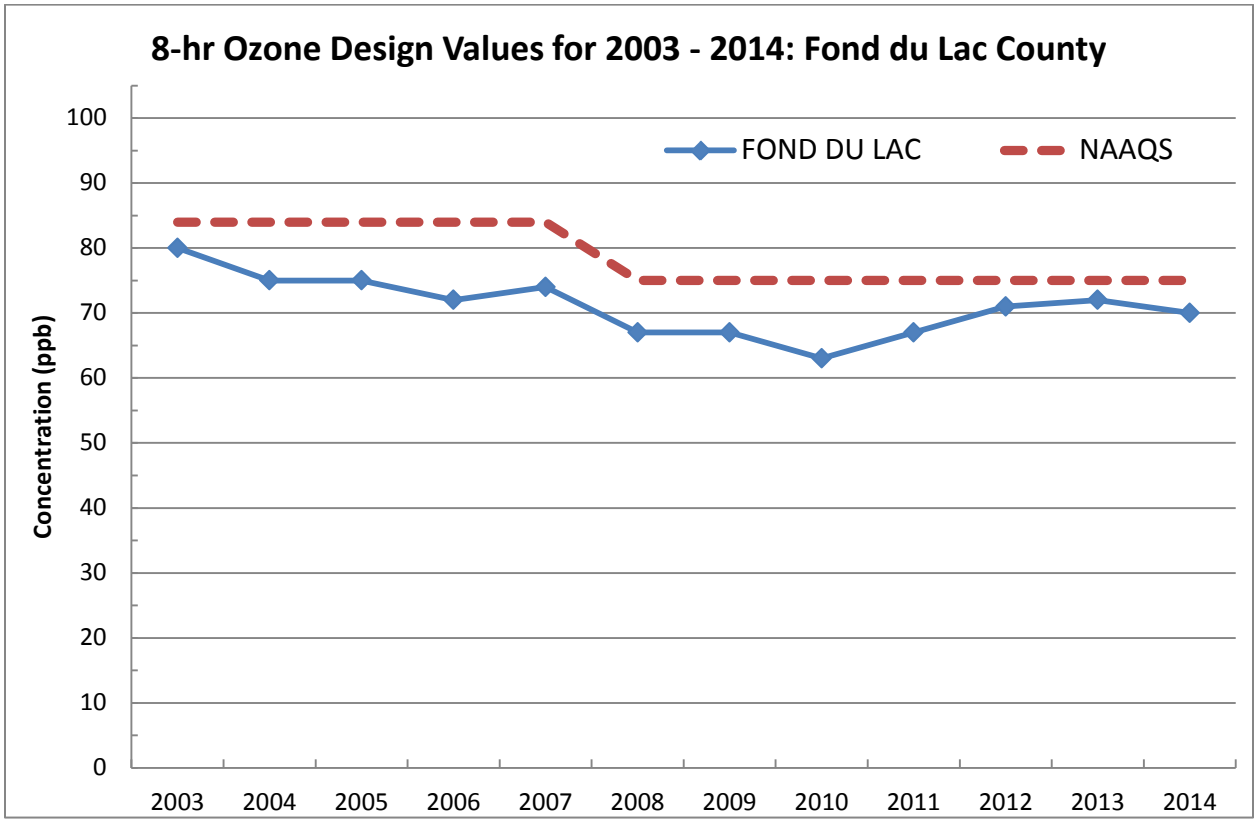
Door County

Ozone monitoring in Door County takes place at Newport State Park at 475 County Trunk Highway NP in Ellison Bay. The site is located inside the state park.



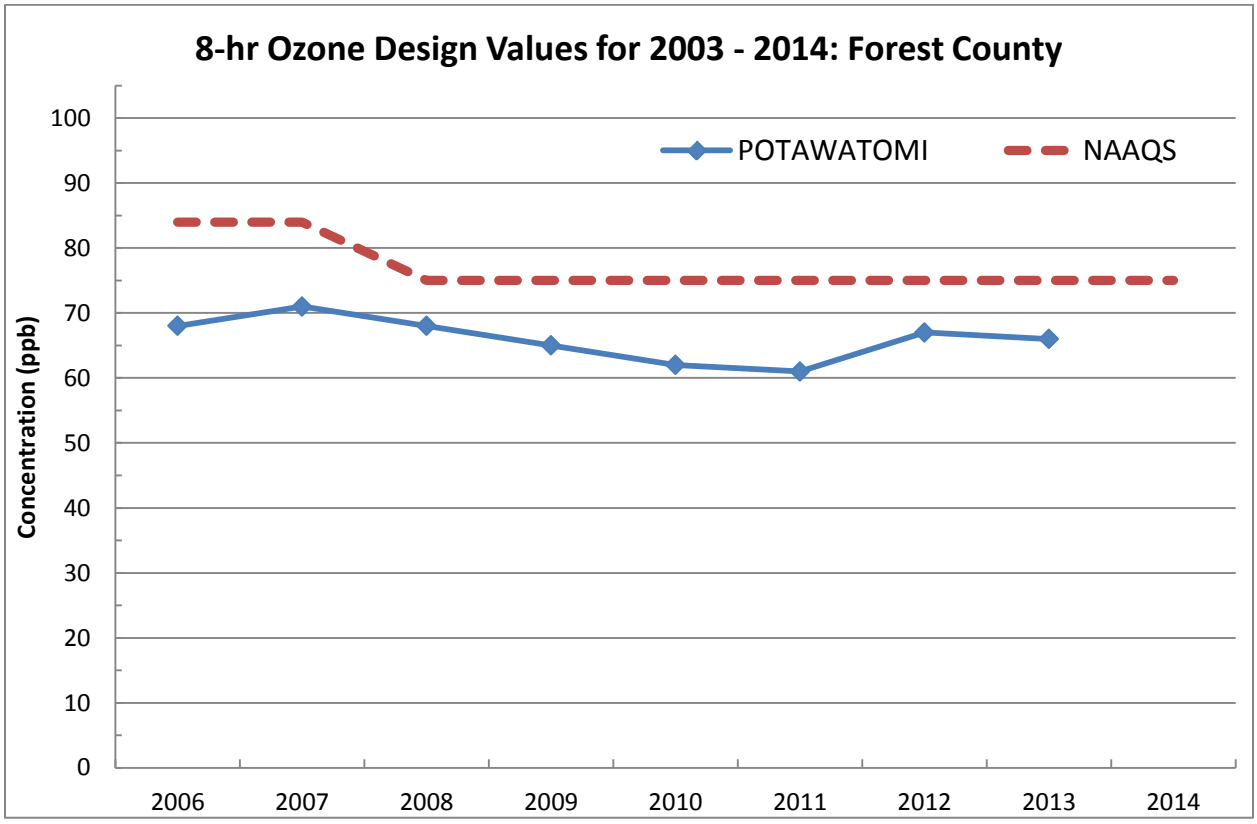
Fond du Lac County

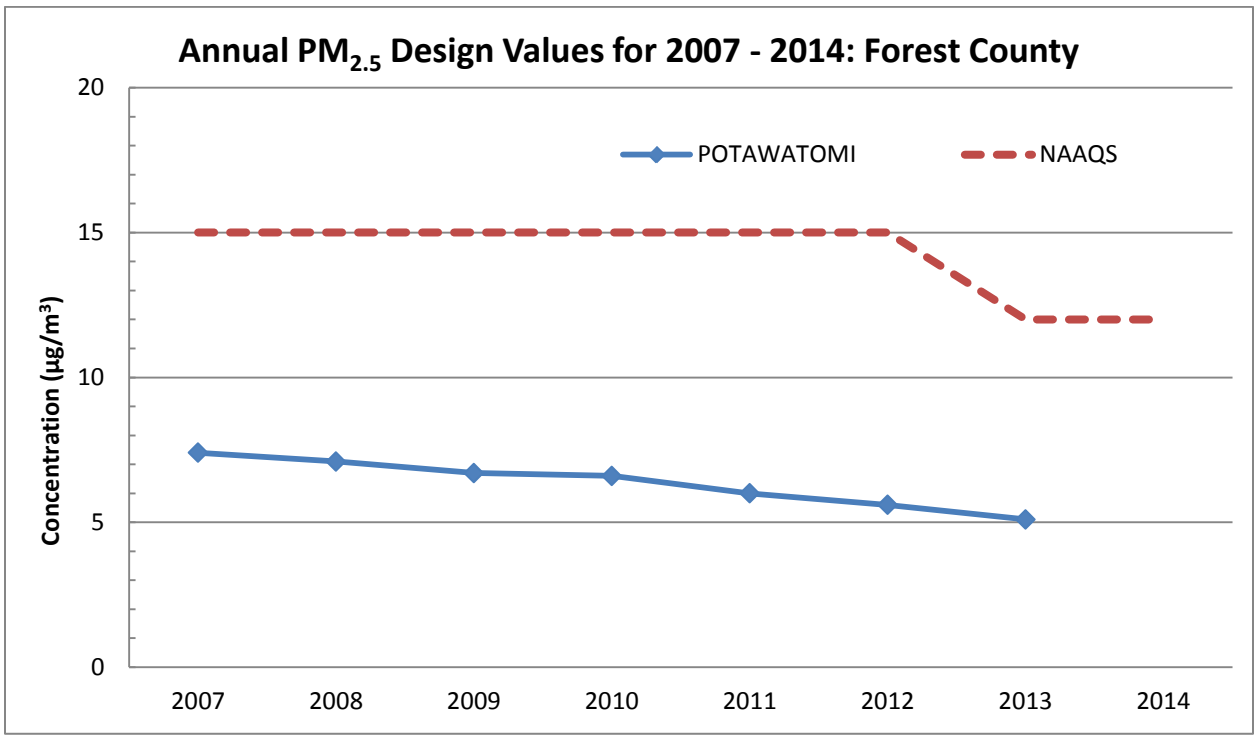
Ozone monitoring in Fond du Lac County is performed at N3996 Kelly Road in the Town of Byron. The site is located at the edge of a farm field.

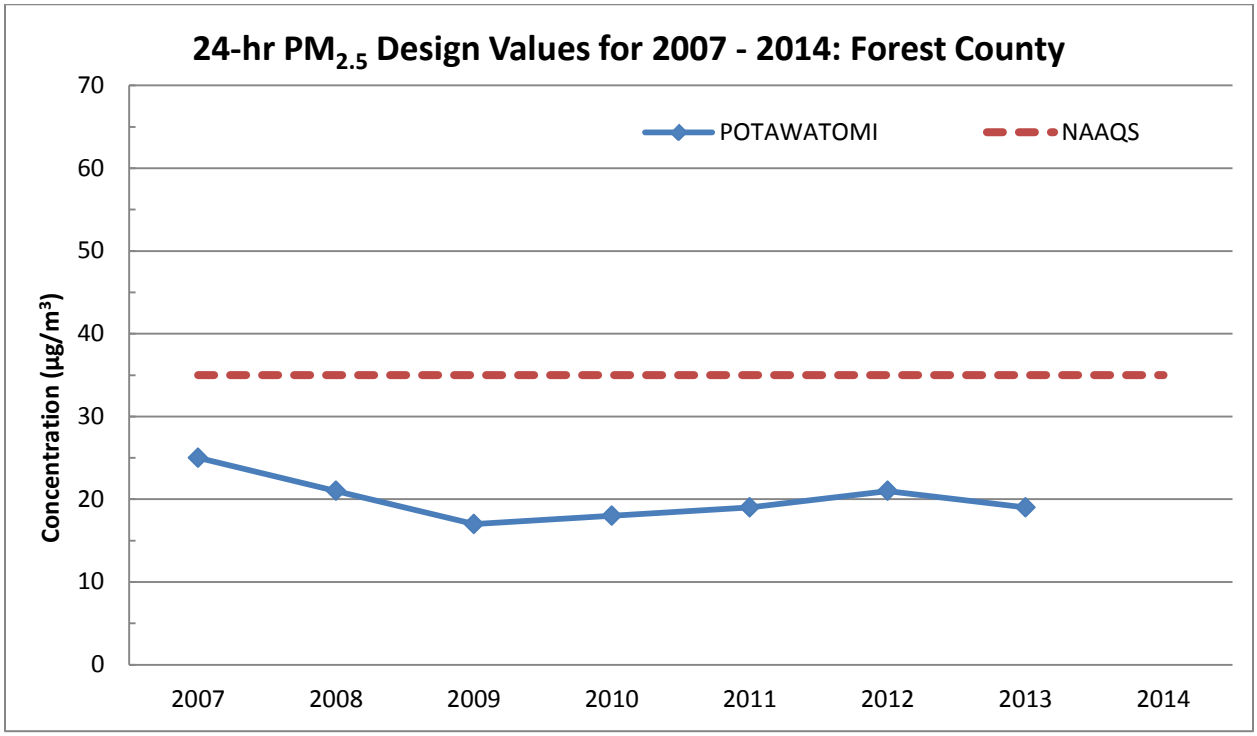


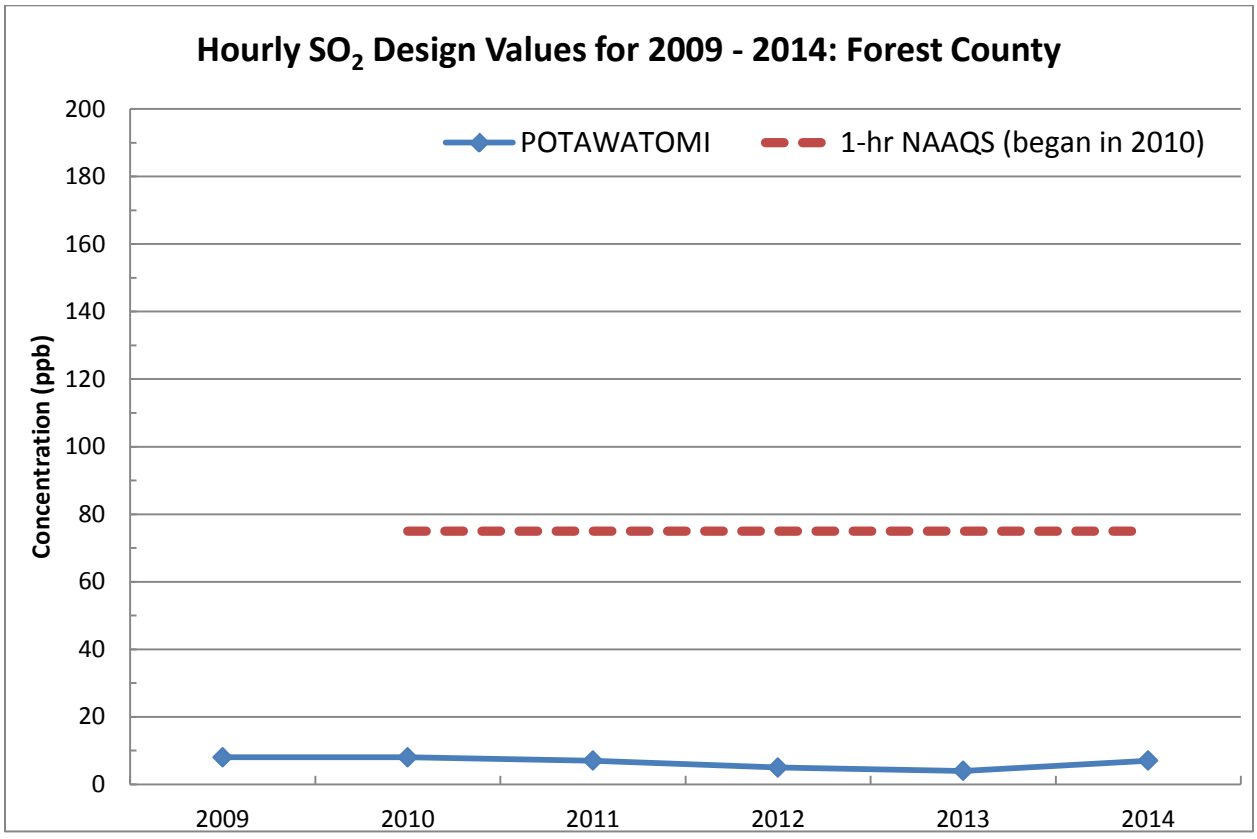
Forest County

Monitoring for ozone, $PM_{2.5}$, SO_2, and NO_2 is conducted by the Forest County Potawatomi Tribe in Crandon. The 2014 design values for ozone and PM2.5 were not valid so are not shown. In addition, the site does not have enough data to meet the criteria for NO_2 design value calculation.



