



TOBACCO SURVEILLANCE
& EVALUATION PROGRAM
UNIVERSITY OF WISCONSIN
PAUL P. CARBONE
COMPREHENSIVE CANCER CENTER

S&E Report

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Indoor Air Quality in Bars and Restaurants Before and After Implementation of the Smoke-Free Wisconsin Act, 2010

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Executive Summary

The purpose of this research was to determine the effect of the Smoke-Free Wisconsin Act on air quality in bars and restaurants. The common standard of measurement of air quality is the amount of fine particulates or particles in the air. Tobacco smoke is the largest contributing factor to fine particulate matter indoors. Fine particulate matter is defined as particles smaller than 2.5 microns, or about one tenth the width of a human hair. The small size of the particles is significant because they are able to penetrate deep into lung tissue and the walls of arteries causing damage.

Air quality was tested in 214 bars and restaurants where smoking was allowed in 41 counties in every region of Wisconsin between April 2 and June 18, 2010, prior to the implementation of the smoke-free air law. The average air quality in 80% of these establishments was at or above the unhealthy level (more than 35 micrograms of fine particulate matter/cubic meter) according to Wisconsin Department of Natural Resources (DNR) standards (See **Figure 1**). Overall, one in five establishments (21%) was found to have hazardous air quality; one in four (28%) was found to have very unhealthy air quality; and one in three (38%) was found to have unhealthy air quality determined by levels of fine particles measured in the air.

Following enactment of the Smoke-Free Wisconsin Act on July 5, 2010, smoking was prohibited in bars and restaurants as well as all other enclosed workplaces. A total of 183 sites whose average air quality was found to be unhealthy, very unhealthy or hazardous during tests conducted prior to the smoke-free air law enactment were re-tested between September and October, 2010. In most cases, these sites were re-tested on the same day of the week and time of day to assure comparable conditions.

Tests conducted after enactment of the law found a sharp and nearly uniform reduction in establishments with unhealthy air. Overall, we measured a 92% reduction in the mean particulate matter detected in the air in eating and drinking establishments that had unhealthy air before the smoke-free law went into effect. Only six out of 183 tested sites had unhealthy or worse quality air and in only one site was the air hazardous.

Background and Introduction

Since the 1986 U.S. Surgeon General's Report, *The Health Consequences of Involuntary Smoking*¹ first made Americans aware of the dangers of secondhand smoke, public understanding of its health consequences has grown. Despite this increase in knowledge, in Wisconsin, secondhand smoke is estimated to cause more than 800 lung cancer and heart disease deaths each year while thousands more are made seriously ill by asthma, allergic attacks and chronic disease.²

While smoke-free workplaces are increasingly the norm, bars and restaurants are among the last public places where smoking is usually allowed. As a result, these establishments commonly have extremely high levels of secondhand smoke, typically at levels that are multiples of the Environmental Protection Agency (EPA) allowable daily exposure limit.³ As a result of the exposure to secondhand smoke, many employees suffer from respiratory symptoms and have impaired lung functions.⁴

The air quality in Wisconsin's bars and restaurants presented a serious health risk for patrons and employees because:

- There is no safe level of exposure to environmental tobacco smoke.
- It is not possible for patrons and employees to determine the level of environmental tobacco smoke in any specific establishment.
- Patrons and employees may believe they are not exposed to unsafe levels of secondhand smoke because of the presence of ventilation and air conditioning systems. However, these systems do not reduce pollutants to safe levels and are used primarily to remove offensive odors and visible particles.
- Bars and restaurants may contain very high levels of dangerous pollutants for long periods after the last cigarette has been extinguished.
- Some employees are likely to be engaged in on-going strenuous physical activity while working in highly hazardous air quality conditions. Similarly, patrons may dance or bowl which causes exertion and increased breathing of toxins.

- Children, who are most susceptible to smoke-related illness, cannot choose to avoid smoke-filled environments.

In 1992, the City of Madison enacted the first smoke-free restaurant ordinance in Wisconsin. The measure applied to establishments requiring a restaurant license and whose alcohol sales were less than 33% of their gross receipts. In subsequent years, similar ordinances were passed in much of La Crosse County, the City of Eau Claire and numerous other communities across the state. In 2003, Madison passed the first ordinance in Wisconsin that required all workplaces, including bars, to be smokefree. By 2008, Appleton, Eau Claire, Fond du Lac and Marshfield passed similar comprehensive ordinances. In May 2009, Governor Jim Doyle signed Act 12 (the Smoke-Free Wisconsin Act). The law went into effect on July 5, 2010. Act 12 prohibits smoking in most indoor public places and workplaces including public buildings, bowling centers, hotels and motels and restaurants and taverns.

Methods

Prior to the implementation of the Smoke-free Air Act, a convenience sample of 214 bar and restaurants where smoking was allowed in 41 counties in each region of the state were selected. The test sites were selected because they were representative of a class of establishment such as a restaurant-bar combination, restaurant only and bar only. These establishments were visited primarily during the evening hours between April 2 and June 18, 2010.

After the Smoke-Free Wisconsin Act took effect on July 5, 2010, a second round of air quality tests was conducted in establishments where the average scores in the initial tests were greater than 35 micrograms/cubic meter (Unhealthy). These tests were conducted from August 28 through October 23.