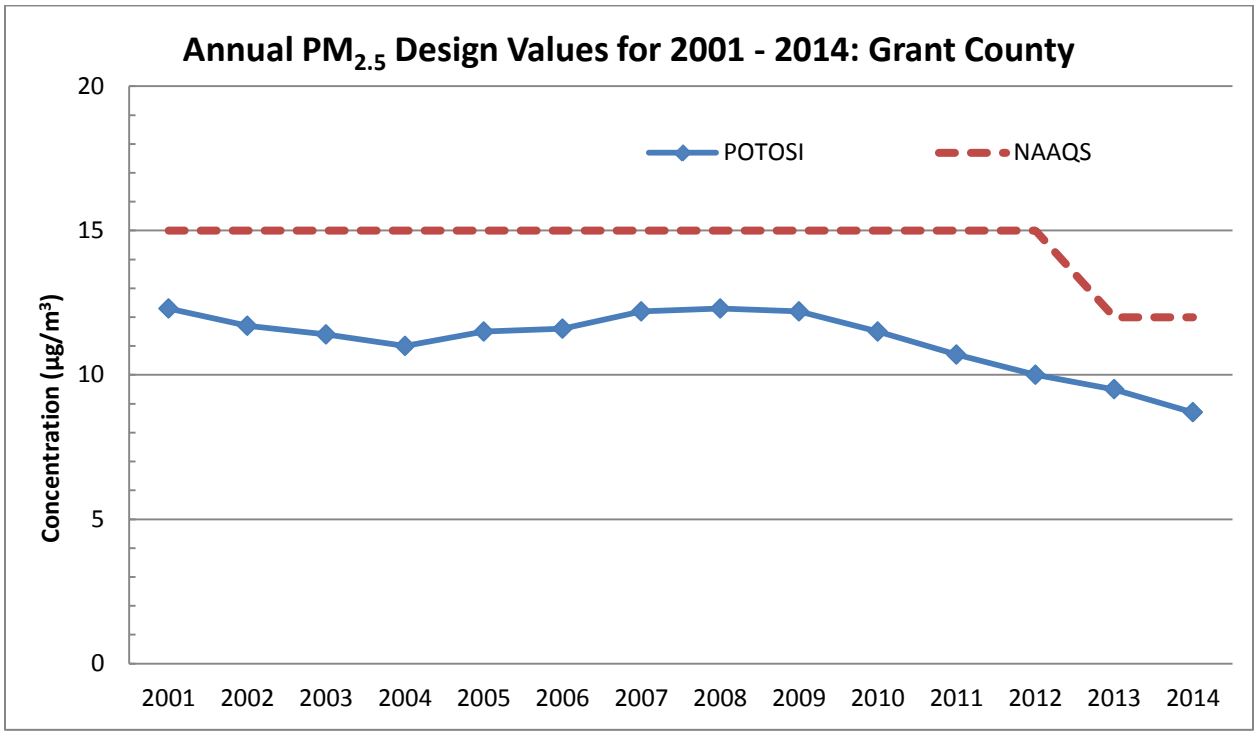


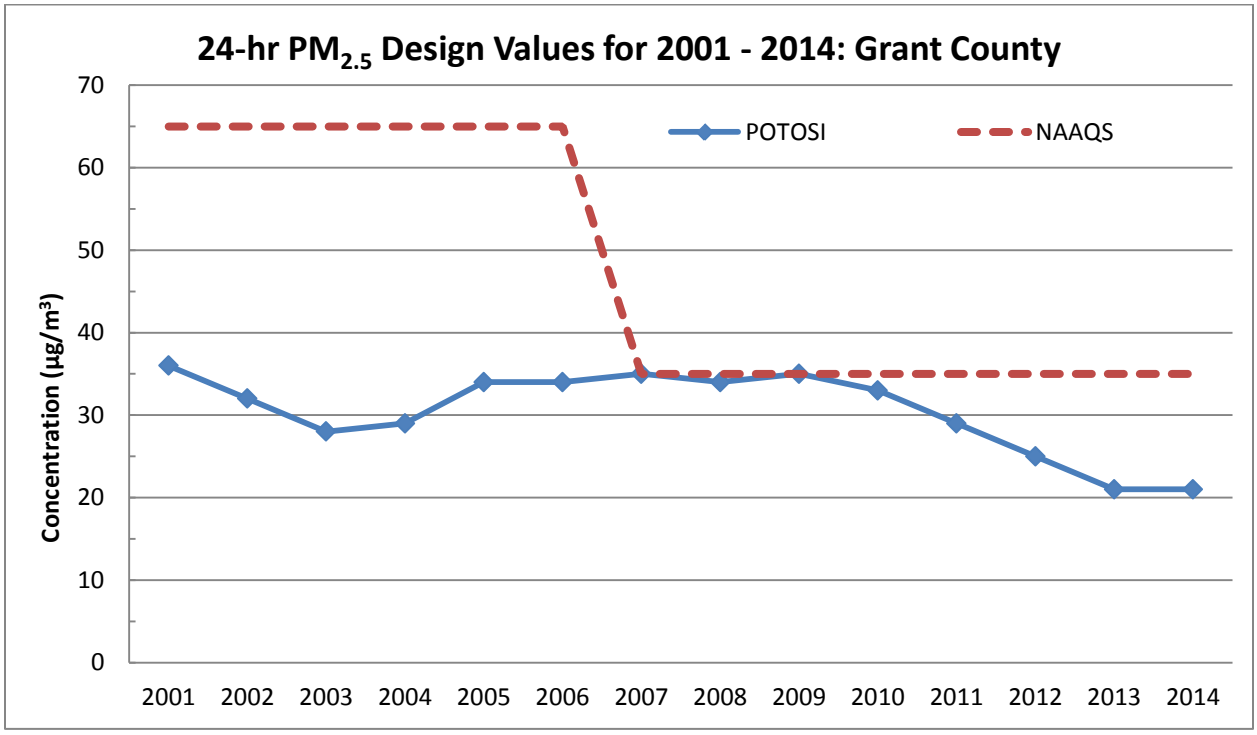

24-hr PM2.5 Design Values for 2007 - 2014: Forest County
Concentration (µg/m³)
70
60
50
40
30
20
10
0
POTAWATOMI
NAAQS
2007
2008
2009
2010
2011
2012
2013
2014


Hourly SO2 Design Values for 2009 - 2014: Forest County
Concentration (ppb)
200
180
160
140
120
100
80
60
40
20
0
POTAWATOMI
1-hr NAAQS (began in 2010)
2009
2010
2011
2012
2013
2014

Grant County

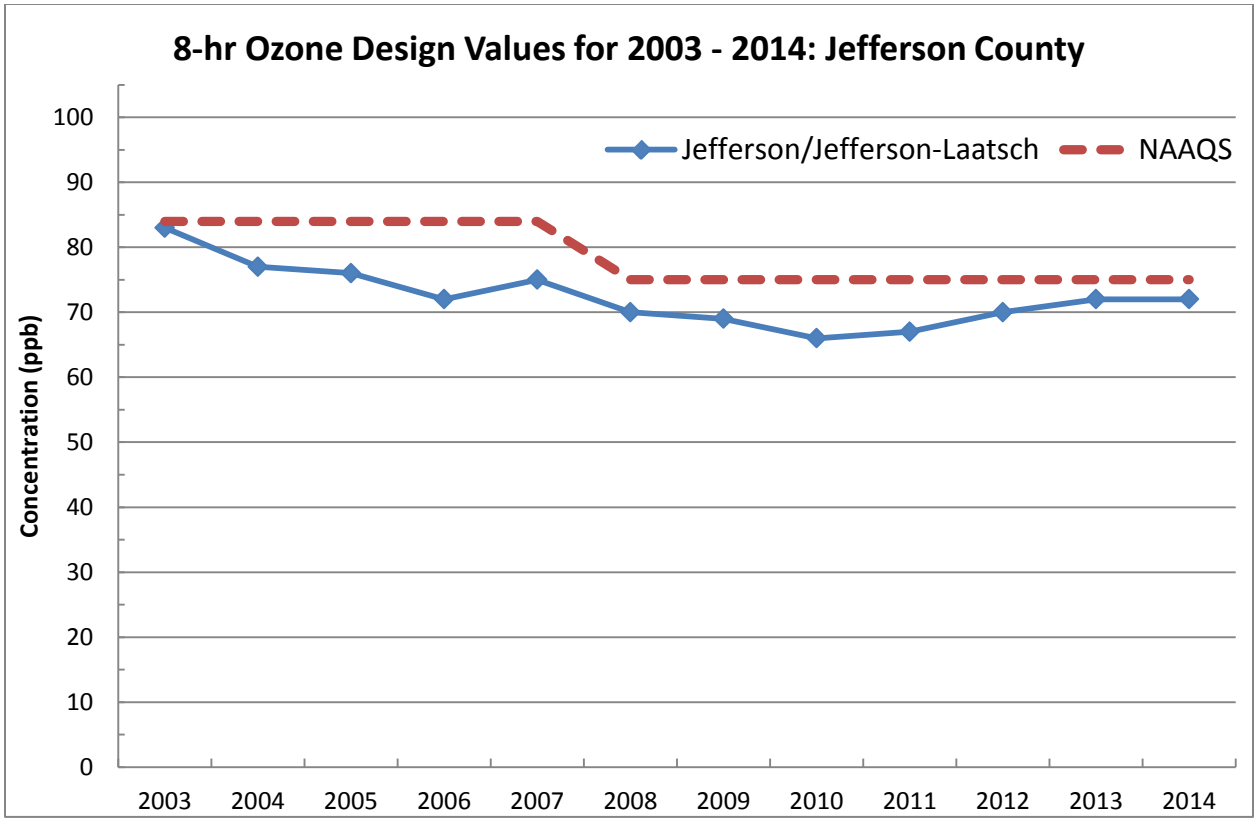
Monitoring for $PM_{2.5}$ in Grant County takes place at 128 Highway 61 on Potosi High School property.





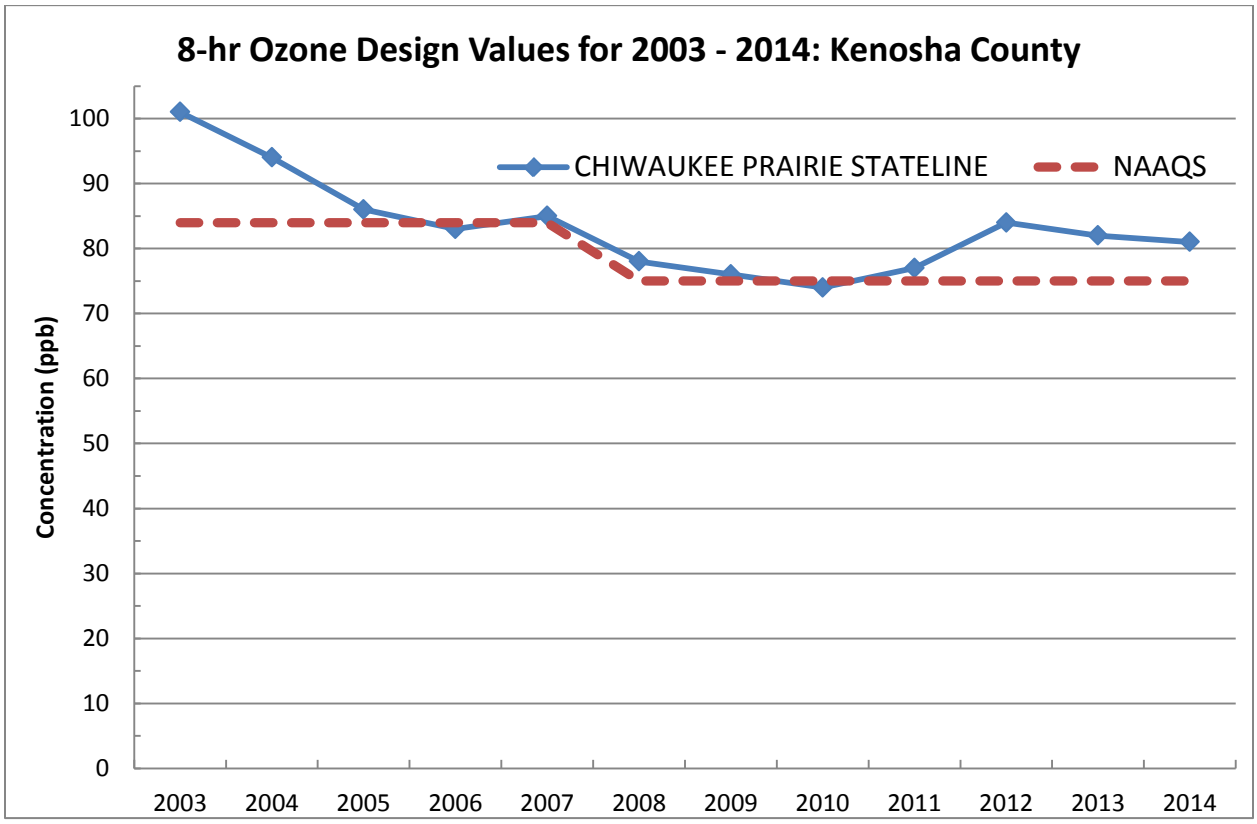
Jefferson County

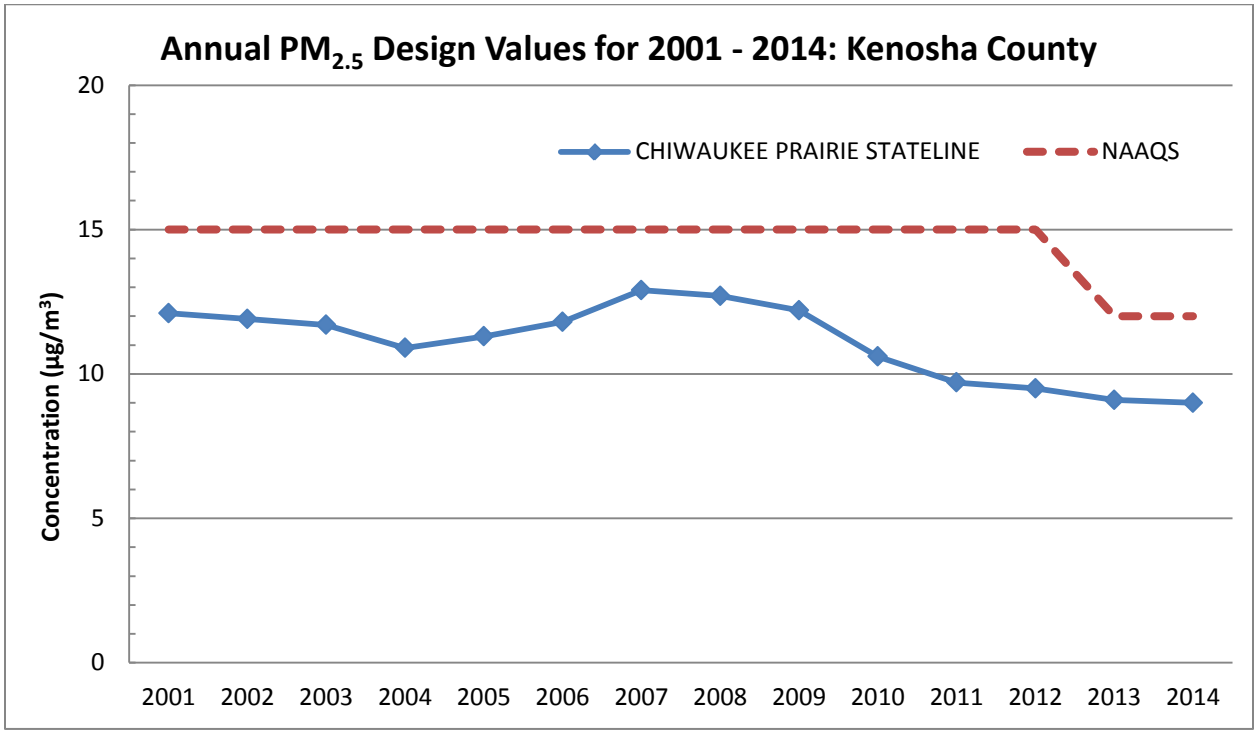
Ozone monitoring in Jefferson County was previously conducted at Jefferson High School next to the sports field grounds at 634 West Linden Drive. For the 2013 ozone season, the monitoring site was moved near the elementary school grounds at Laatsch Lane in the City of Jefferson. This is approximately ¾ mile from the previous site.

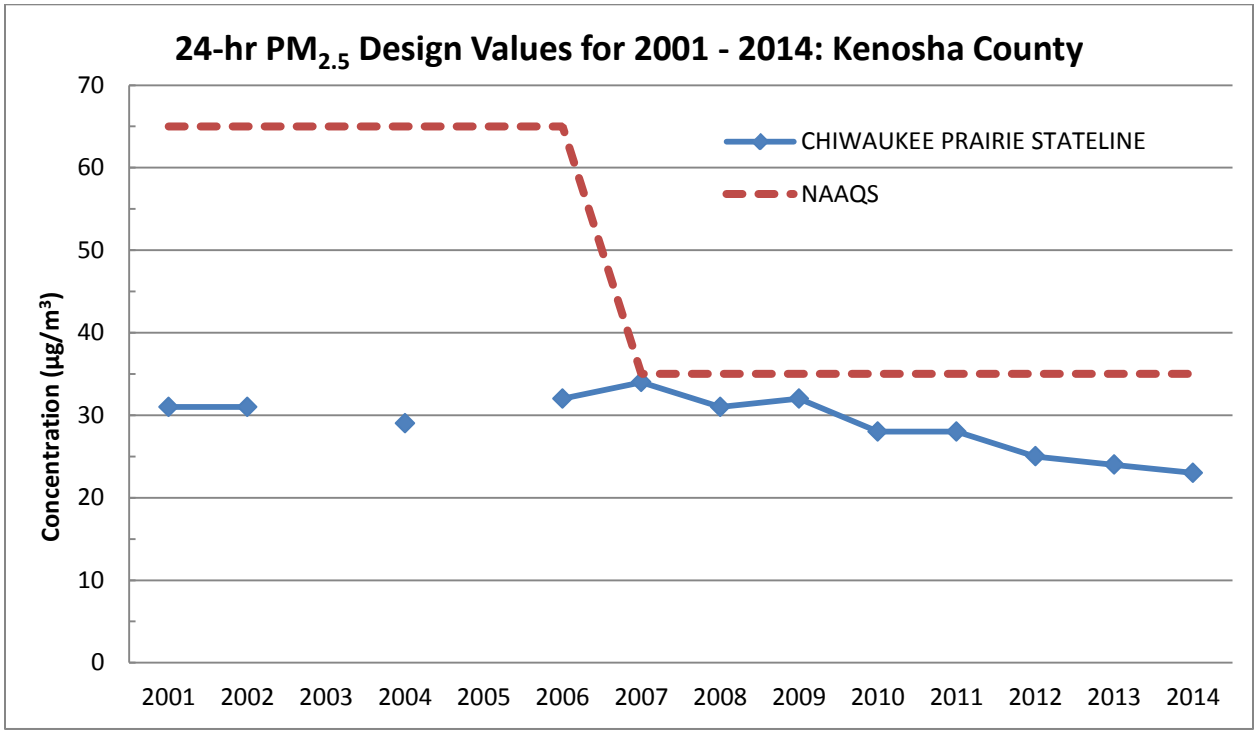


Kenosha County

Ozone and $PM_{2.5}$ monitoring for Kenosha County is performed at 11838 First Court in the Chiwaukee Prairie, which is a rural area near the Wisconsin – Illinois border. A second ozone monitoring site in Kenosha County was added in 2013 at the water tower located at 4504 64th Street. The Kenosha - water tower site is designated as a special purpose monitor. This report only shows design values from the Chiwaukee Prairie site because of the short length of record at the Kenosha - water tower site.