Tests were conducted by personnel trained in air quality testing methods. Each monitoring team spent approximately 30 minutes in each establishment. The number of people inside the venue, the number of patrons and the number of cigarettes burning were recorded every 15 minutes during air sampling.

A TSI SidePak AM510 Personal Aerosol Monitor was used to sample and record the level of fine particles that are 2.5 microns or smaller (PM_{2.5}) in micrograms per cubic

meter. It is used to measure and record in real-time the level of fine particulate matter in the air. The SidePak was zero-calibrated prior to each use. The equipment recorded particulate levels every second and records the average particulate level at one minute intervals. The monitor was located at different locations within the main areas of each establishment to get a sample of readings.

The Ambient Air Quality Index of the Department of Natural Resources (DNR) is the standard for air quality analysis. (See **Figure 1**) The national standard from which the DNR standard is based on was established in 2005 by the EPA. On April 1, 2008, the DNR slightly modified (lowered) the standard for ozone and fine particulates. The pollutants measured under these standards are considered harmful to public health and the environment. The primary standard for a healthy level of fine particulate matter (defined as less than 35 micrograms of particulates smaller than 2.5 microns in a cubic meter) is the limit set to protect public health, including the health of sensitive populations such as asthmatics, children and the elderly. The standard for annual exposure to fine particulate matter, that is the average of the different rates of exposure over one year, is 15 micrograms per cubic meter.

Air samples were taken outside of the establishments to obtain a baseline measure. This recording helps assure that the air quality measured inside is not polluted air that has infiltrated from the outside. The measures of the ambient or outside air consistently indicated healthy air with fine particulate matter measured at less than 10 micrograms per cubic meter. Data from the SidePak was downloaded by field testers and sent to the University of Wisconsin Comprehensive Cancer Center's Tobacco Surveillance and Evaluation Program which analyzed the data and prepared this report.

The establishments monitored for air quality are not identified by name, only by general area and type, in this report. We do not identify the establishments because there is no reason to believe air quality in the monitored eating and drinking establishments, all of which allowed smoking before the Smoke-Free Wisconsin Act went into effect, had more or less polluted air than any other establishment that allowed smoking not included in the sample. Previous research has shown that any establishment that allows smoking can have dangerous levels of pollutants at any time which presents a health risk to staff and patrons.

Results

Prior to implementation of the Smoke-Free Wisconsin Act, the mean air quality in all establishments that allowed smoking was very unhealthy, with fine particulate matter levels measured at 160 micrograms/cubic meter. After implementation of the law, the average air quality level was good with small particulate matter levels of 13 micrograms/cubic meter - a 92% reduction in mean small particulate levels (See **Figure 2**. See **Appendix A** for mean air quality results from all counties before and after the implementation of the Smoke Free Wisconsin Act). Prior to the implementation of the law, only 13% of the sites had air quality that was either “good” or “satisfactory.” After implementation, 97% of the tested sites had “good” or “satisfactory” air quality (See **Figures 3 and 4**).

Of the 214 sites tested before the Act, only 31 establishments had air particulate levels at the good or satisfactory level (<35 micrograms/cubic meter). The other 183 sites had air quality that was unhealthy, very unhealthy or hazardous; one-fifth of the establishments (21%) that allowed smoking prior to the Smoke-Free Wisconsin Act were found to have air with fine particulate matter at or above the level considered hazardous to health; just over a quarter of establishments (28%) had air quality rated very unhealthy; and just over a third of establishments (38%) had air quality rated unhealthy.

Of the 183 sites tested after the enactment of the SFA, only six establishments registered air pollutants in excess of 35 micrograms/cubic meter and had unhealthy air. The air particulate levels in these establishments were 37, 42, 55, 90, 160 and 272 micrograms/cubic meter. Based on these levels and written reports of the on-site testers, there is evidence to conclude that smoking was occurring in each of these sites or immediately outside and had a door open.

As noted in **Table 1** below, there were substantial changes in average particulate levels and air quality in counties where establishments were tested. Counties that reported only one establishment were excluded from this table.

Table 1: Average air quality (micrograms/cubic meter) in bars and restaurants before and after enactment of the Smoke-Free Law.

County	Average Air Quality Before SFA	Average Air Quality After SFA
Adams	124	3
Ashland	115	7
Bayfield	404	7
Brown	220	8
Dodge	393	3
Douglas	278	32
Jefferson	233	5
Juneau	66	3
Kenosha	92	9
Kewaunee	214	2
La Crosse	346	6
Lincoln	263	25
Manitowoc	314	37
Marquette	65	14
Milwaukee City	103	13
Milwaukee County	149	4
Oneida	136	8
Outagamie	251	10
Ozaukee	200	8
Polk	184	10
Portage	49	6
Racine	85	10
Richland	99	3
Rock	243	9
Rusk	197	18
St. Croix	49	8

Vilas	71	5
Washington	149	5
Waukesha	242	10
Winnebago	238	2
Wood	142	2

County-level average air quality ranged from a high of 404 micrograms/cubic meter in Bayfield County to 49 in Portage and St. Croix County before the ban. Thirteen counties had average air quality that was “hazardous”. Bayfield at 404 micrograms/cubic meter and Dodge at 393 micrograms were found to have average levels almost twice the threshold level of “hazardous”. The average air quality in six counties was at the “very healthy” level including Ozaukee County with 200 micrograms/ cubic meter and Rusk County at 197- nearly at the uppermost threshold of 209 micrograms/ cubic meter. The average air quality level in 12 counties was “unhealthy”. The lowest level among these counties, Portage and St. Croix counties had an average of 49 micrograms/ cubic meter. Although these measurements may seem low in the context of this study, air quality at this level in the outdoor (ambient) air would be among the worst days of the year in any region of the state.

Following enactment of the law, 30 of 31 counties had average air quality levels that were “good” (0-14 micrograms/cubic meter) or “satisfactory” (15-34). Only one county, Manitowoc, had air quality that was on average, “unhealthy” due to a single establishment that allowed smoking had very unhealthy levels of small particulate.

Appendix B provides graphs of the actual readings at one-minute intervals in selected counties. These data indicate the wide range of variation between counties and between each establishment. The differences within each site were much greater before enactment of the SFA than afterwards when air particulate levels were generally flat. For example, air quality in an establishment in the Milwaukee and Ozaukee counties sample differed in a single establishment by over 200% as the air testing team moved from one location to another during the test.

Differences in air quality between establishments that allowed smoking were also substantial. As indicated in data from Waukesha County, the average particulate levels in one establishment were more than three times higher than “hazardous” (750

micrograms/cubic meter) and the air quality in another venue tested had “unhealthy” (47 micrograms/cubic meter) air.

Air quality was much more uniform after the SFA. The brief “spikes” in unhealthy air quality tended to be recorded at the beginning and end of tests when the air testing team walked through an entrance area where smokers were congregated. Often the smoke air flow entered the initial space of the bar or restaurant.

Discussion

The results of the statewide examination of air quality in bars and restaurants before and after the implementation of the Smoke-free Act indicated an extraordinary improvement in air quality due to a high level of compliance with the new law. The decrease in mean fine particle concentration is similar to reductions in other areas after a smoking ban, such as 92% reduction observed in Scotland, 84% reduction in Western New York⁵ and 93% reduction in Lexington, Kentucky.⁶

Assuming that the establishments that had good or satisfactory levels of particulates prior to implementation of the Smoke-Free Wisconsin Act continued to have those levels, the compliance rate among establishments that were primarily bars and restaurant-bars was 97%. This compares very favorably with reported 73% and 69% compliance rate in bars in smoke-free communities in the US and Canada, respectively.⁷ In 2002 (four years after enactment of the Smoke-free law), a random sample of inspections in Los Angeles found compliance at 76% in bars and 99% in bar/restaurants.⁸

There is a “dose-response” relationship to both incidental and chronic exposure to passive smoking related to cardiovascular and respiratory diseases and cancer. For individuals such as bar and restaurant workers who are exposed to high levels of tobacco smoke for long periods of time, the additional risk of illness and death is substantial. In one study, non-smokers living in a household with 2 or more smokers had a 75% greater risk of lung and other cancers, a 150% greater risk of emphysema and twice the risk of stroke compared to a non-smoker relatively unexposed to high levels of smoke.⁹ Given the extraordinarily high levels of smoke found in many of the establishments, it is probable that the additional risks of disease and subsequent death are multiples of those cited above.

A study of the effects of secondhand smoke exposure of bartenders in Wisconsin bars found that non-smoking bartenders reported eight upper respiratory symptoms associated with exposure (wheezing, shortness of breath, cough first thing in the morning, cough during the rest of the day, cough up phlegm, red or irritated eyes, runny nose and sore or scratchy throat). The bartenders also reported significant improvement in relief from all of the symptoms one month after the implementation of the smoke-free policies.¹⁰

It has been established by many earlier studies that implementation of smoke-free conditions at either the individual establishment level or throughout political jurisdictions will result in substantial reductions in indoor pollutants and improvements in air quality.¹¹ While there are significant esthetic and safety benefits to eliminating secondhand smoke, the most significant reason for smoke-free air is the elimination of health detriments caused by such exposure.

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Figure 1: Air quality thresholds for fine particles (2.5 microns and smaller) in micrograms/cubic meter, DNR, 2008