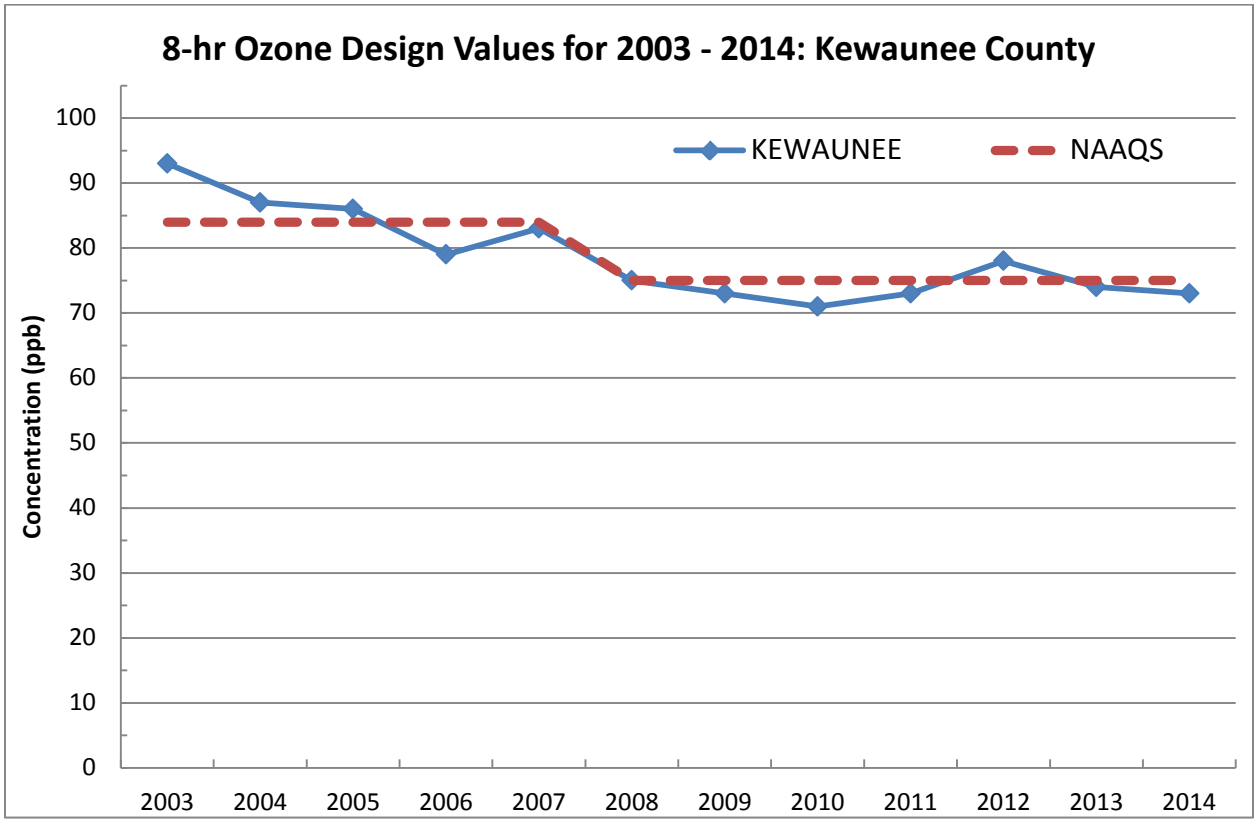



Annual PM2.5 Design Values for 2001 - 2014: Kenosha County
Concentration (µg/m³)
20
15
10
5
0
CHIWAUKEE PRAIRIE STATELINE
NAAQS
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014


24-hr PM2.5 Design Values for 2001 - 2014: Kenosha County
Concentration (µg/m³)
70
60
50
40
30
20
10
0
CHIWAUKEE PRAIRIE STATELINE
NAAQS
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014

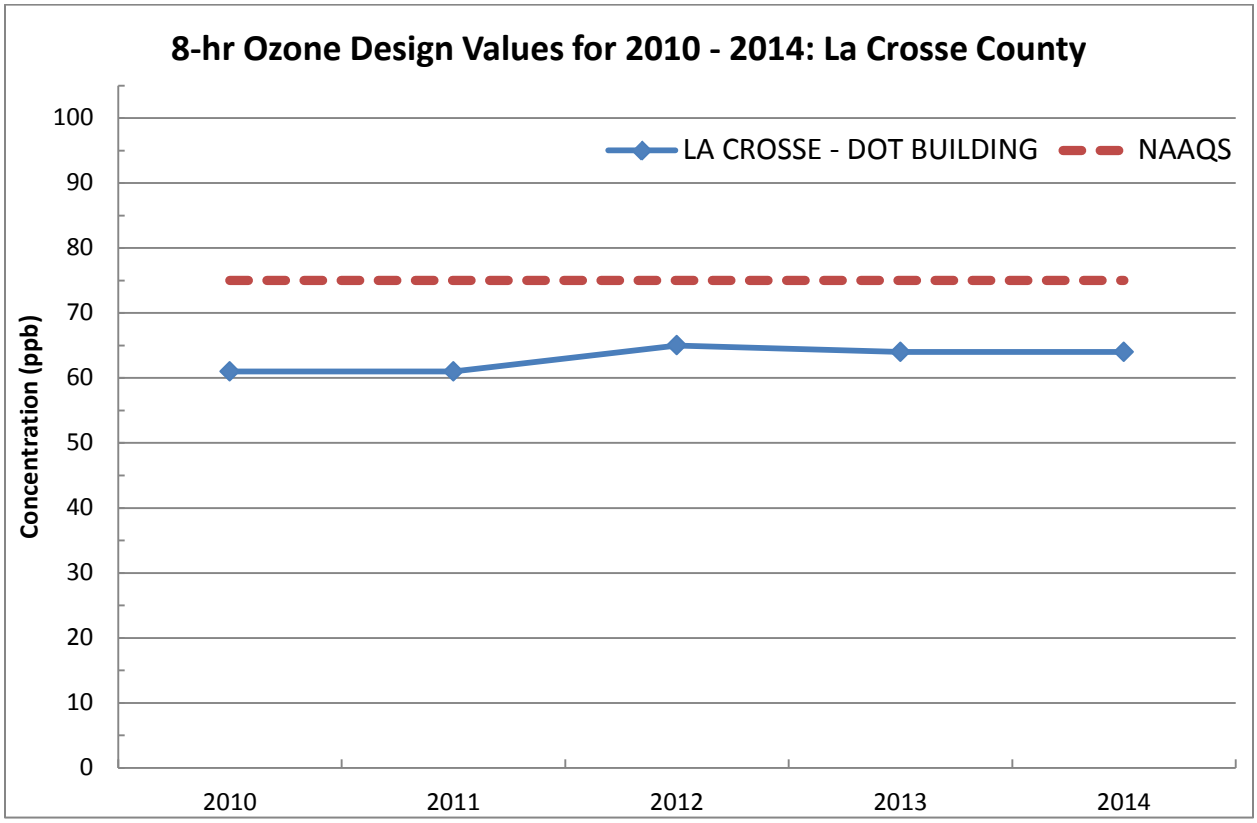
Kewaunee County

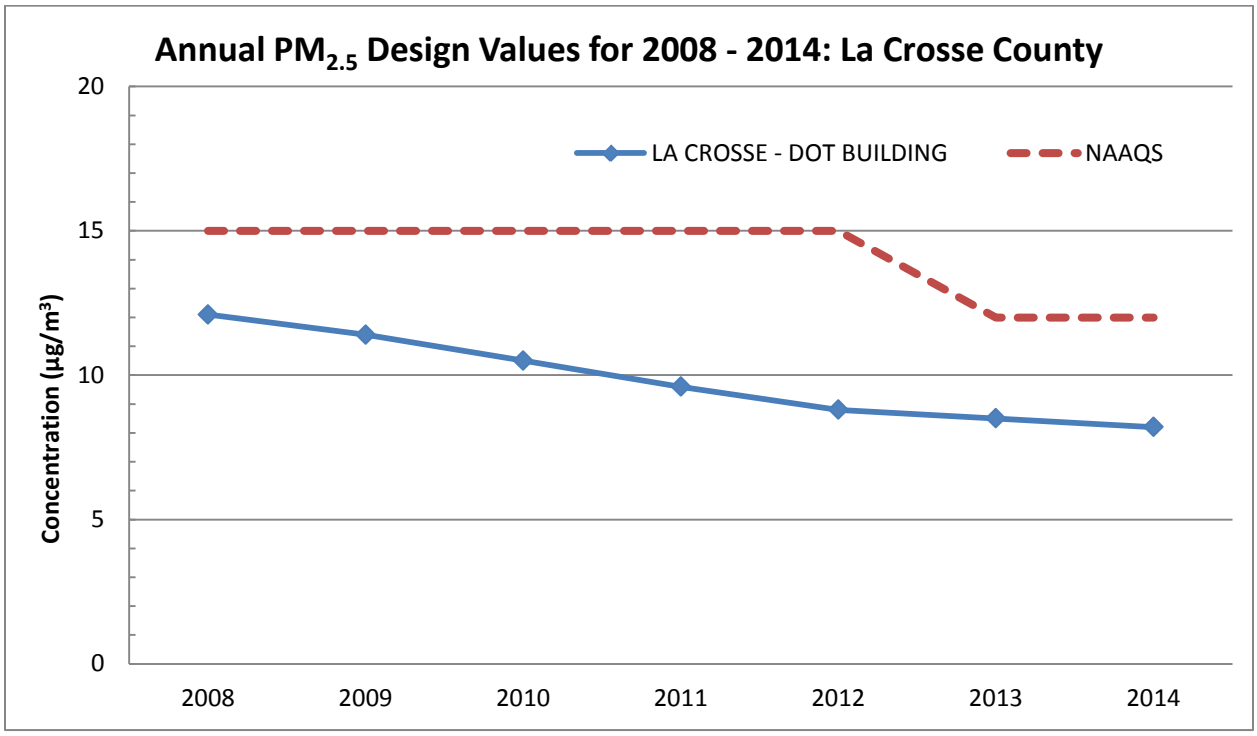
Ozone monitoring in Kewaunee County takes place at Rural Route #1, Highway 42 on a bluff over Lake Michigan.

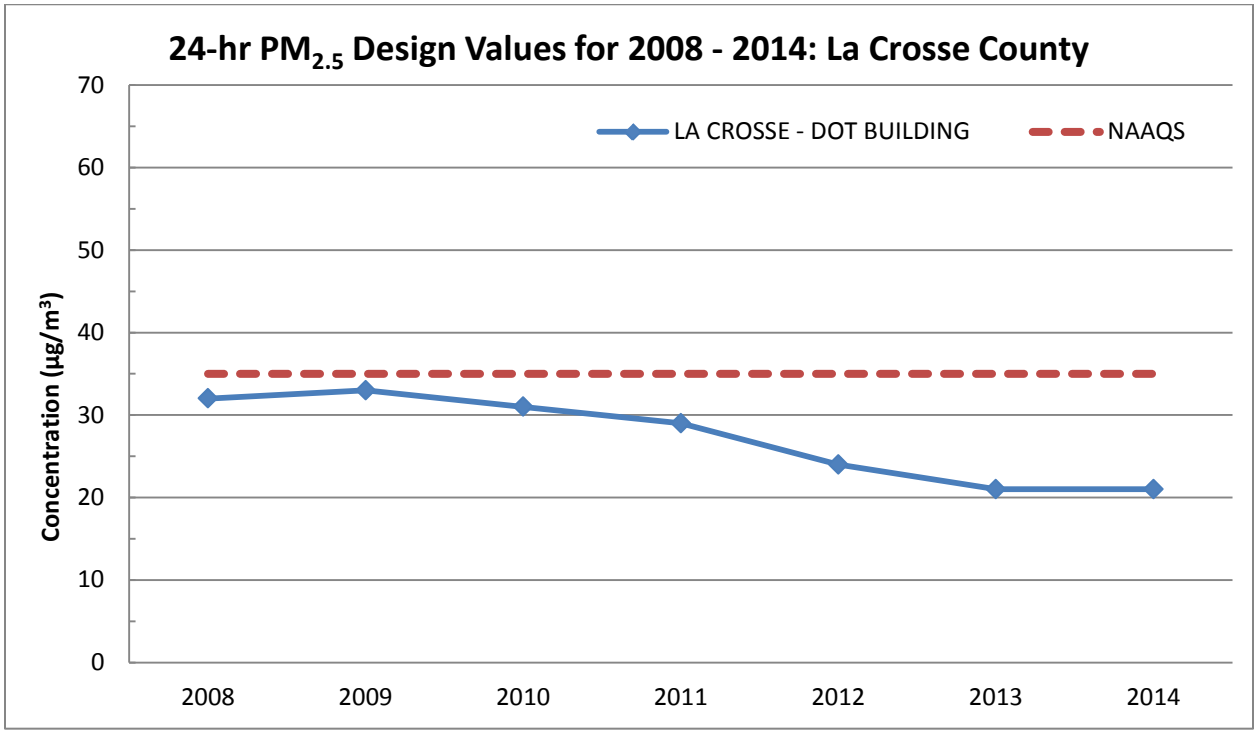


La Crosse County

Ozone and $PM_{2.5}$ monitoring for La Crosse County is conducted at the Department of Transportation office located at 3350 Mormon Coulee Road in La Crosse.

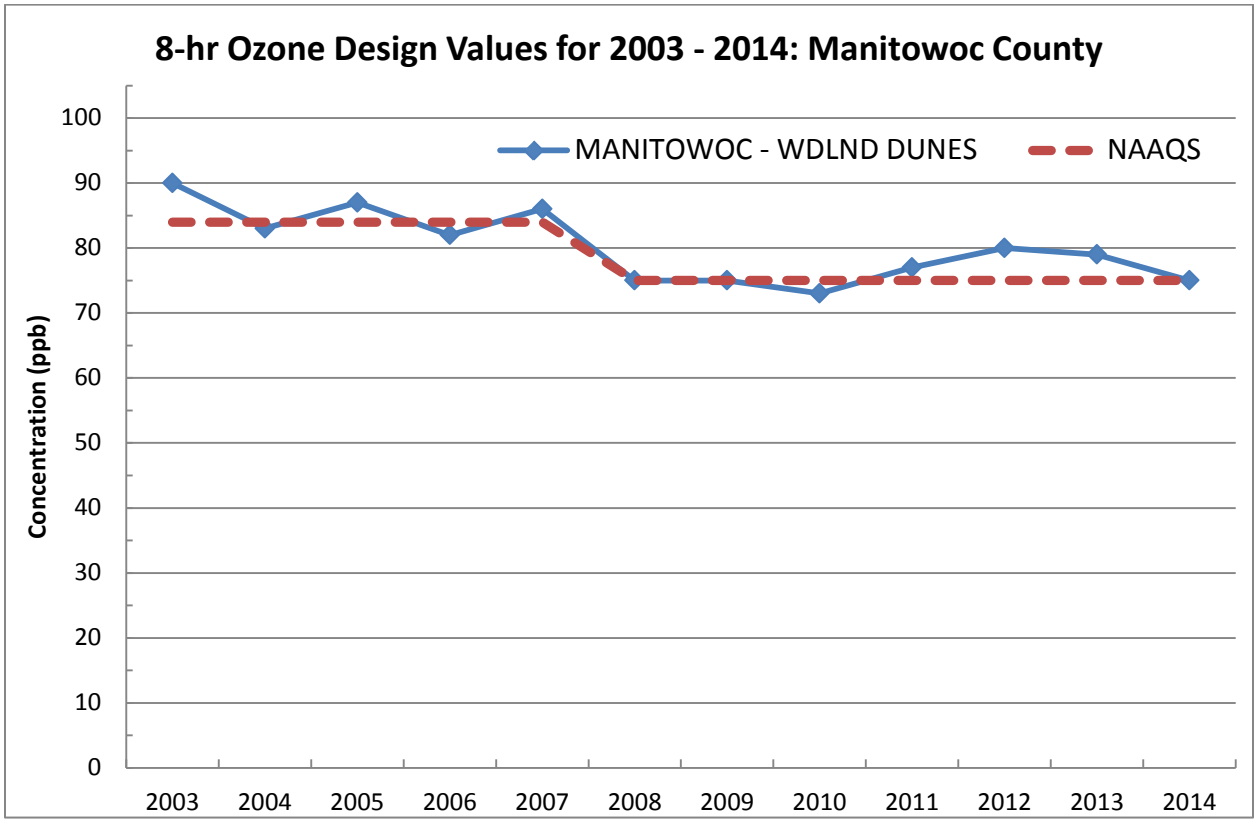





24-hr PM2.5 Design Values for 2008 - 2014: La Crosse County
LA CROSSE - DOT BUILDING
NAAQS
Concentration (µg/m³)
70
60
50
40
30
20
10
0
2008
2009
2010
2011
2012
2013
2014

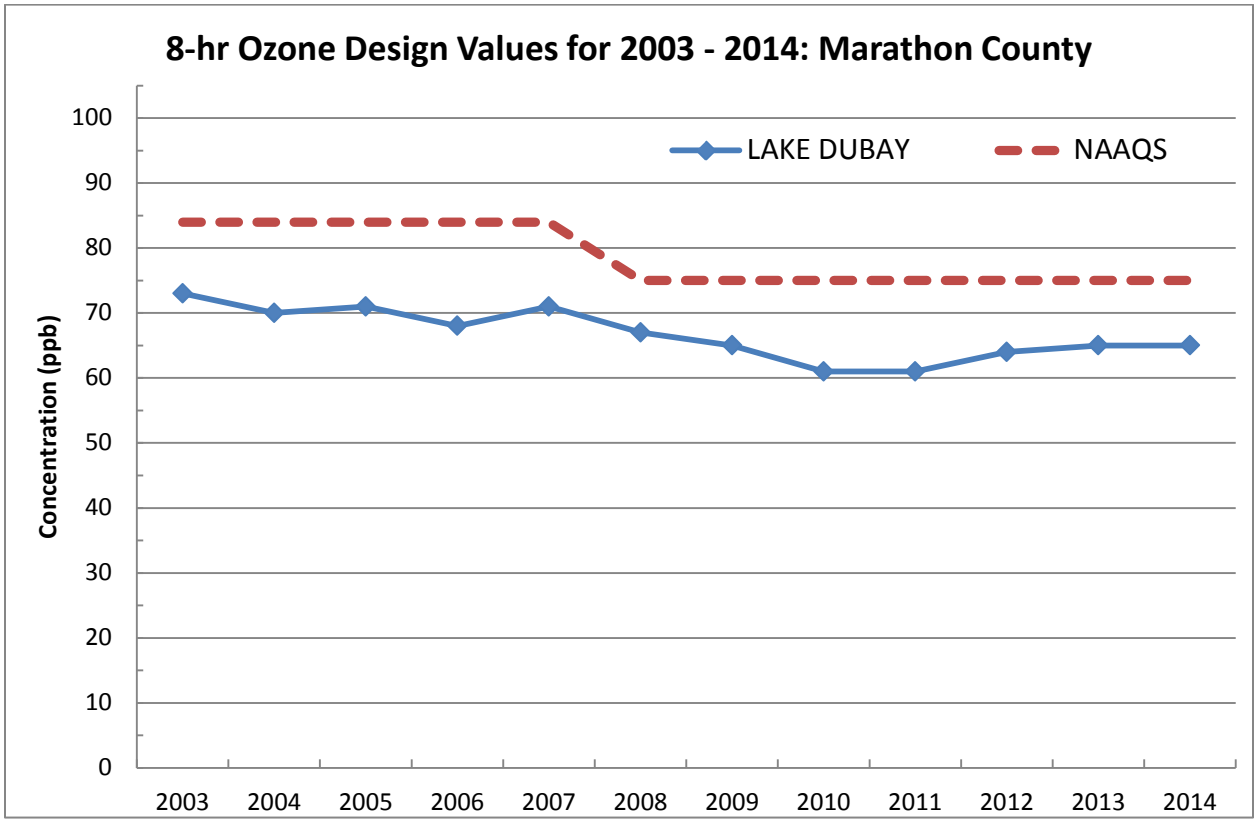
Manitowoc County

Ozone monitoring for Manitowoc County is performed at 2315 Goodwin Road in Two Rivers at the Woodland Dunes Nature Center and Preserve.



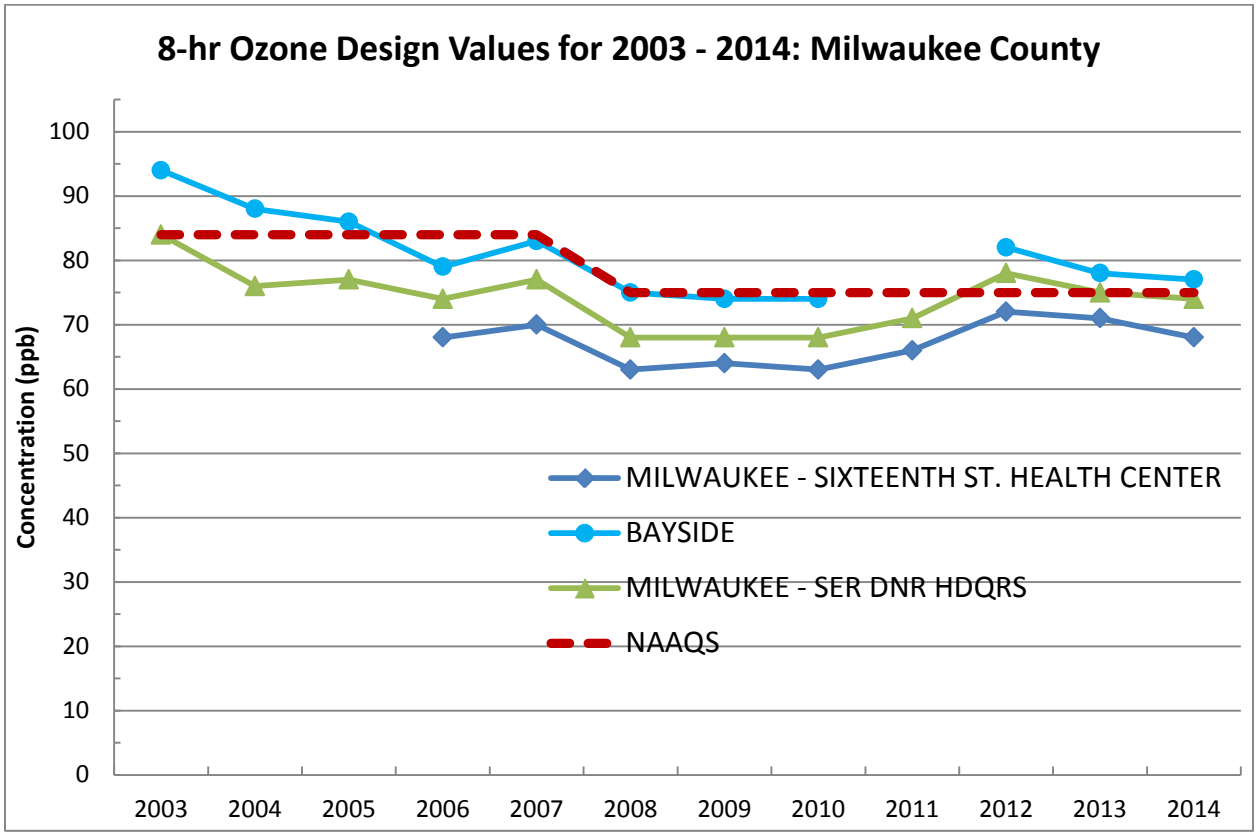
Marathon County

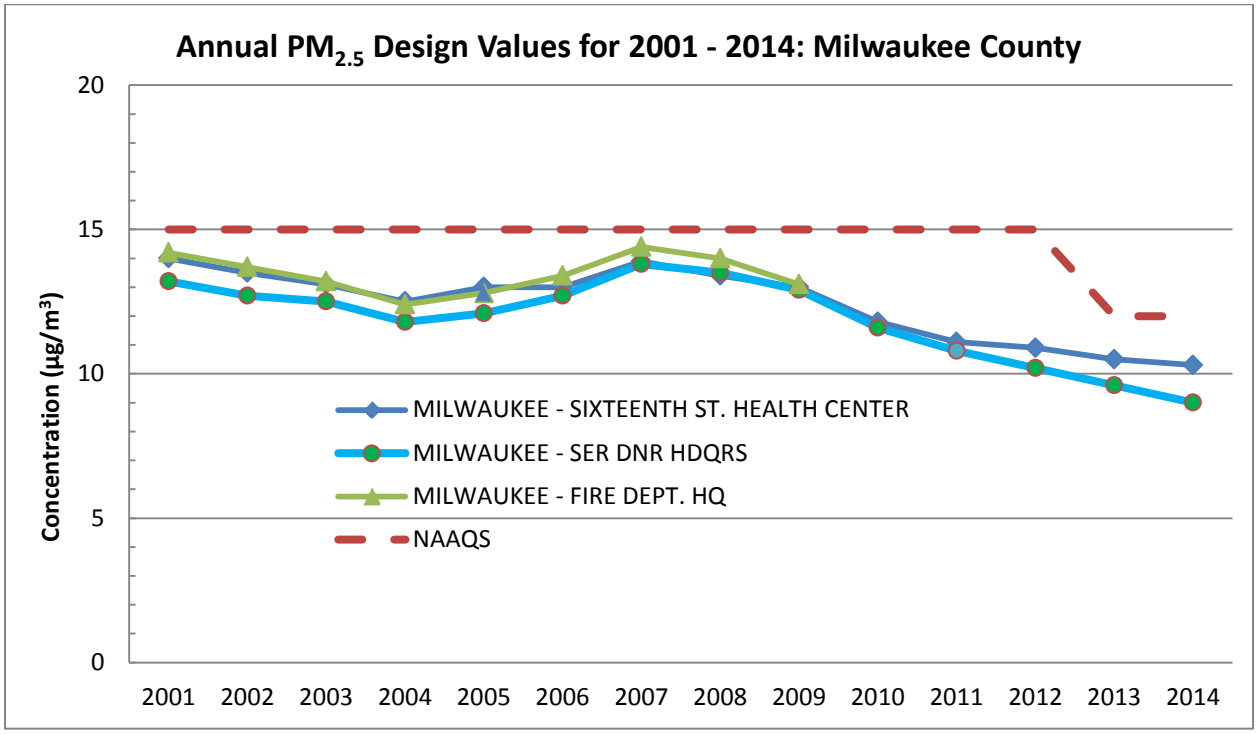
Ozone monitoring in Marathon County is conducted at a rural location at 1780 Bergen Road near Lake Dubay, in Bergen Township.

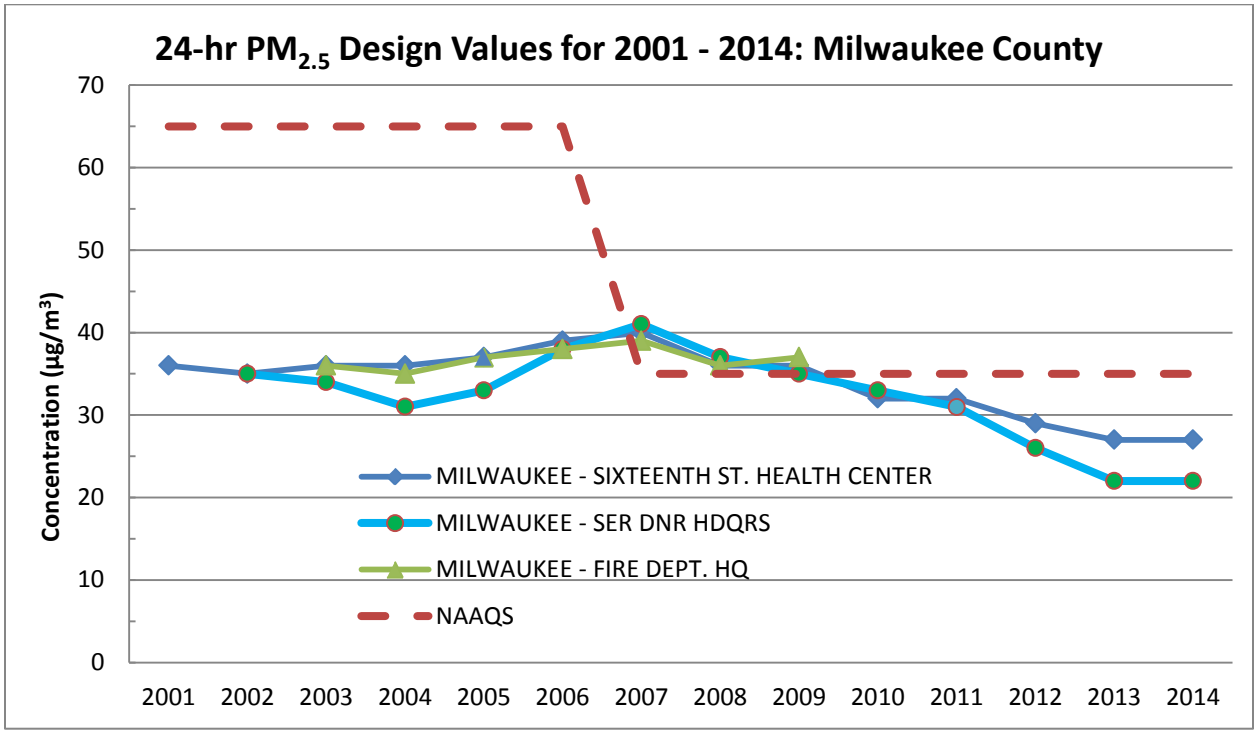


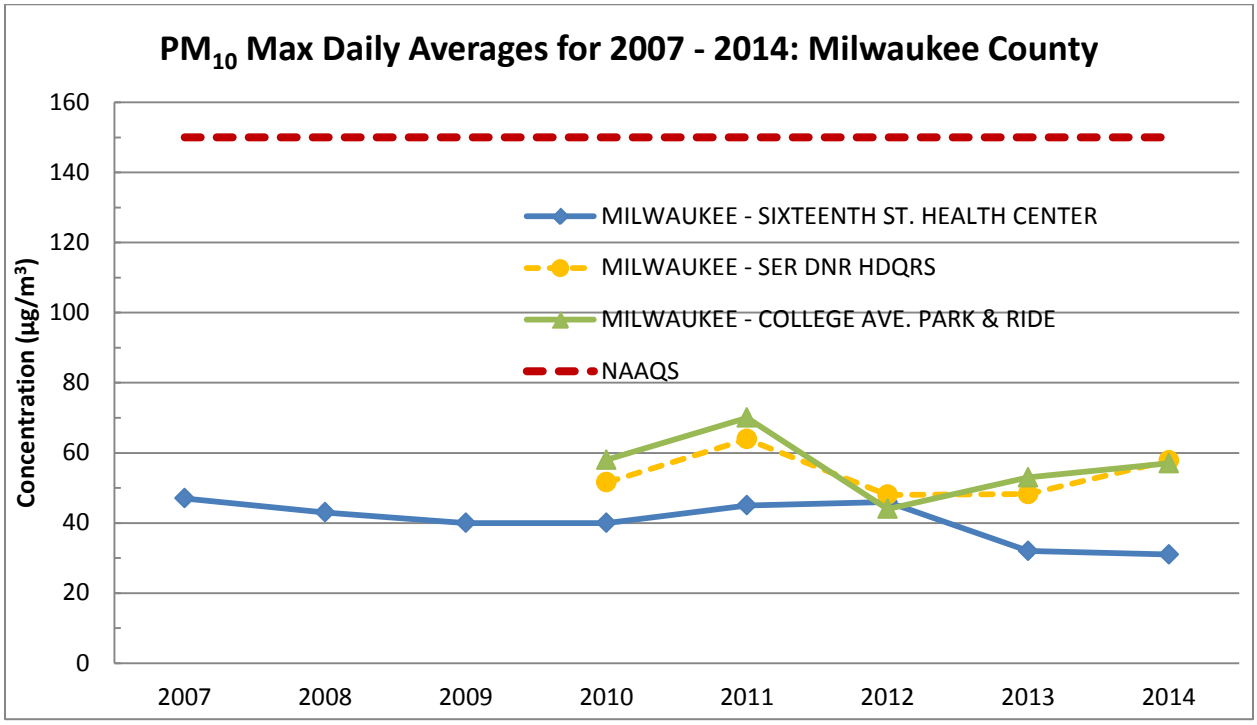
Milwaukee County

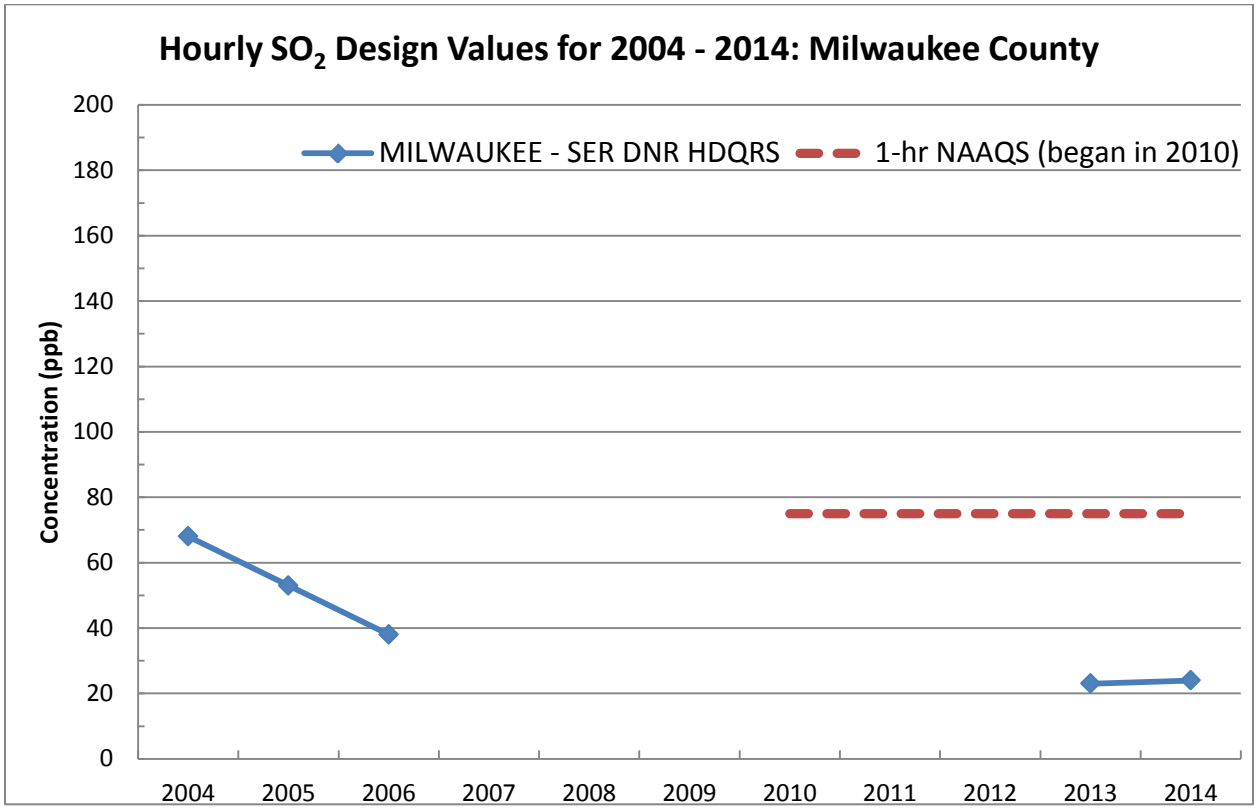
Ozone, $PM_{2.5}$, and PM_{10} monitoring for Milwaukee County takes place at multiple sites which are shown together in the following graphs for comparison. Nitrogen dioxide is monitored at the DNR Headquarters office at 2300 N. Dr. Martin Luther King Jr. Drive as well as at the College Avenue – Near Road site which was established in 2013. Only data from the DNR SER Headquarters site are shown for NO_2 due to the short history and/or invalid design values at College Avenue – Near Road site. Monitoring for SO_2 is performed only at DNR SER Headquarters, while monitoring for CO takes place only at the College Avenue – Near Road site starting in 2014. Graphs for CO are not shown here because of the short record.



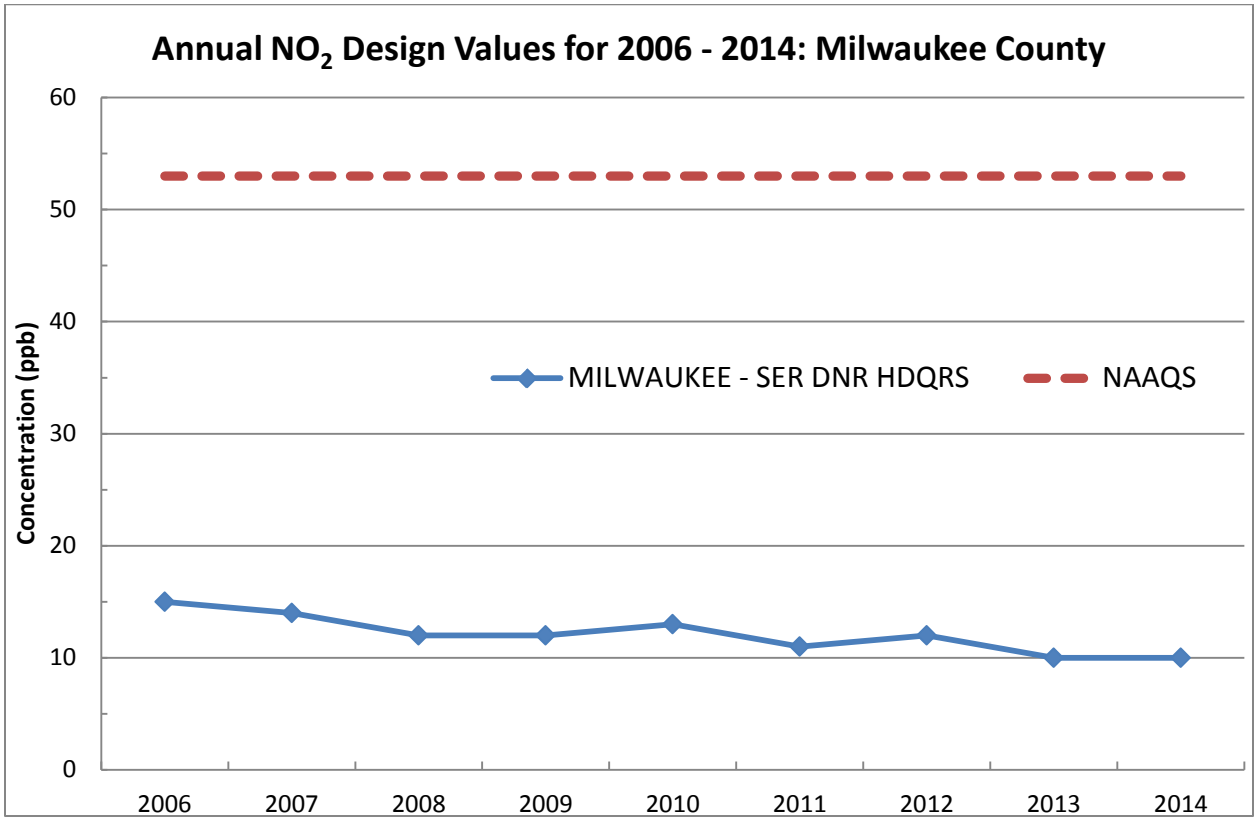

Annual PM2.5 Design Values for 2001 - 2014: Milwaukee County
Concentration (µg/m³)
20
15
10
5
0
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
MILWAUKEE - SIXTEENTH ST. HEALTH CENTER
MILWAUKEE - SER DNR HDQRS
MILWAUKEE - FIRE DEPT. HQ
NAAQS

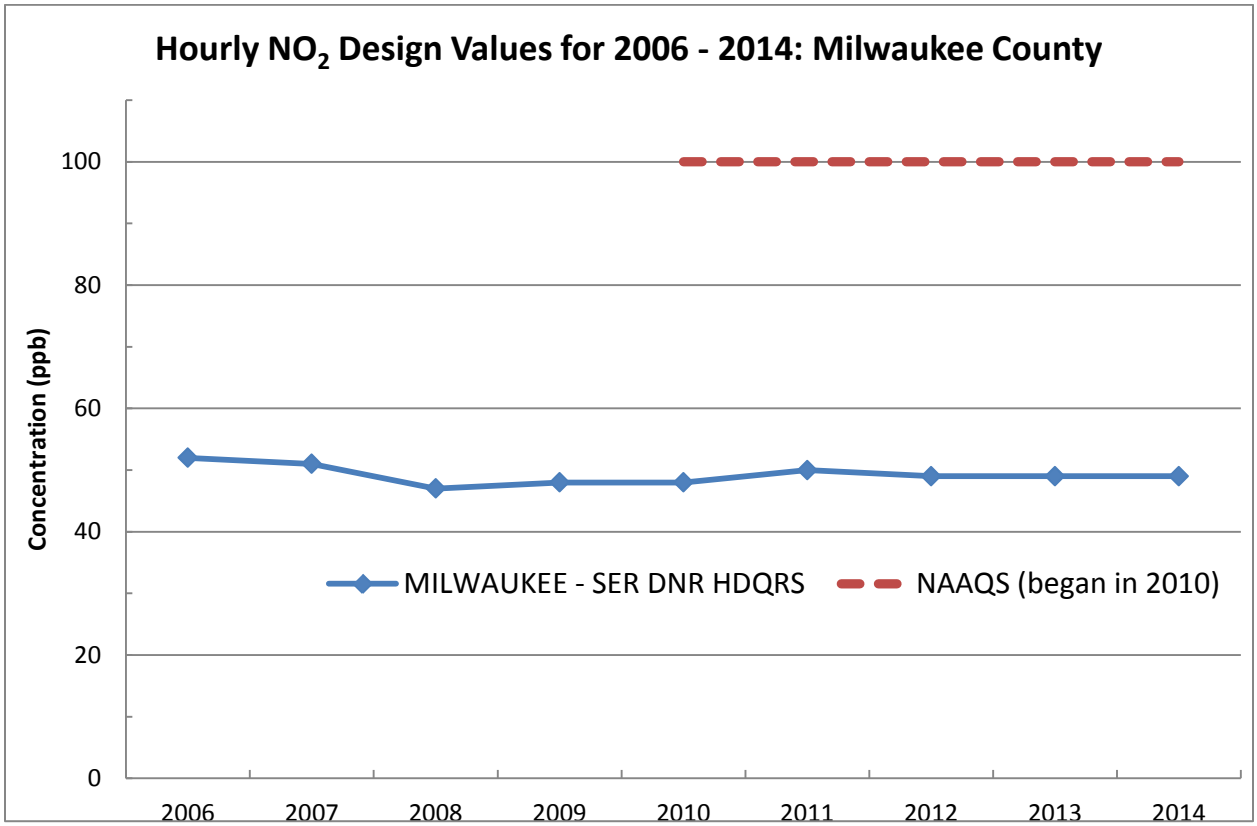

24-hr PM2.5 Design Values for 2001 - 2014: Milwaukee County
Concentration (µg/m³)
70
60
50
40
30
20
10
0
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
MILWAUKEE - SIXTEENTH ST. HEALTH CENTER
MILWAUKEE - SER DNR HDQRS
MILWAUKEE - FIRE DEPT. HQ
NAAQS