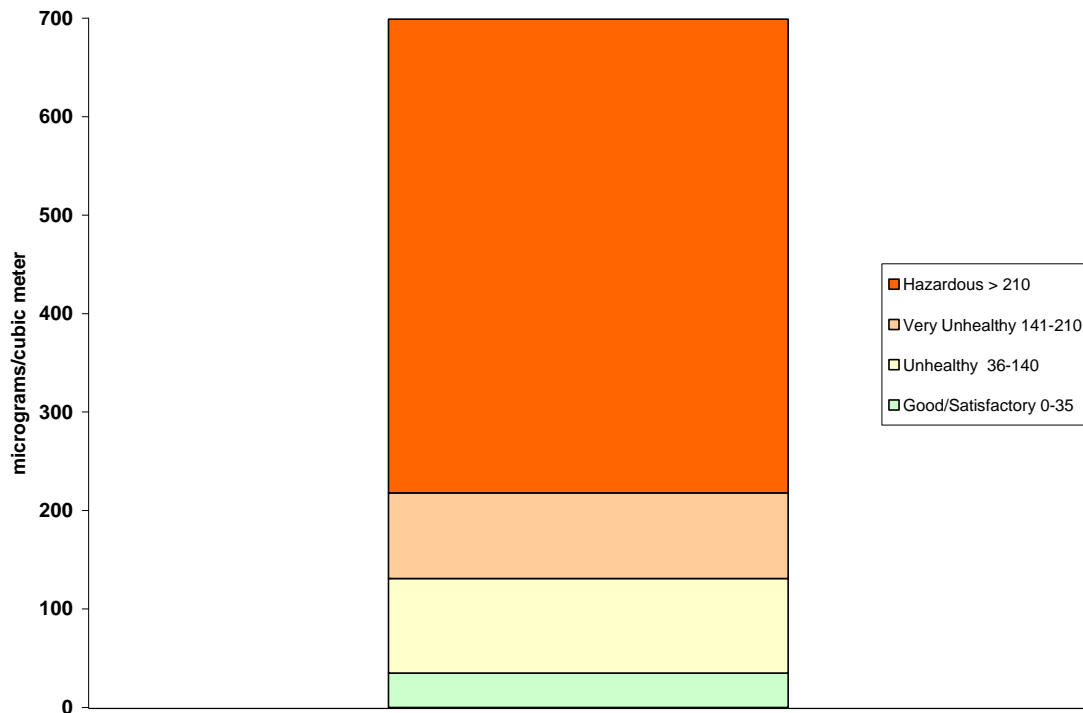


Figure 2: Average small particulate (< 2.5 micrograms/cubic meter) for all tested bars and restaurants before and after enactment of Smoke-Free Act.

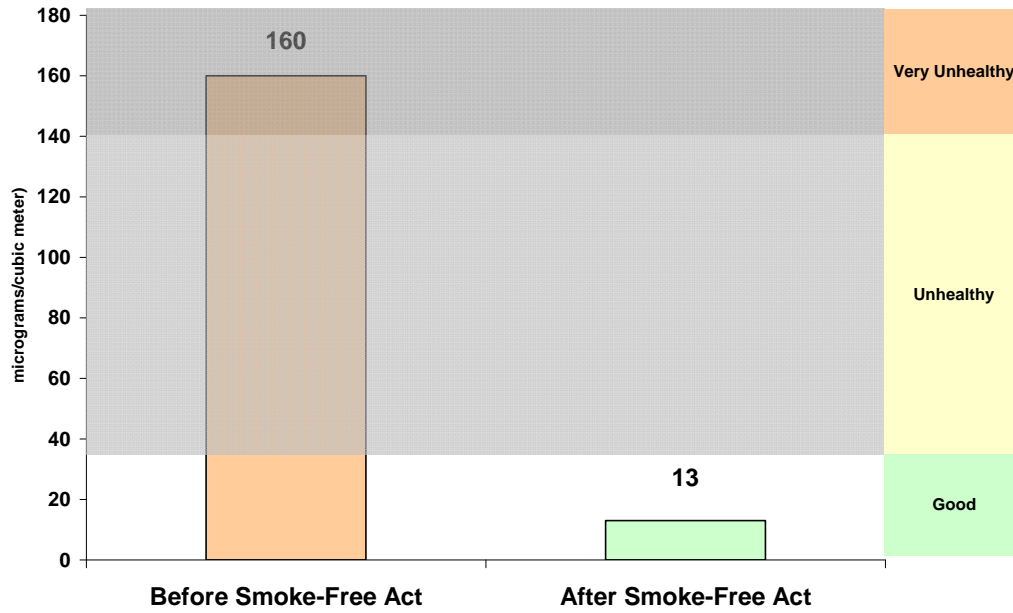
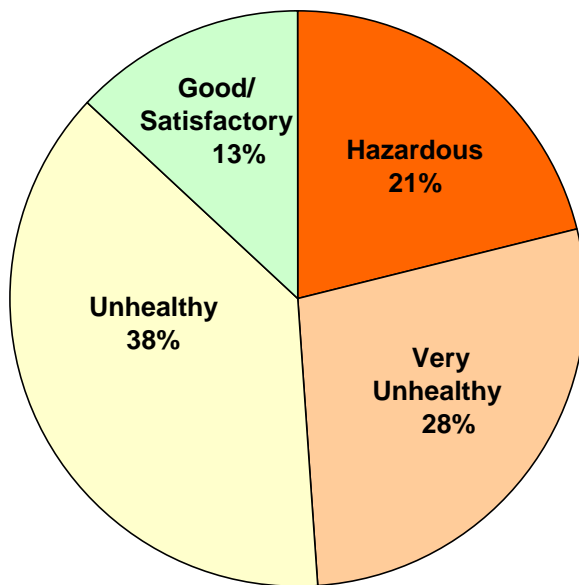
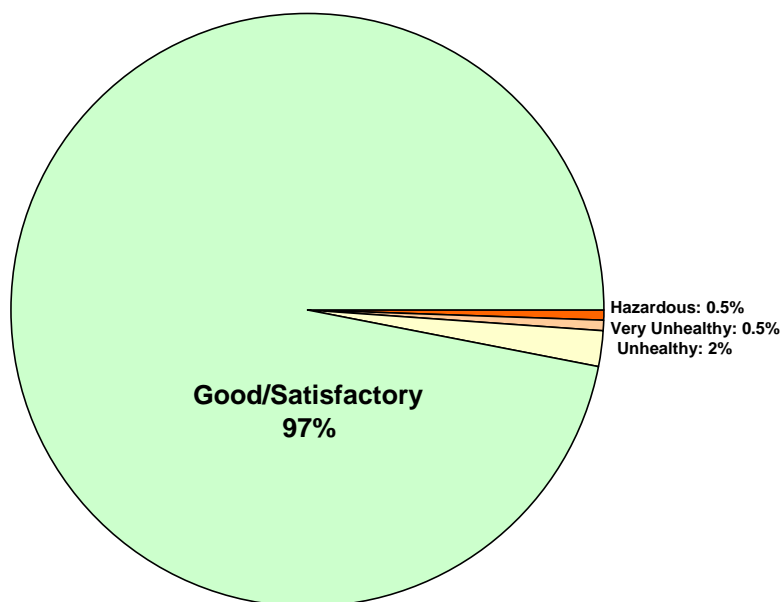