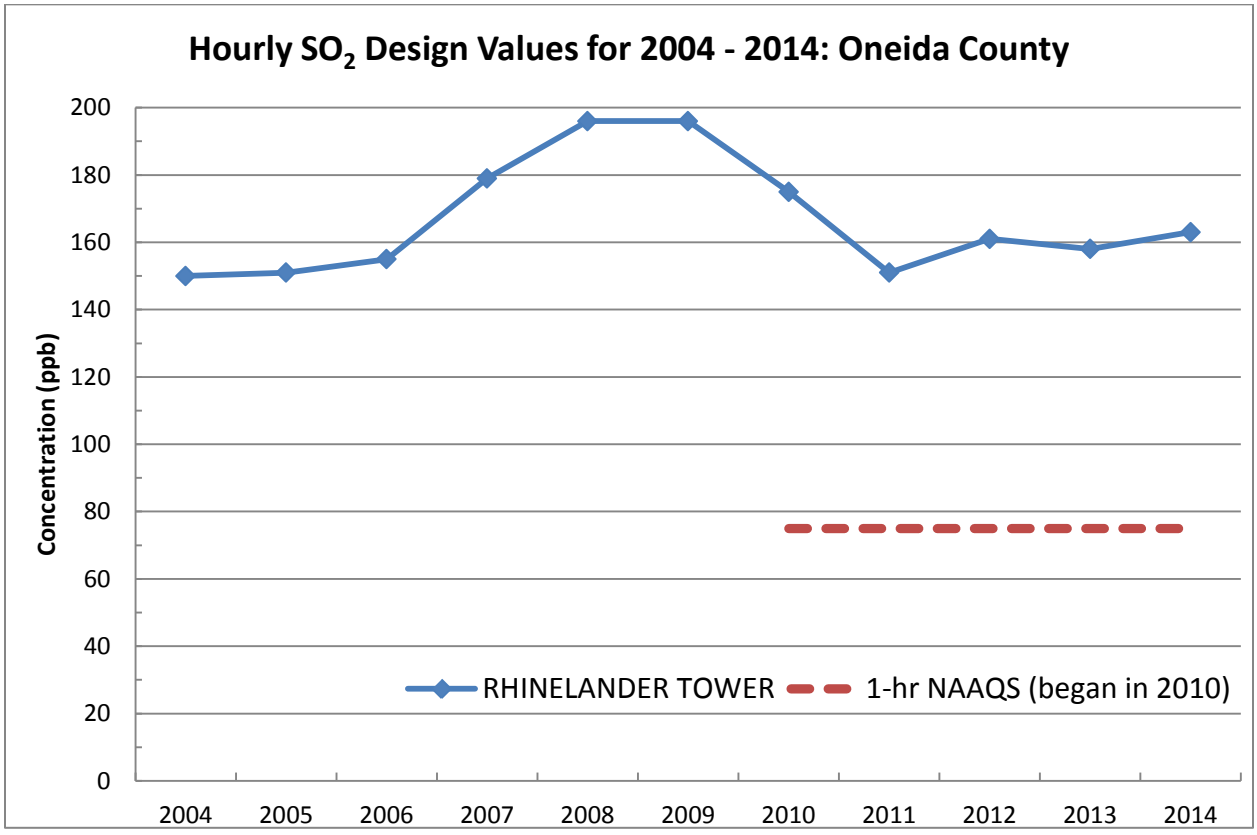
The EPA established an hourly SO_2 standard in 2010 that replaced the previous 24-hr and annual standards.


Annual NO2 Design Values for 2006 - 2014: Milwaukee County
Concentration (ppb)
60
50
40
30
20
10
0
2006
2007
2008
2009
2010
2011
2012
2013
2014
MILWAUKEE - SER DNR HDQRS
NAAQS


Hourly NO2 Design Values for 2006 - 2014: Milwaukee County
Concentration (ppb)
100
80
60
40
20
0
2006
2007
2008
2009
2010
2011
2012
2013
2014
MILWAUKEE - SER DNR HDQRS
NAAQS (began in 2010)

Oneida County

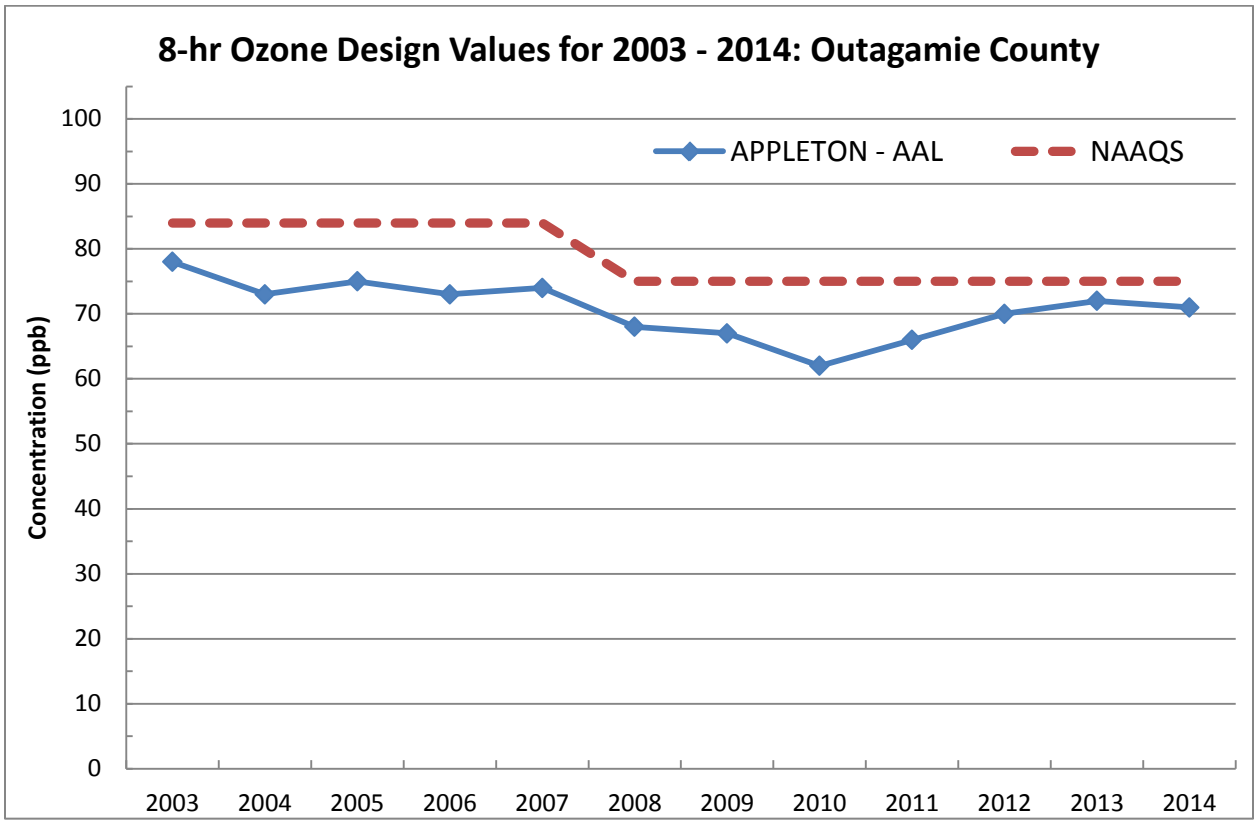
Monitoring for SO_2 in Oneida County takes place at 434 High Street, next to the Rhinelander water tower. This site is source-oriented and is sited to assess compliance with the SO_2 NAAQS. Note that the design values from this site are out of compliance with the hourly standard. The WDNR is submitting an SO_2 NAAQS attainment demonstration that establishes permanent and enforceable SO_2 requirements through Administrative Order AM-01-15 entered between the Department and the facility primarily responsible for the monitored values.

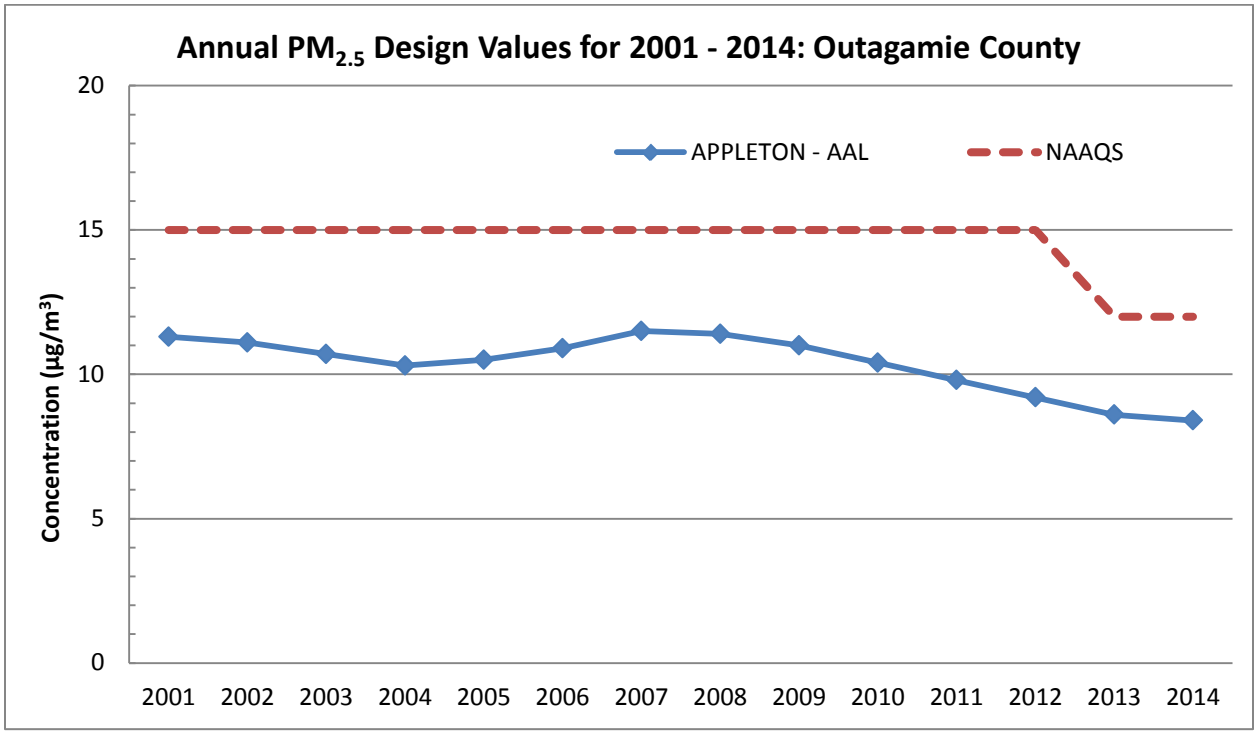


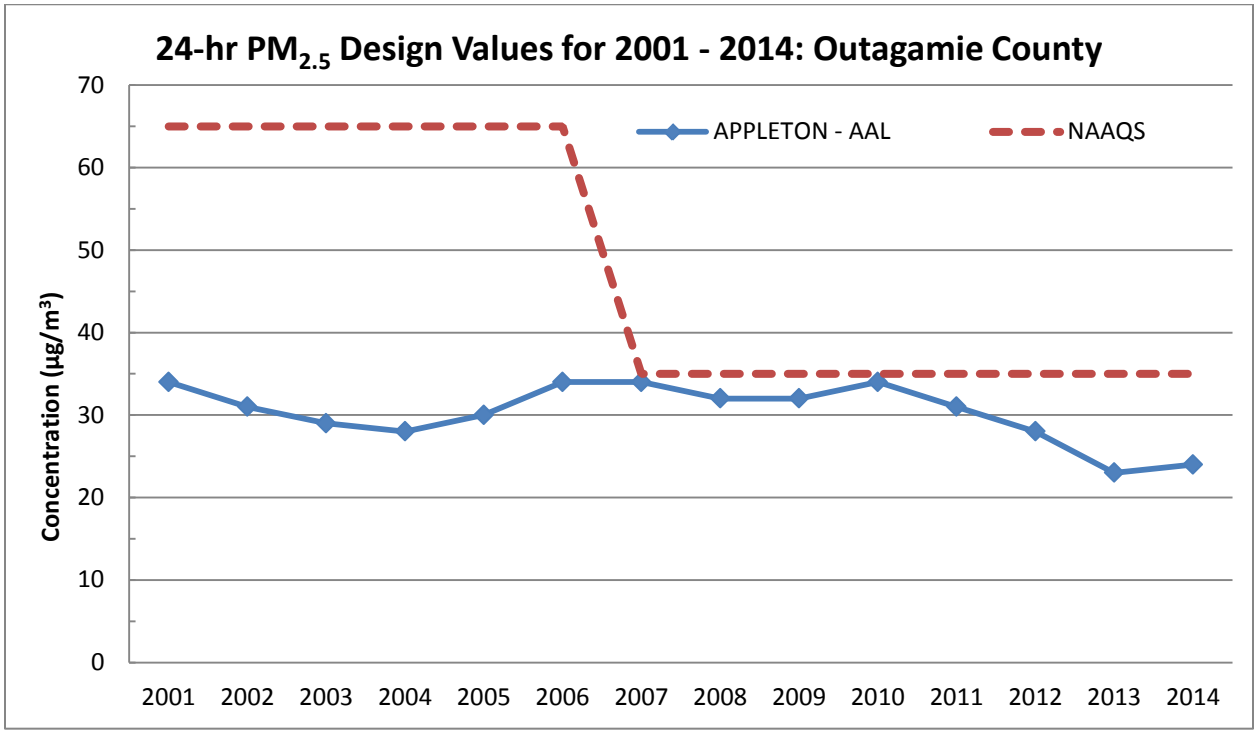
The EPA established a hourly SO_2 standard in 2010 that replaced the previous 24-hour and annual standards.

Outagamie County

Ozone and $PM_{2.5}$ monitoring in Outagamie County is performed at 4432 North Meade Street in Appleton near a residential area.