Figure 3: Pre-implementation air quality in bars and restaurants that allowed smoking before the Smoke-Free Wisconsin Act, April-June, 2010



Number= 214
April-June 2010

Figure 4: Post-implementation air quality in bars and restaurants that allowed smoking before the Smoke-Free Wisconsin Act and were found to have unhealthy or worse quality air in pre-implementation tests, August-October, 2010

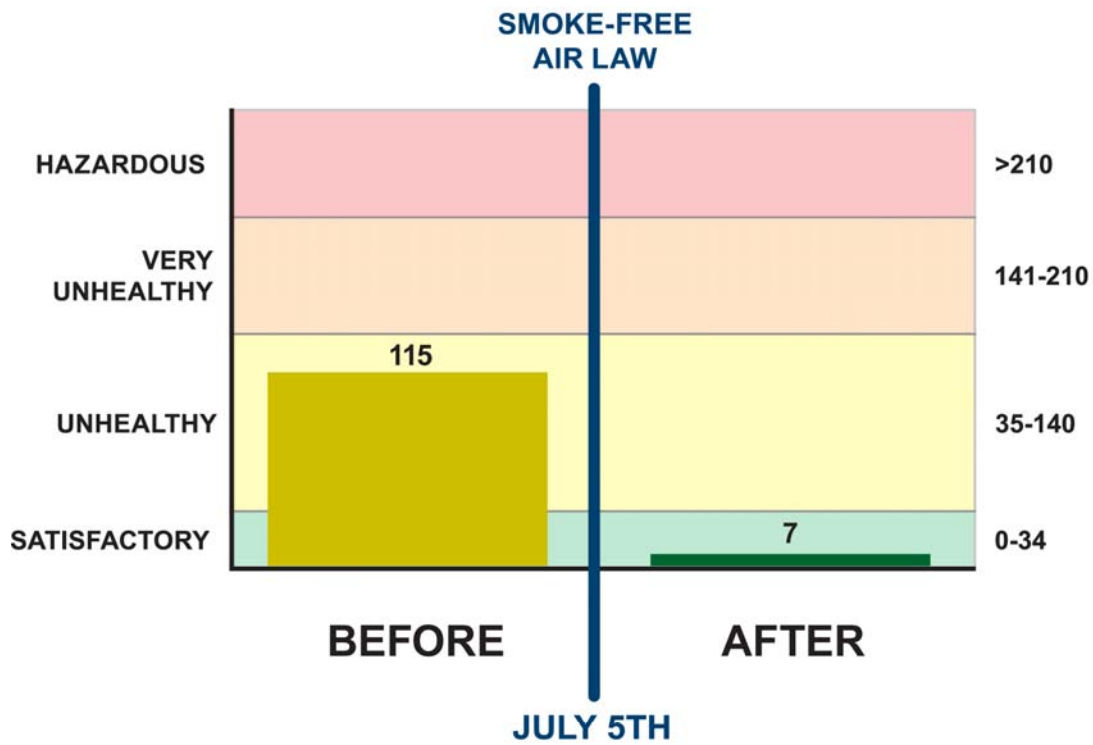


Number = 180
August- October

Appendix A

INDOOR AIR QUALITY

Ashland County

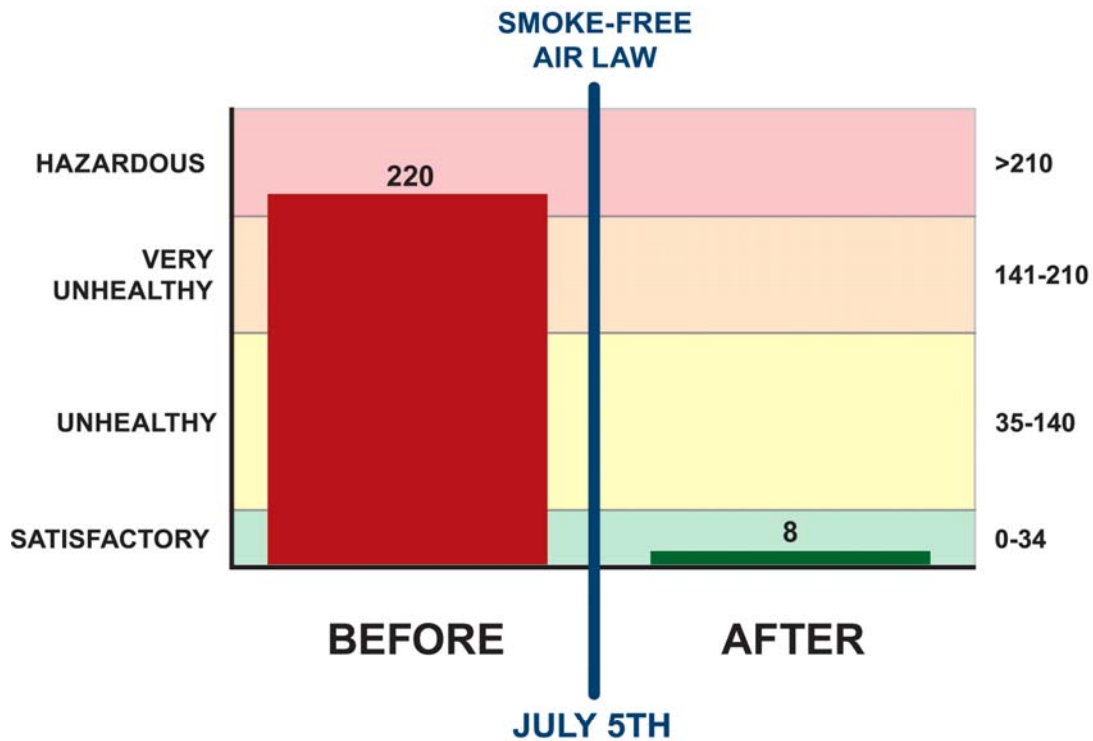


The Wisconsin Tobacco Prevention and Control Program measured air quality at several sites in more than 20 counties, including bars, restaurants and bowling alleys. Measurements were taken before and after July 5, 2010, the date the statewide smoke-free air law went into effect.

The number above each column represents average air-quality level measured, classified as satisfactory, unhealthy, very unhealthy or hazardous based on the Department of Natural Resources' Ambient Air Quality Index, available at <http://www.airnow.gov/index.cfm>.