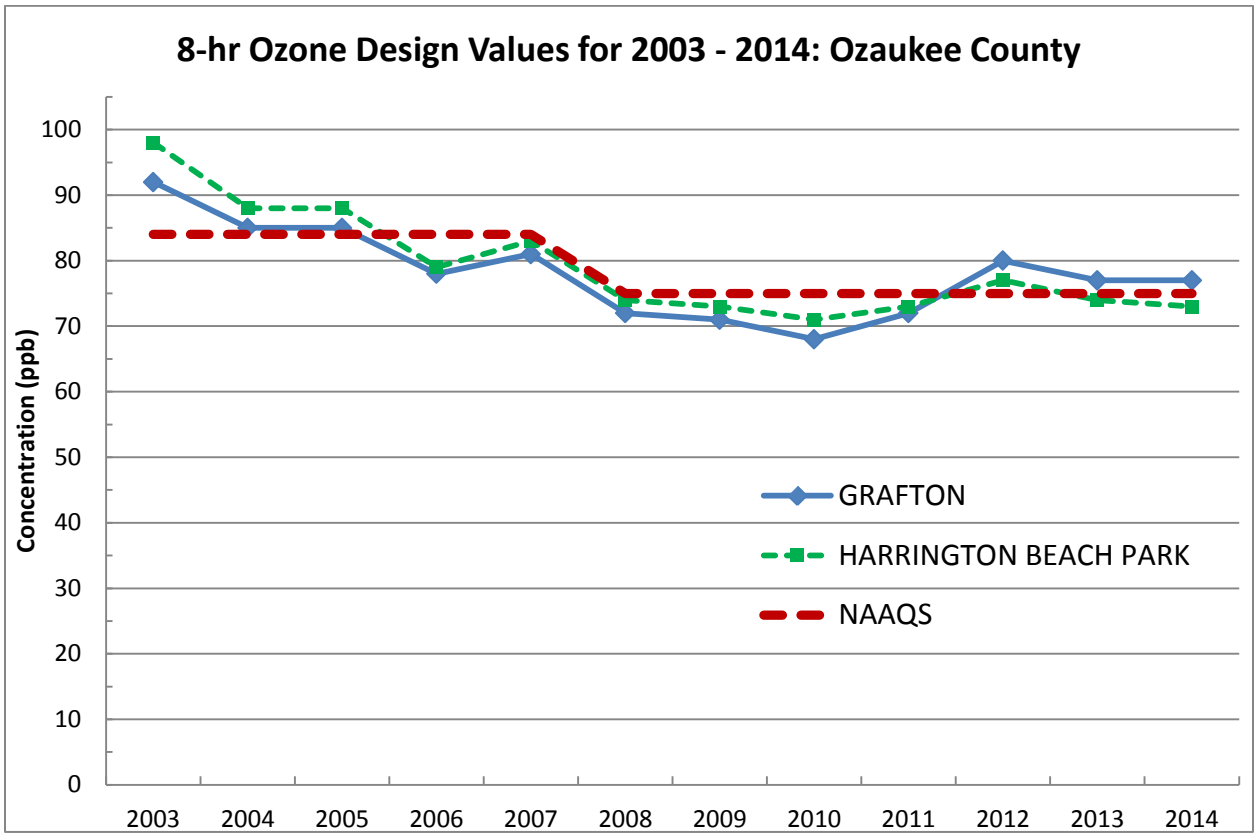


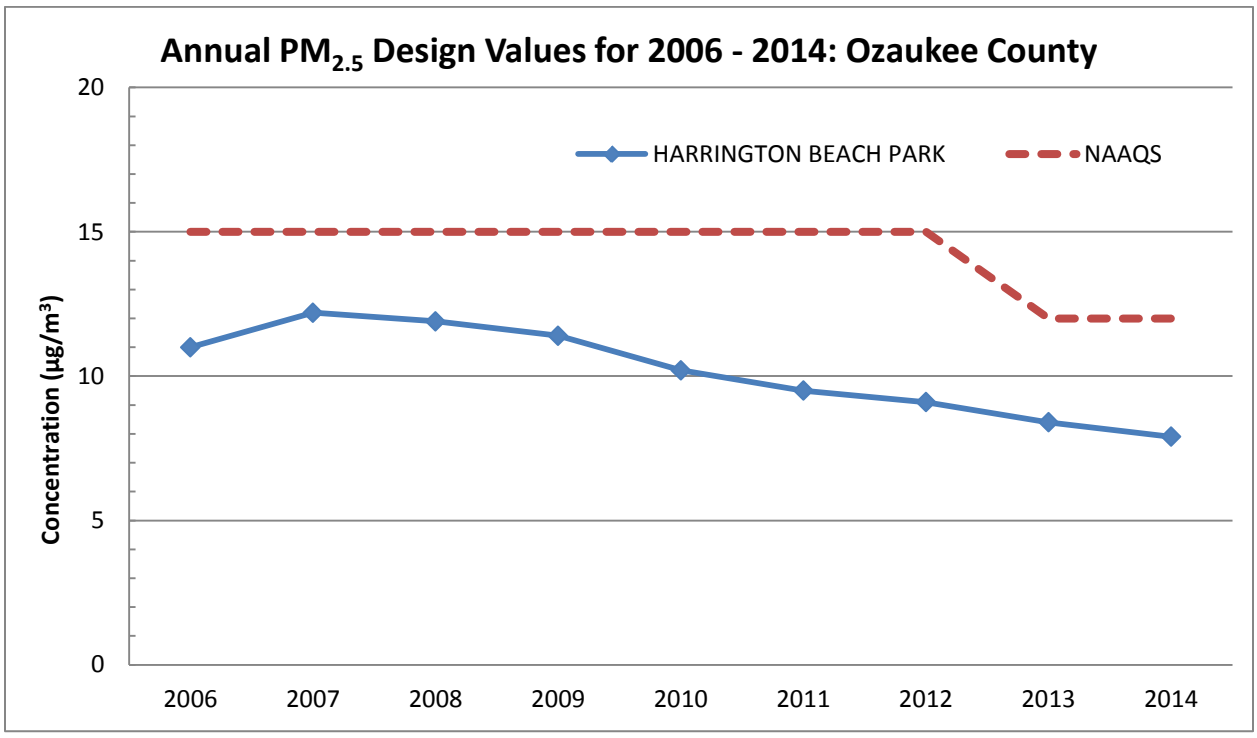


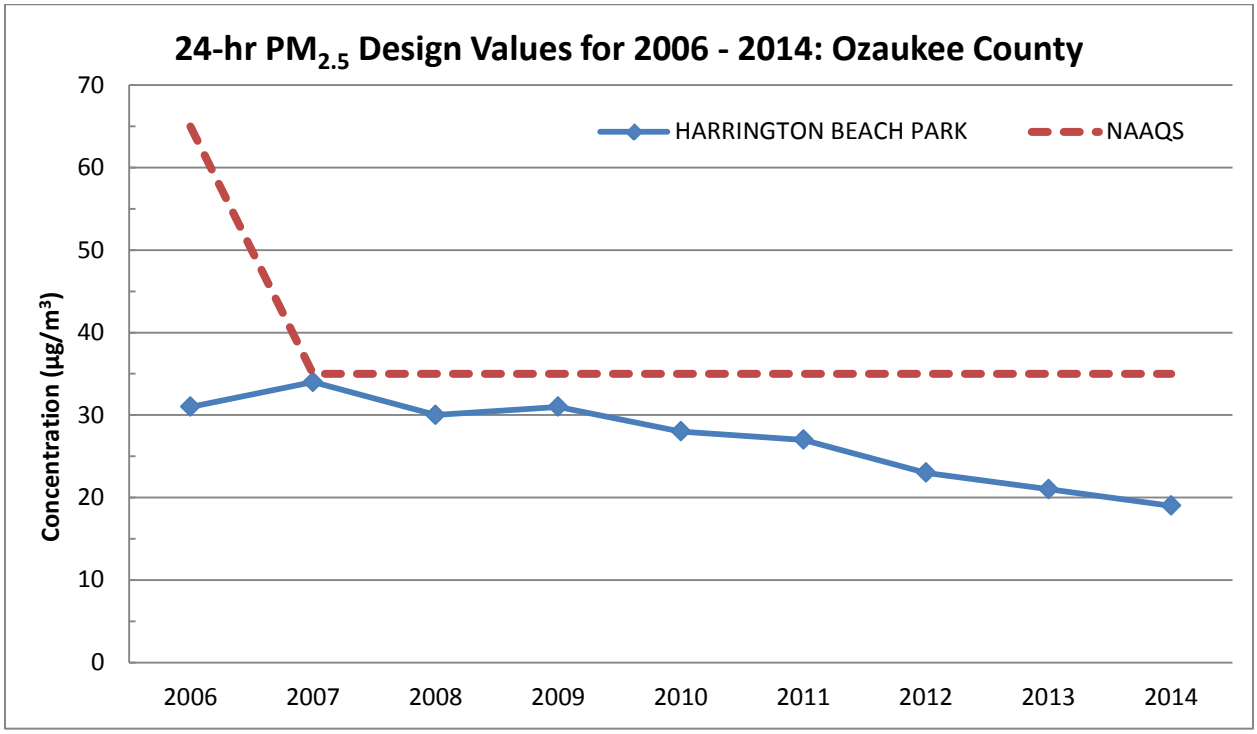

24-hr PM2.5 Design Values for 2001 - 2014: Outagamie County
Concentration (µg/m³)
70
60
50
40
30
20
10
0
APPLETON - AAL
NAAQS
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014

Ozaukee County

Ozone monitoring in Ozaukee County takes place at the intersection of Highway 57 and I-43 in Grafton and at Harrington Beach State Park, located at 531 Highway D. Monitoring for $PM_{2.5}$ takes place only at the Harrington Beach site.





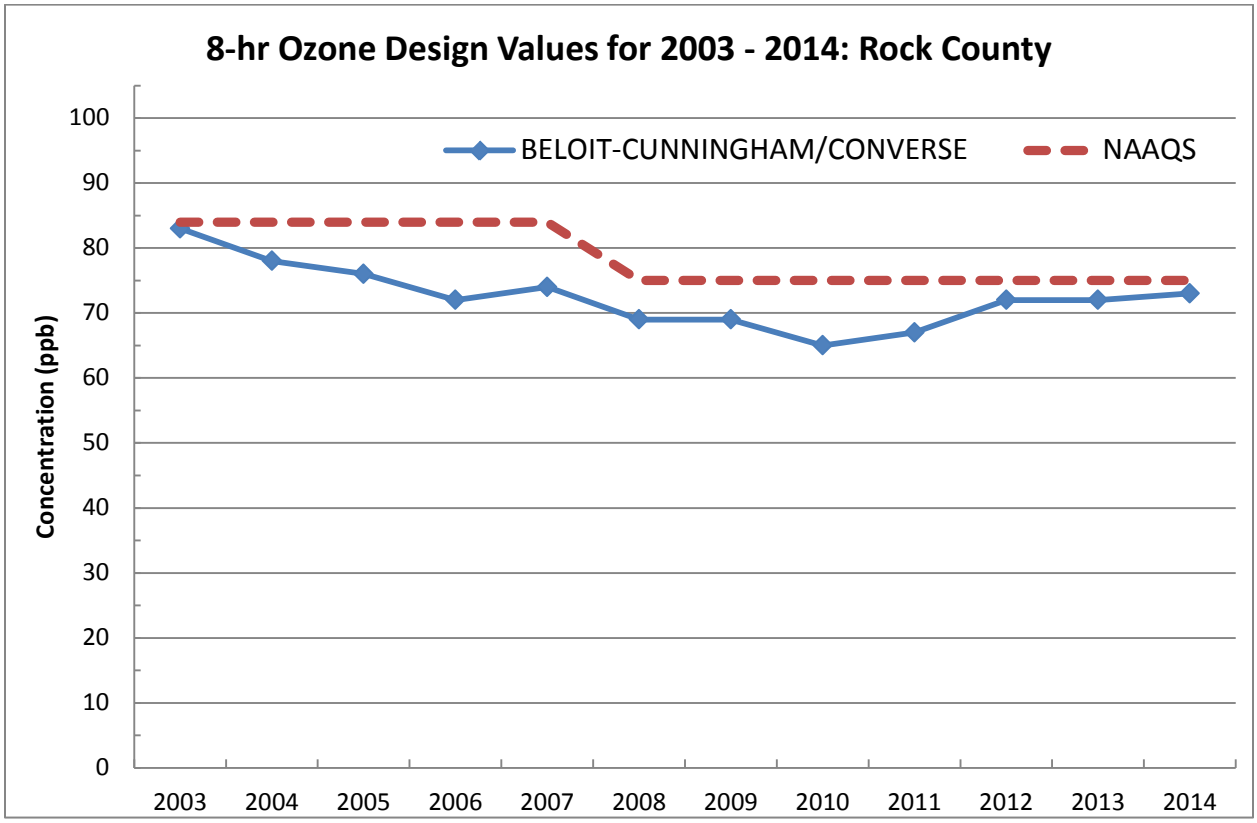

24-hr PM2.5 Design Values for 2006 - 2014: Ozaukee County
Concentration (µg/m³)
70
60
50
40
30
20
10
0
HARRINGTON BEACH PARK
NAAQS
2006
2007
2008
2009
2010
2011
2012
2013
2014

Racine County

Ozone monitoring in Racine County is conducted at 4227 Charles Street in a farm field in the rural village of Caledonia. Sampling began at this site on April 3, 2015. Prior to this date, sampling for ozone in Racine County was performed at 1519 Washington Avenue inside a local business in the downtown area of the City of Racine. This site shut down at the end of 2013. Data from the old and new sites will not be combined. Because sampling at the new site began after 2014, no design values for this site are currently available.

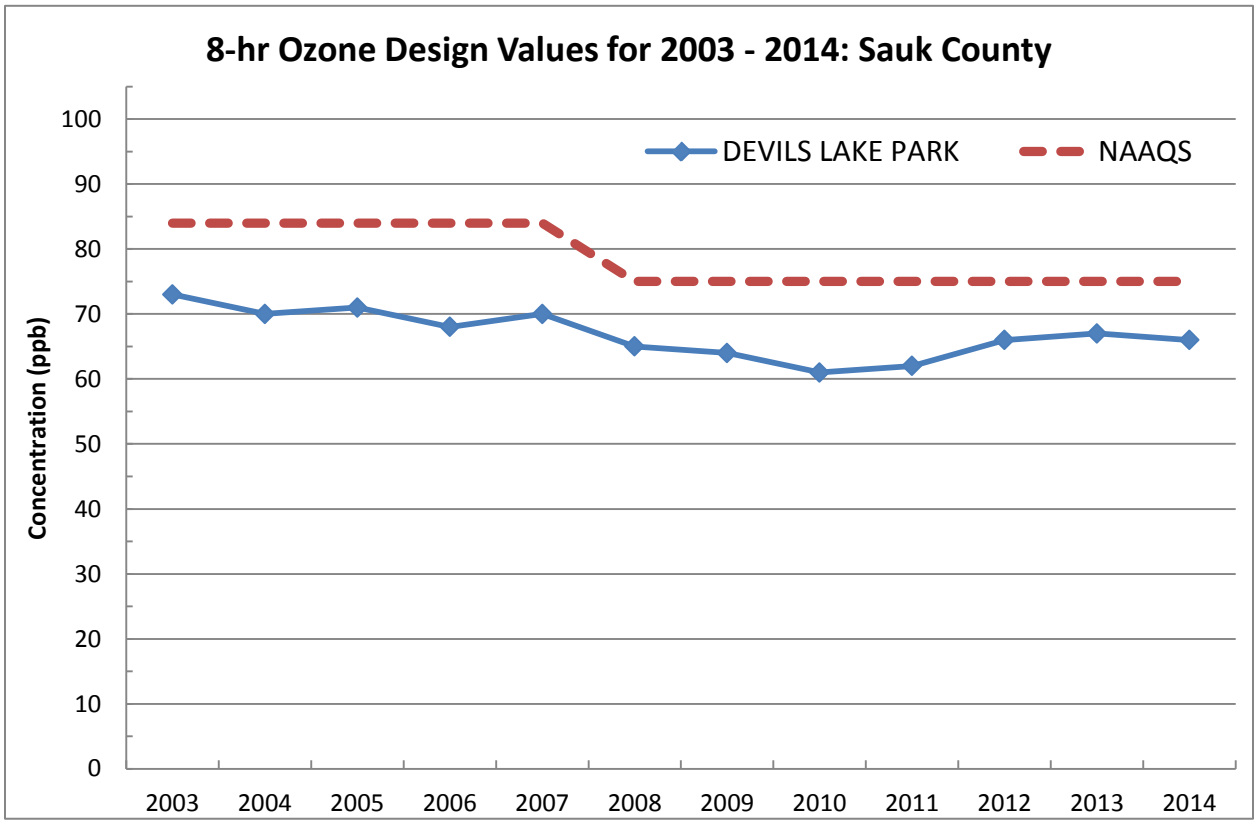
Rock County

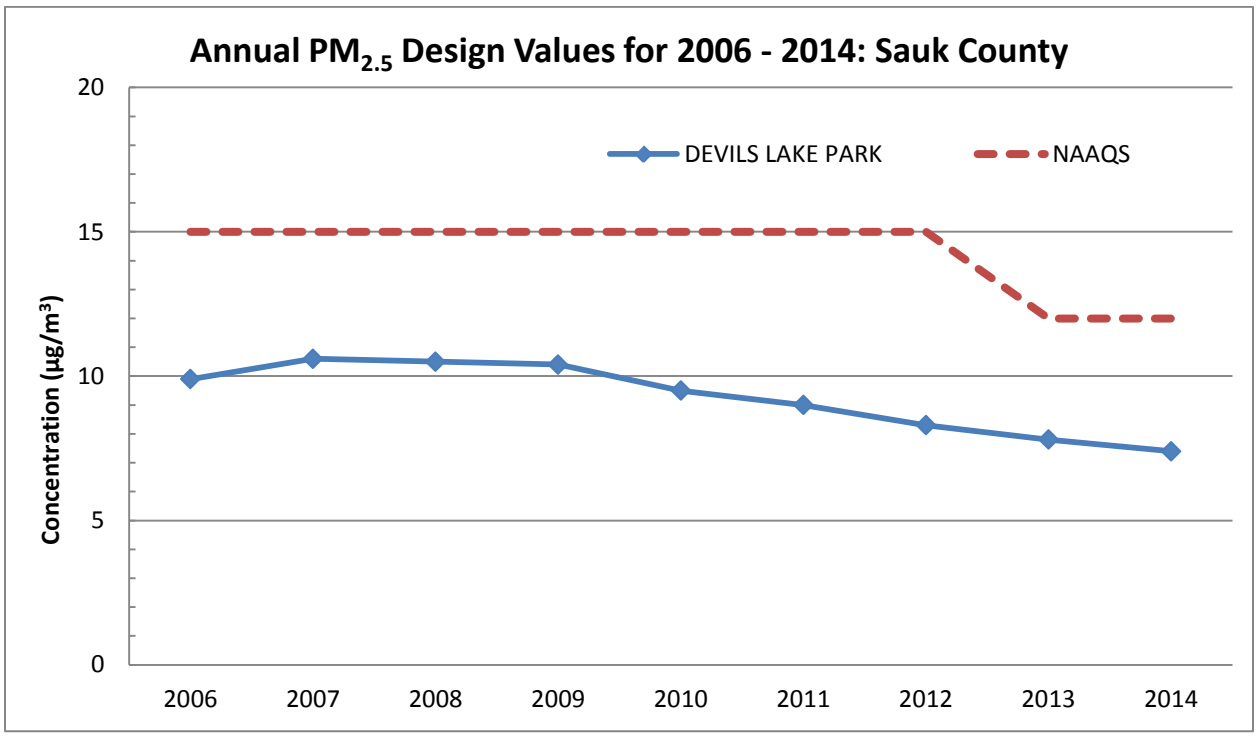
Ozone monitoring in Rock County is conducted at 1948 Merrill Street in Beloit. The site is located in a fenced area at the Cunningham School.

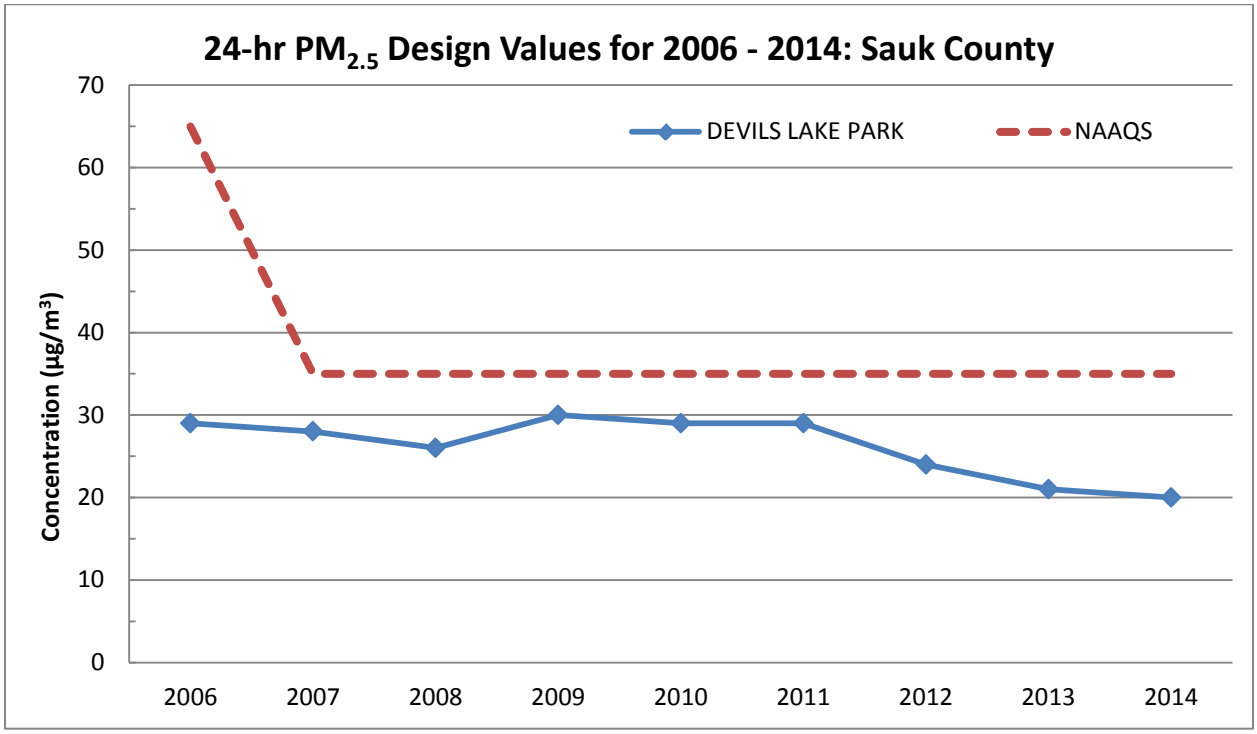


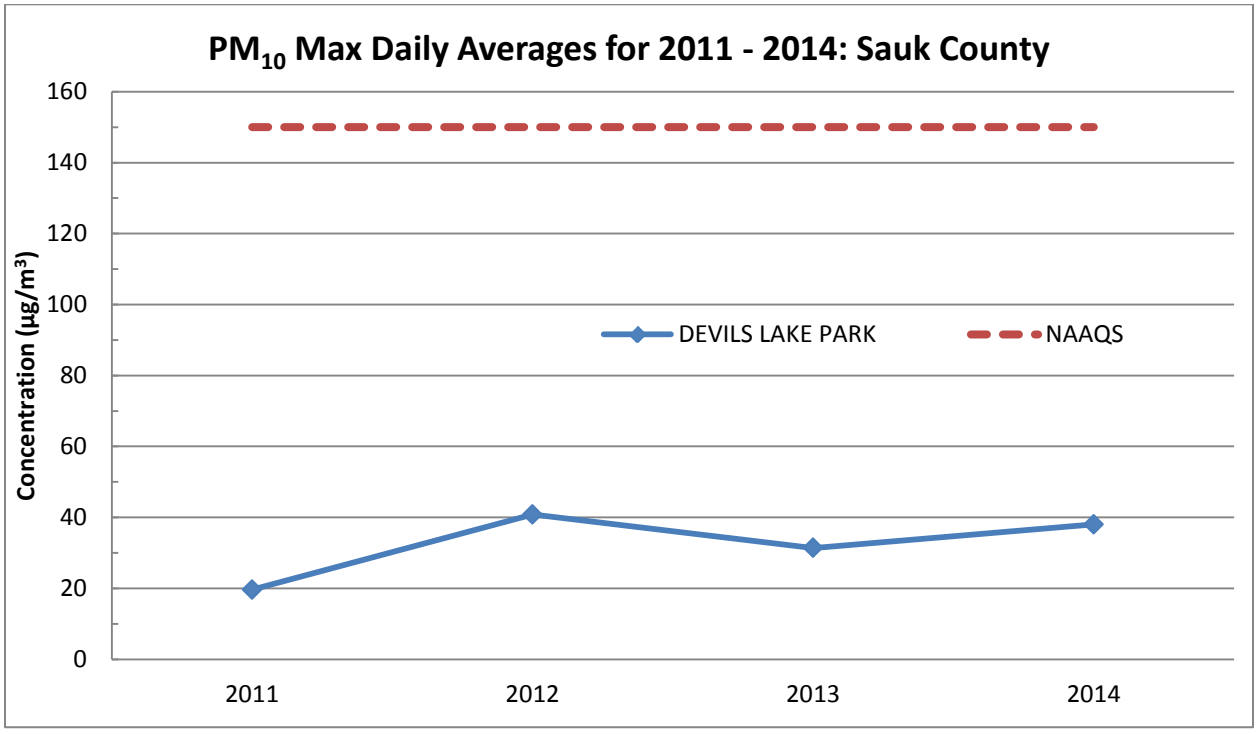
Sauk County

Ozone, $PM_{2,5}$, and PM_{10} monitoring in Sauk County takes place at Devils Lake State Park at E12886 Tower Road in Baraboo.