INDOOR AIR QUALITY

Brown County

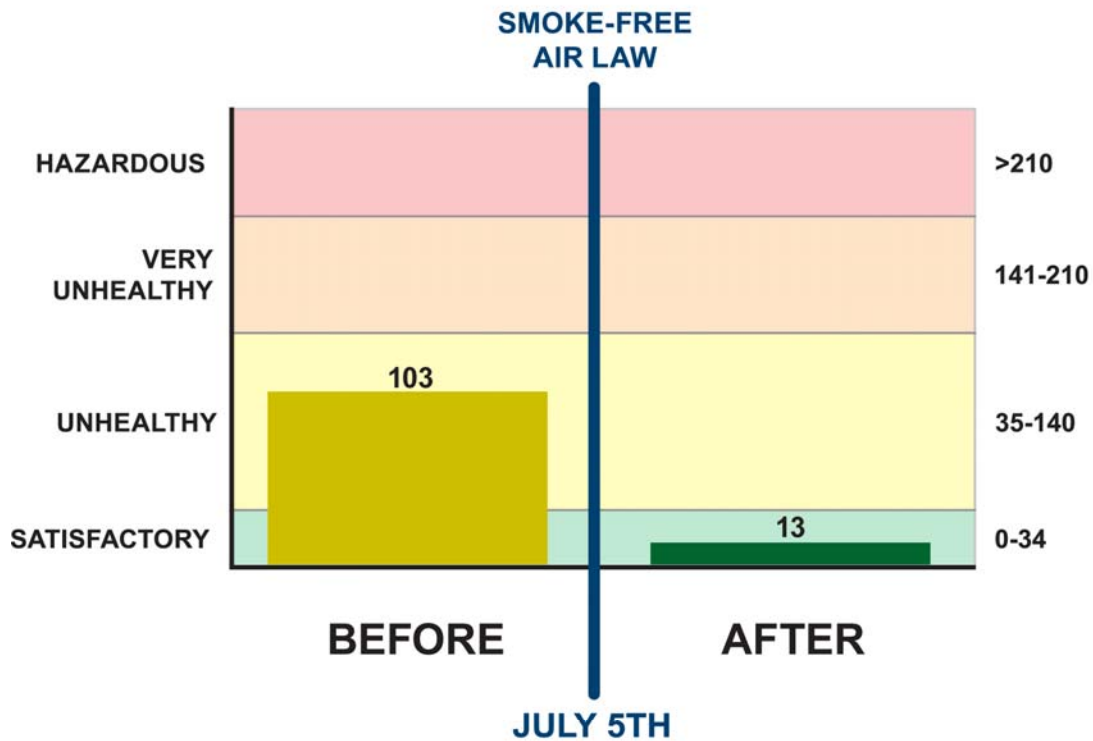


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INDOOR AIR QUALITY

City of Milwaukee

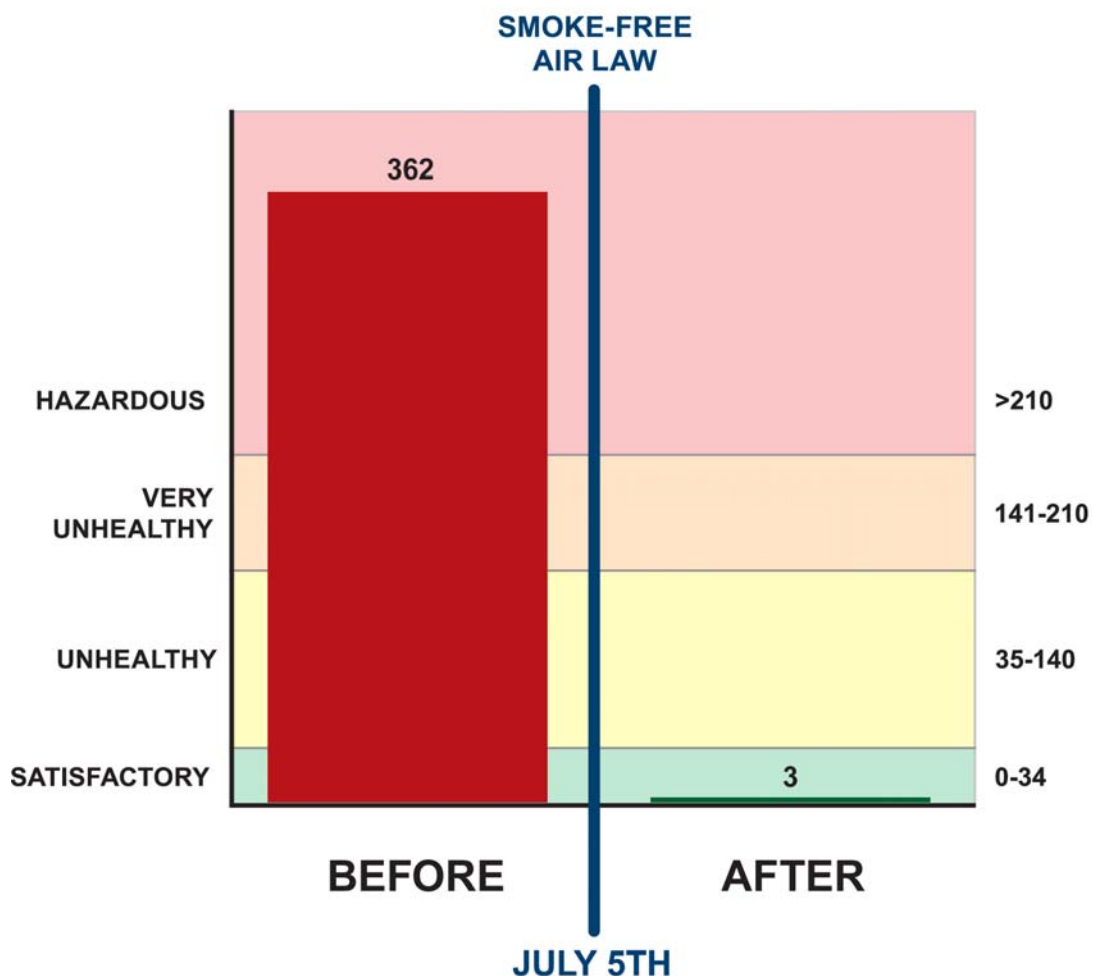


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INDOOR AIR QUALITY

Dodge & Jefferson Counties

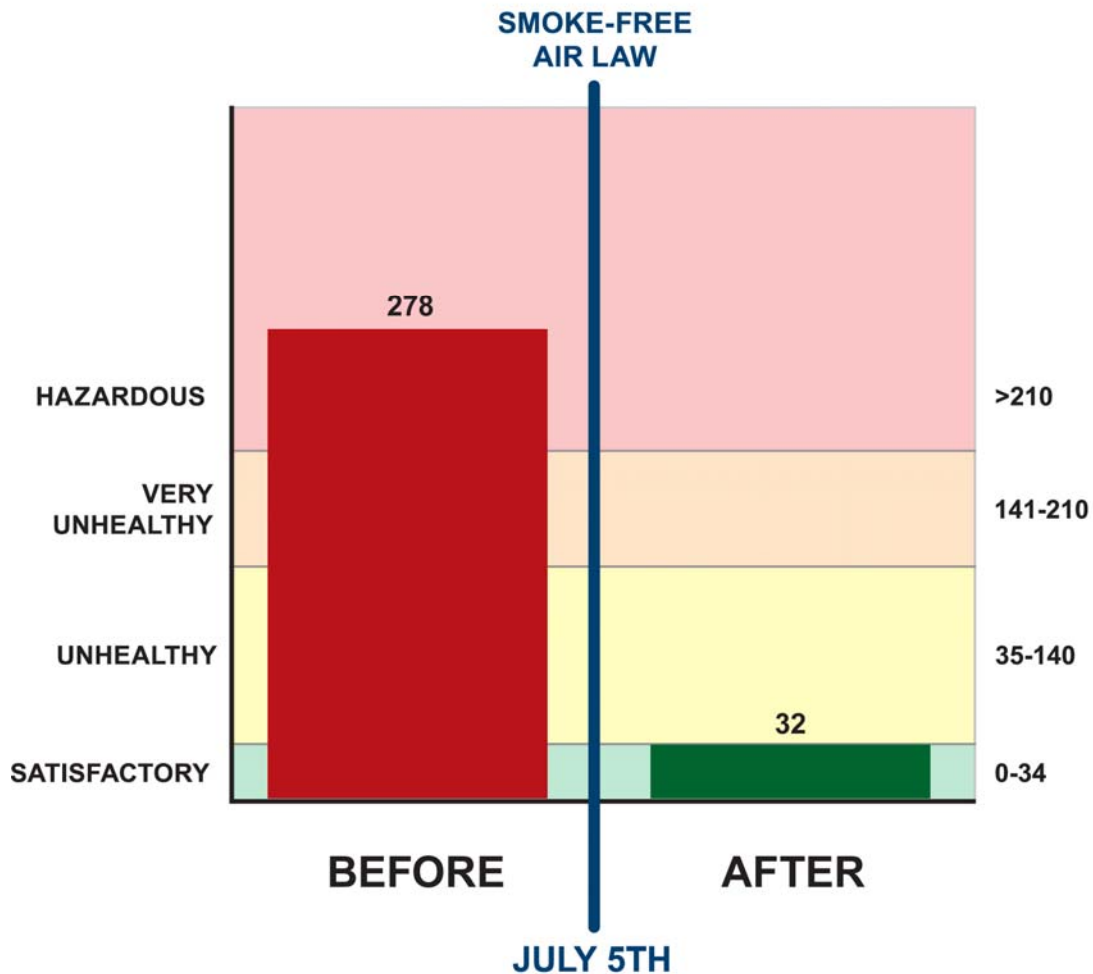


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INDOOR