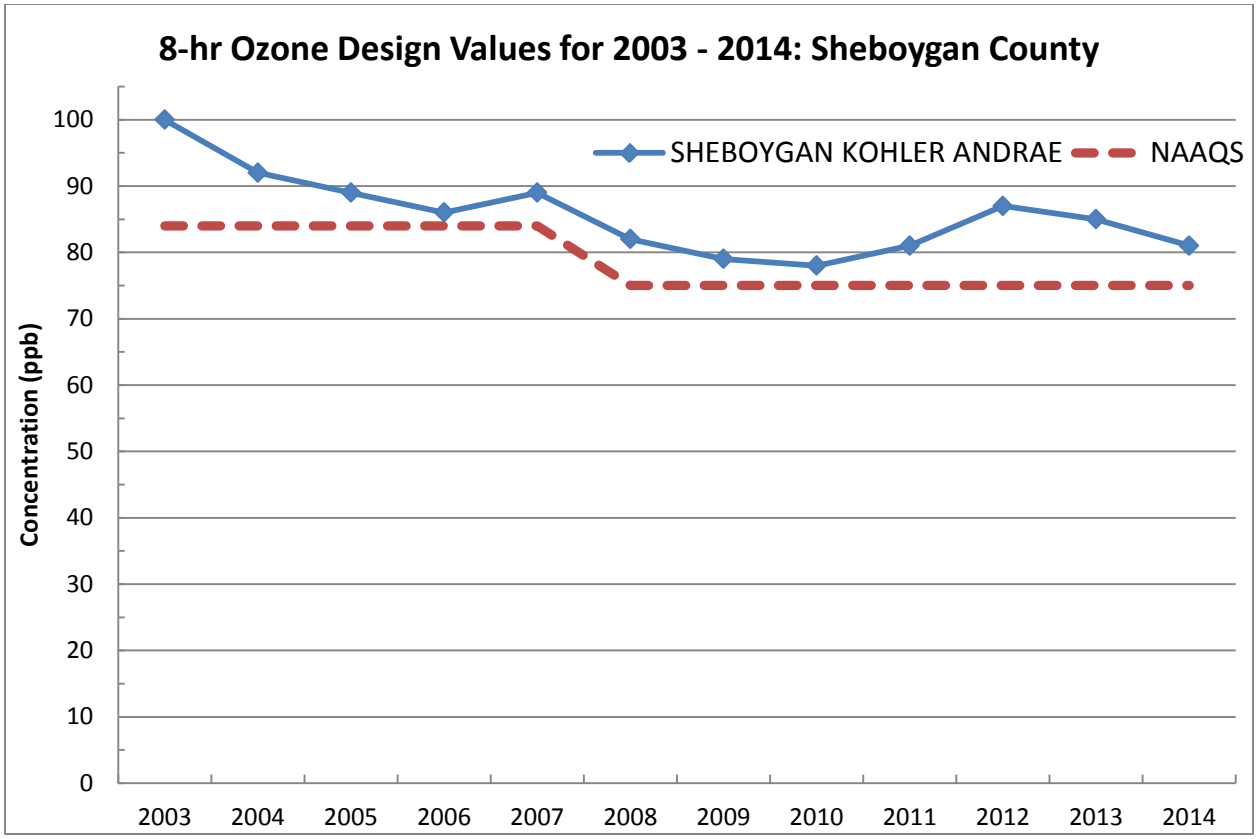



24-hr PM2.5 Design Values for 2006 - 2014: Sauk County
Concentration (µg/m³)
70
60
50
40
30
20
10
0
DEVILS LAKE PARK
NAAQS
2006
2007
2008
2009
2010
2011
2012
2013
2014


PM10 Max Daily Averages for 2011 - 2014: Sauk County
Concentration (µg/m³)
160
140
120
100
80
60
40
20
0
DEVILS LAKE PARK
NAAQS
2011
2012
2013
2014

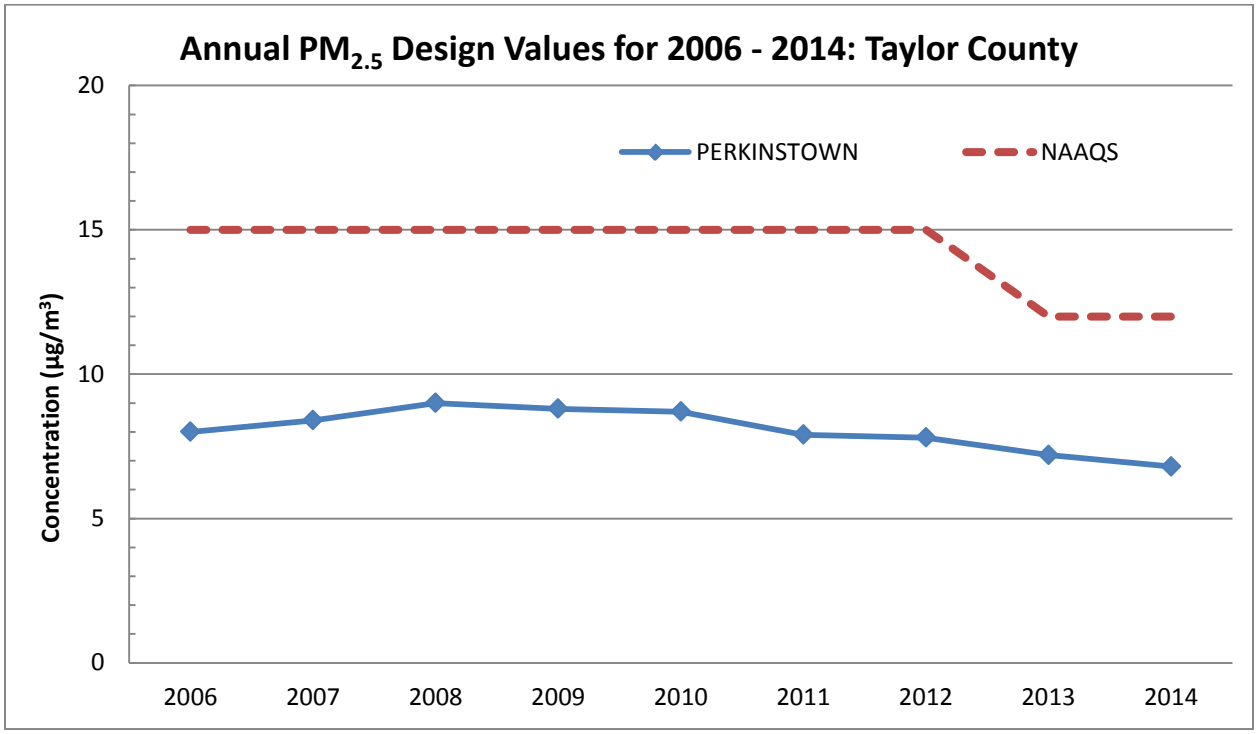
Sheboygan County

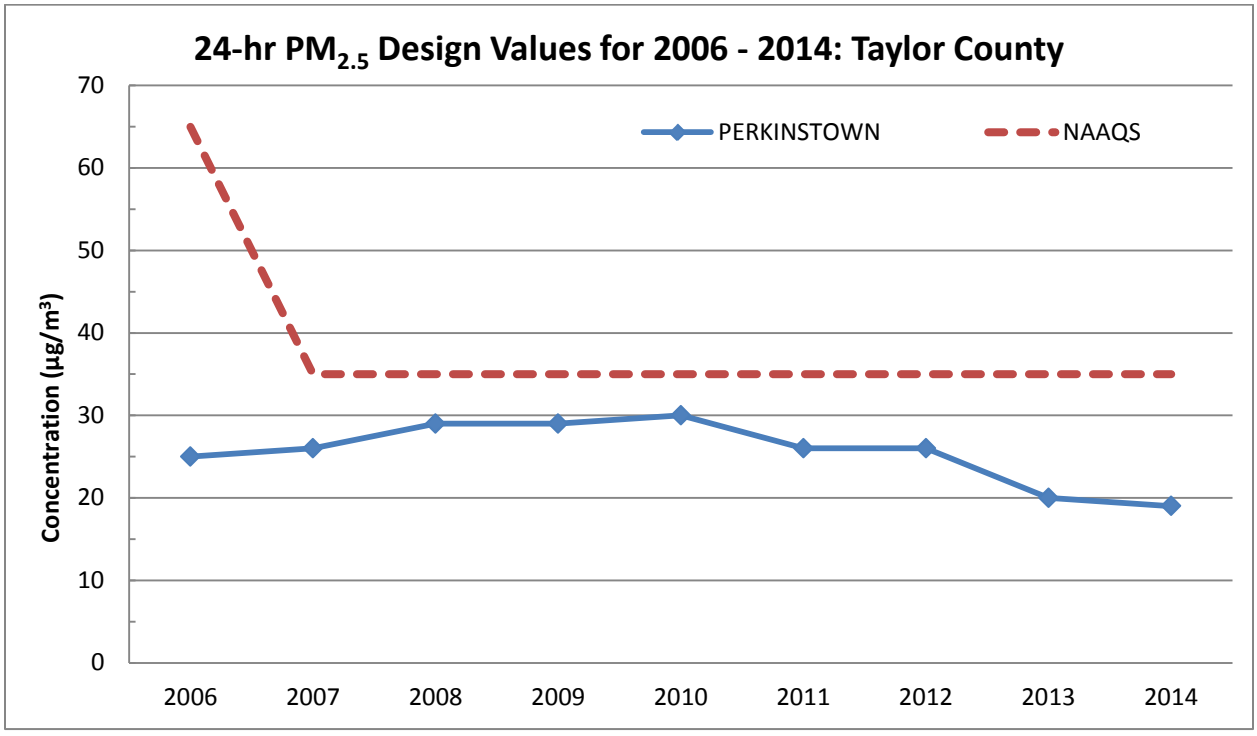
Ozone monitoring in Sheboygan County is performed inside the nature center at Kohler-Andre State Park. This Lake Michigan shoreline site is located at 1520 Beach Park Road. A second special purpose ozone monitoring site was added for the 2014 ozone season. The special purpose site is located near the intersection of Highway 42 and County Road JJ.



Taylor County

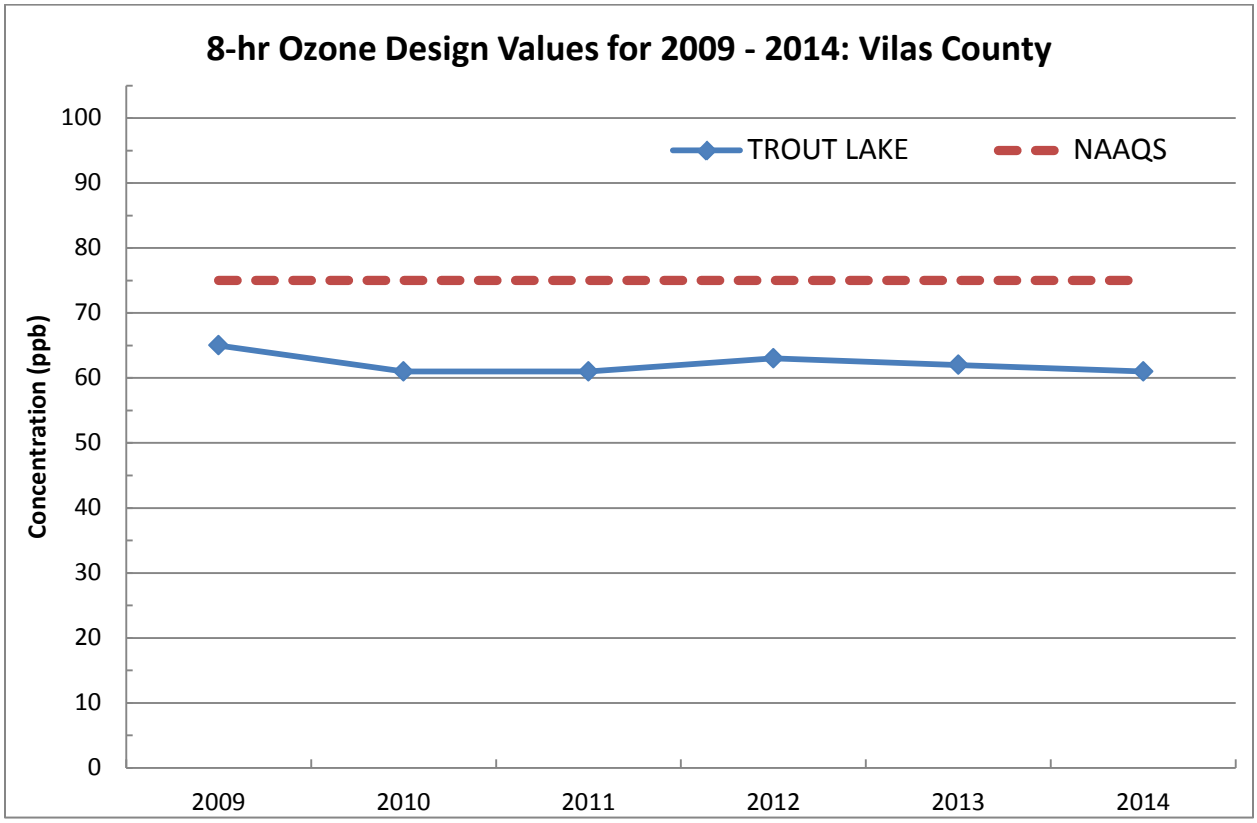
Monitoring for $PM_{2.5}$ in Taylor County takes place at a rural site one mile east of Perkinstown on State Highway M.

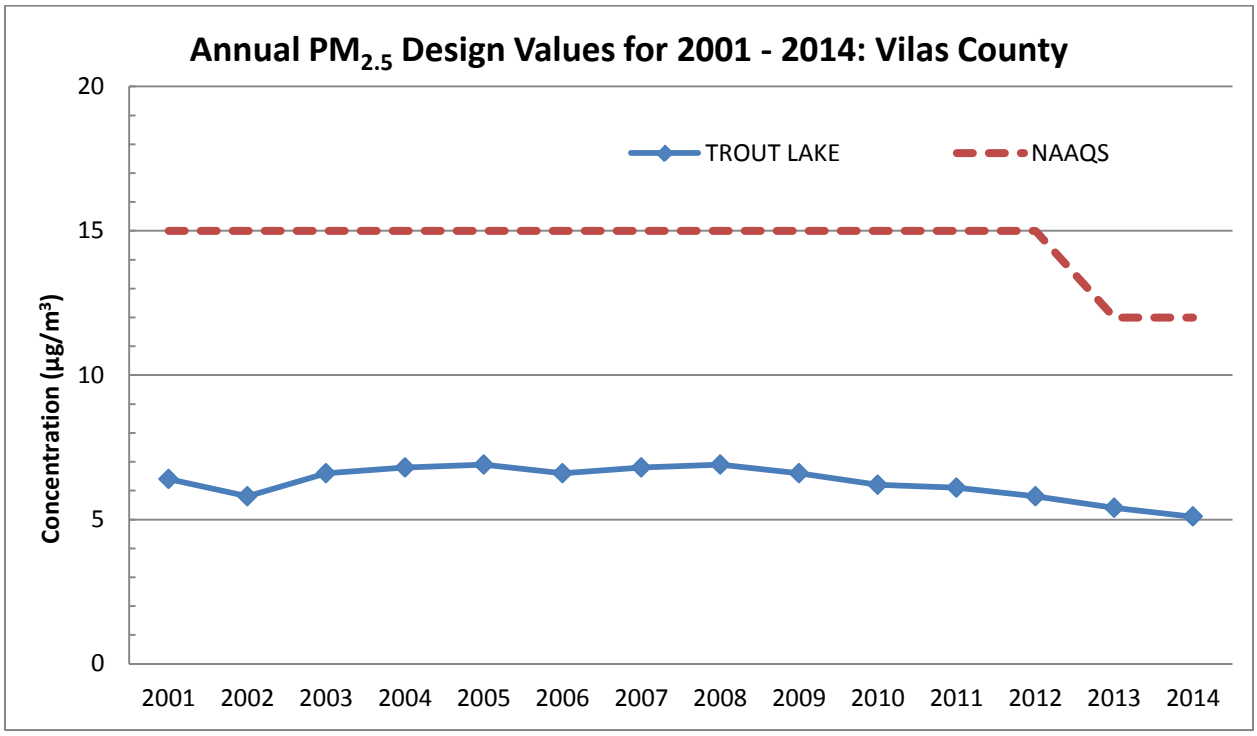


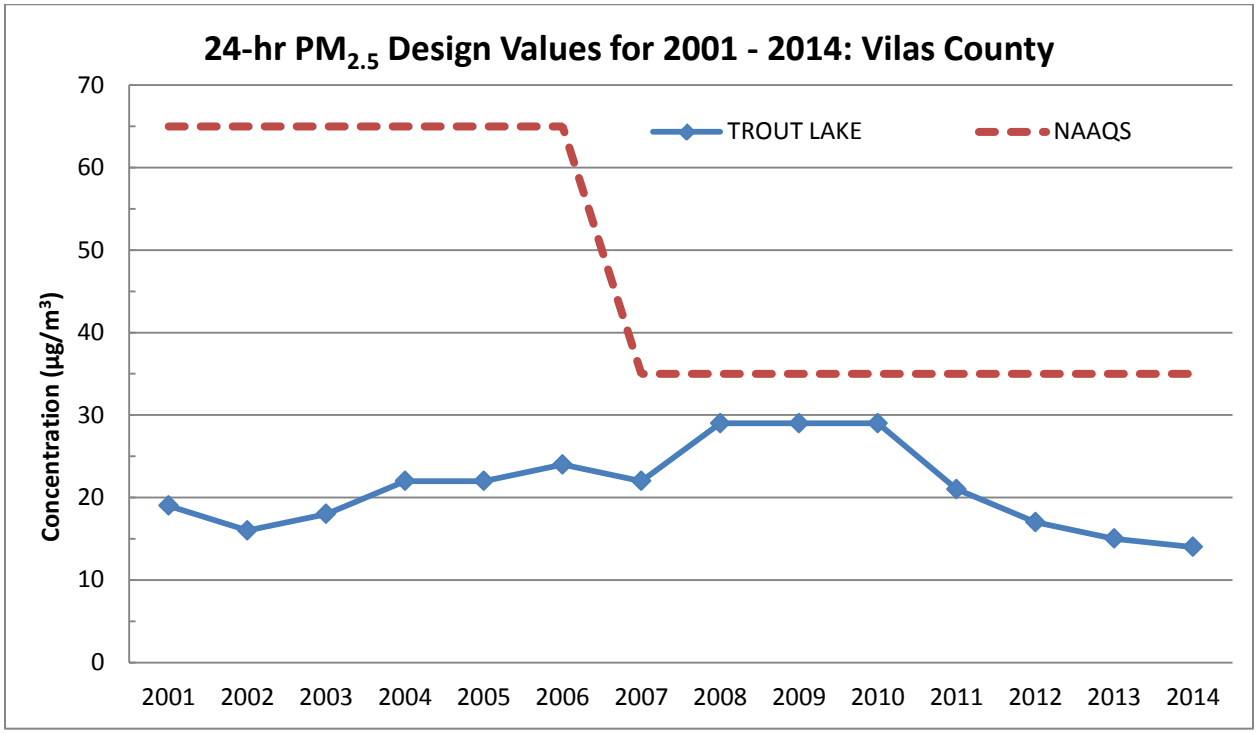


Vilas County

Ozone and $PM_{2.5}$ monitoring in Vilas County is conducted in a field at the DNR Forestry Site at 10810 County Highway M in Boulder Junction.

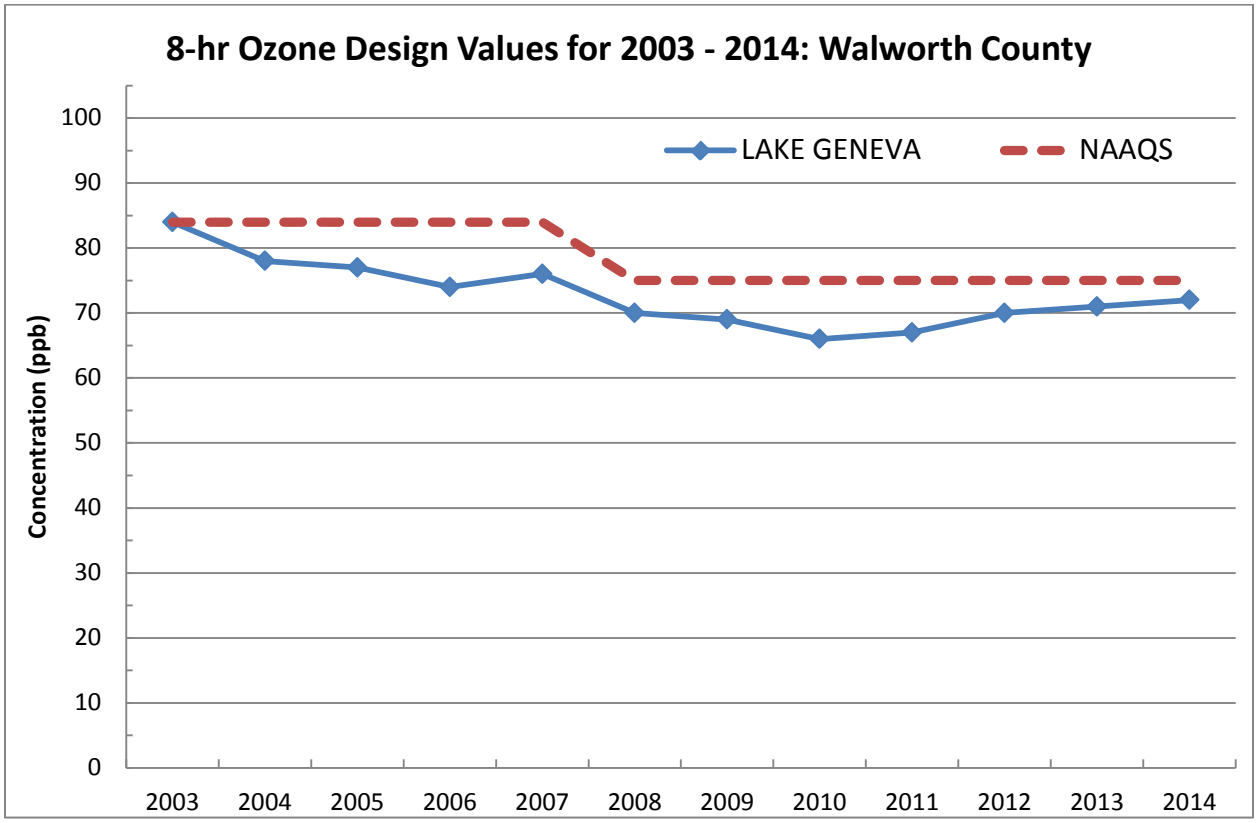





24-hr PM2.5 Design Values for 2001 - 2014: Vilas County
Concentration (µg/m³)
70
60
50
40
30
20
10
0
TROUT LAKE
NAAQS
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014

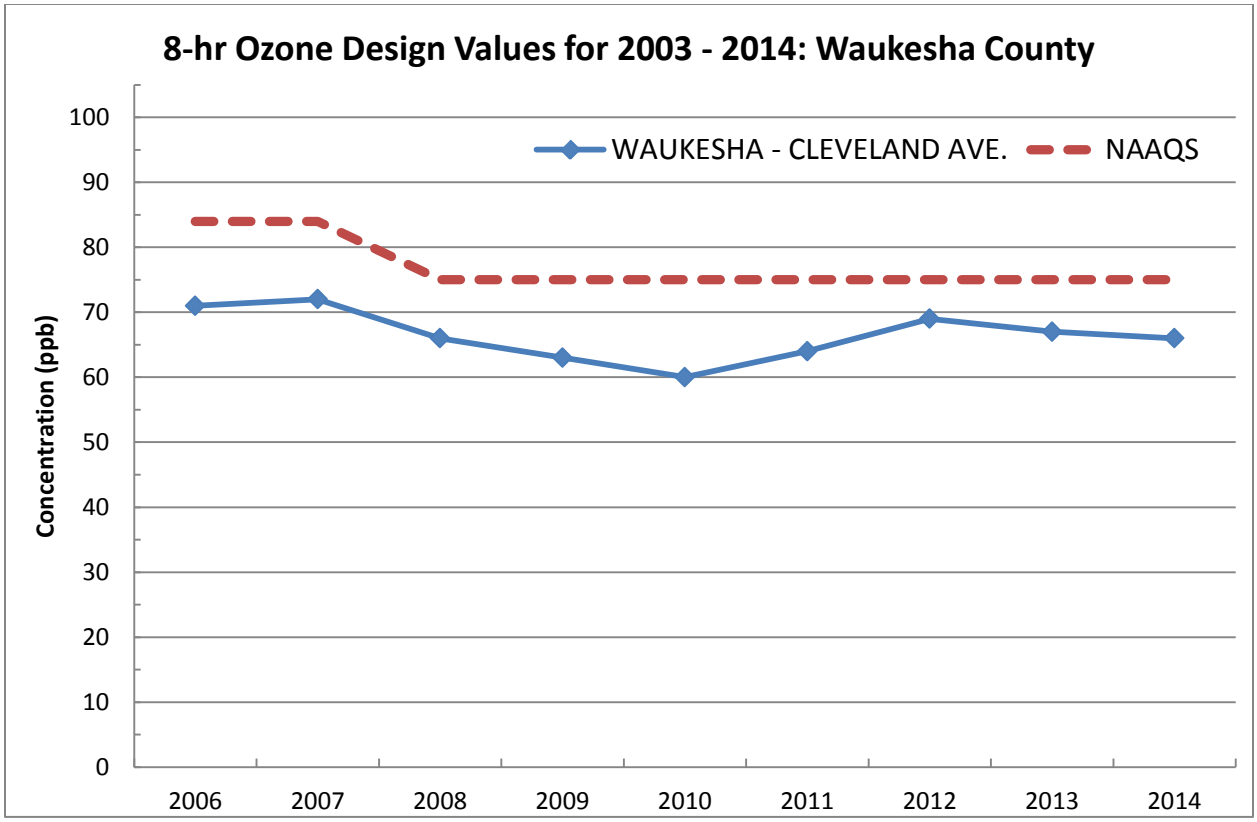
Walworth County

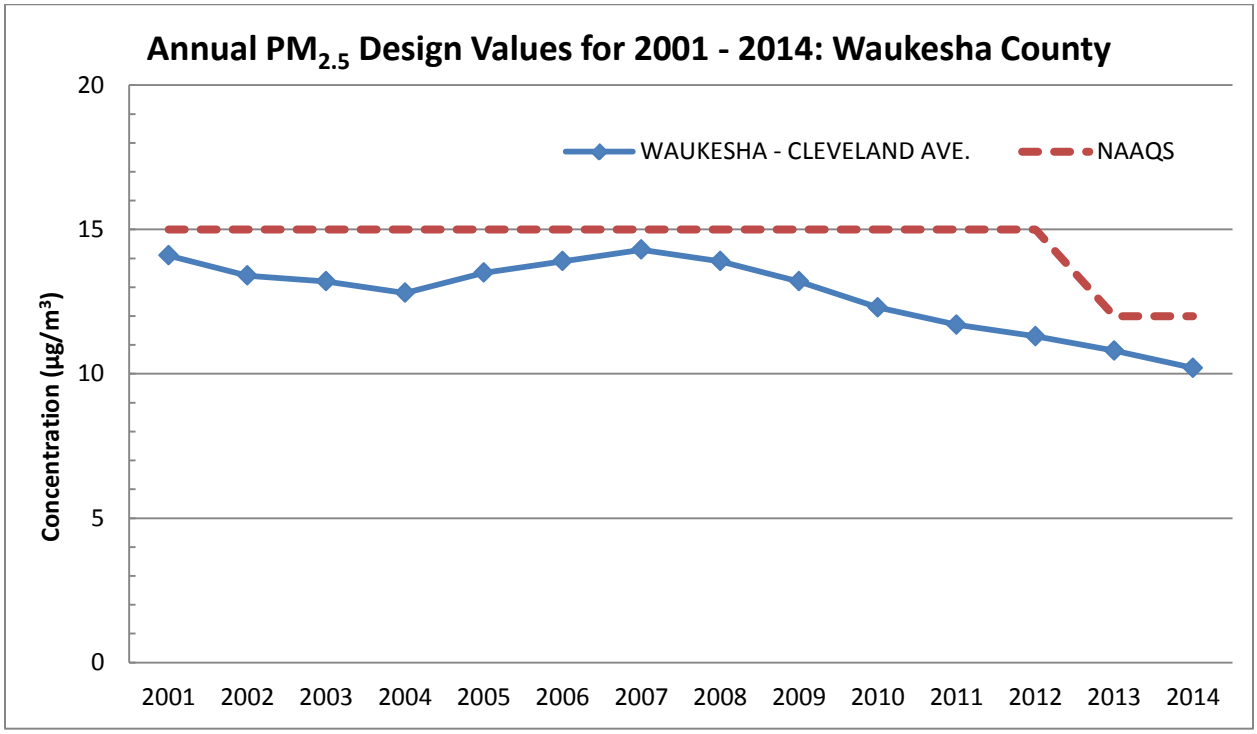
Ozone monitoring in Walworth County is performed at a rural site on the outskirts of the City of Lake Geneva. The address for the site is Rural Route 4 Elgin Club Road.

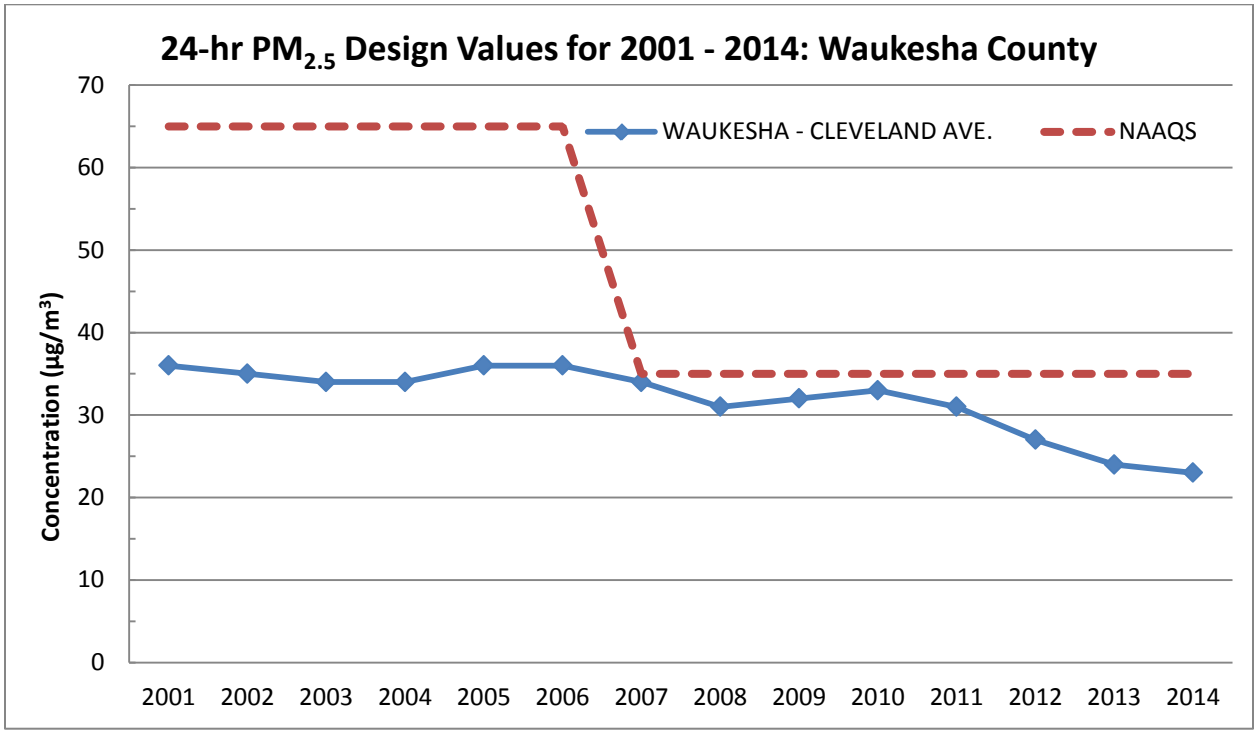


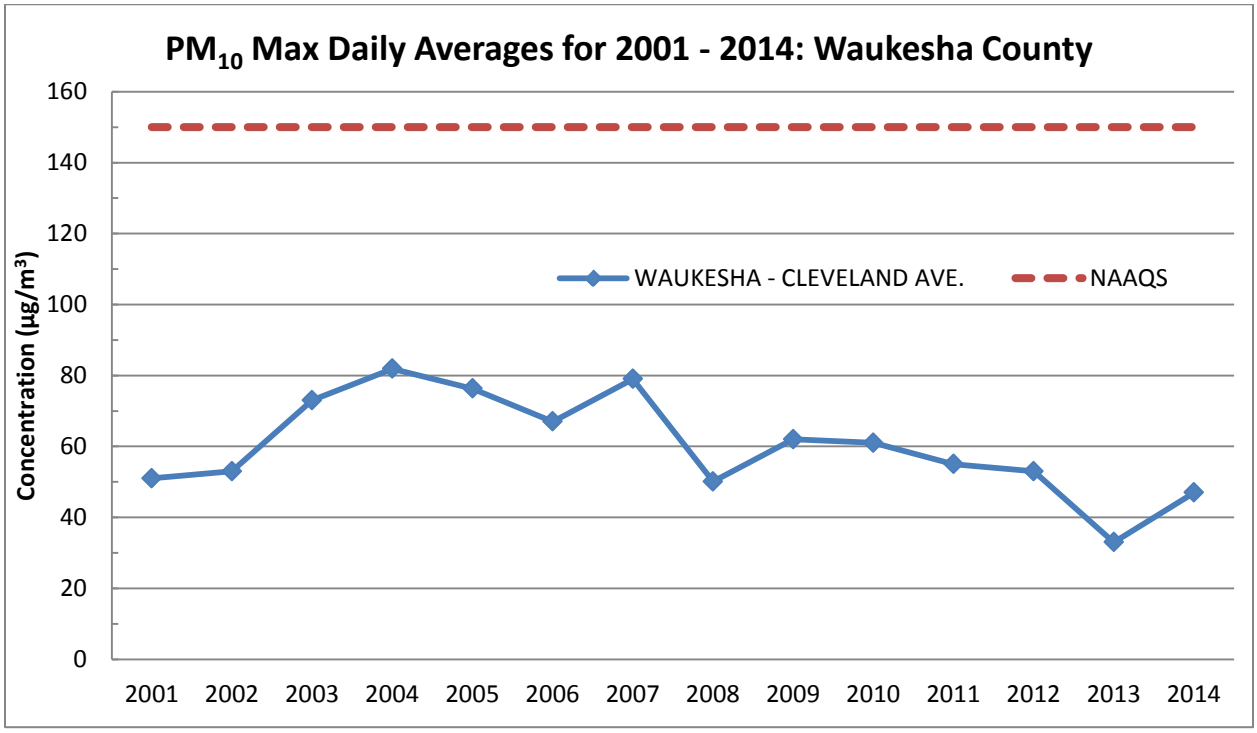
Waukesha County

Ozone, $PM_{2.5}$, and PM_{10} monitoring in Waukesha County is conducted in a fenced-in area on a city lot at 1310 Cleveland Avenue in the City of Waukesha. Sampling for daily concentrations of ozone and $PM_{2.5}$ began on April 29, 2004 and January 22, 2004, respectively. Prior to these dates, sampling for ozone in Waukesha County was performed at a Carroll College site.




Annual PM2.5 Design Values for 2001 - 2014: Waukesha County
Concentration (µg/m³)
20
15
10
5
0
WAUKESHA - CLEVELAND AVE.
NAAQS
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014


24-hr PM2.5 Design Values for 2001 - 2014: Waukesha County
Concentration (µg/m³)
70
60
50
40
30
20
10
0
WAUKESHA - CLEVELAND AVE.
NAAQS
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014


PM10 Max Daily Averages for 2001 - 2014: Waukesha County
Concentration (µg/m³)
160
140
120
100
80
60
40
20
0
WAUKESHA - CLEVELAND AVE.
NAAQS
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014