AIR QUALITY

Douglas County

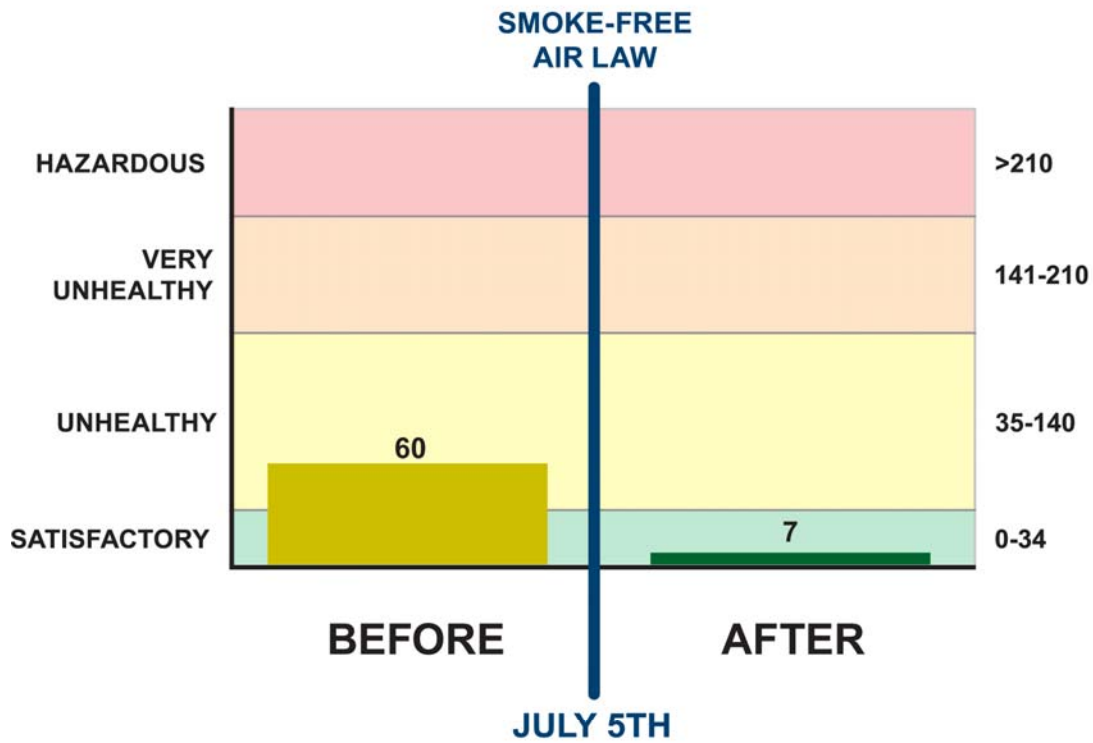


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INDOOR AIR QUALITY

Kenosha & Racine Counties

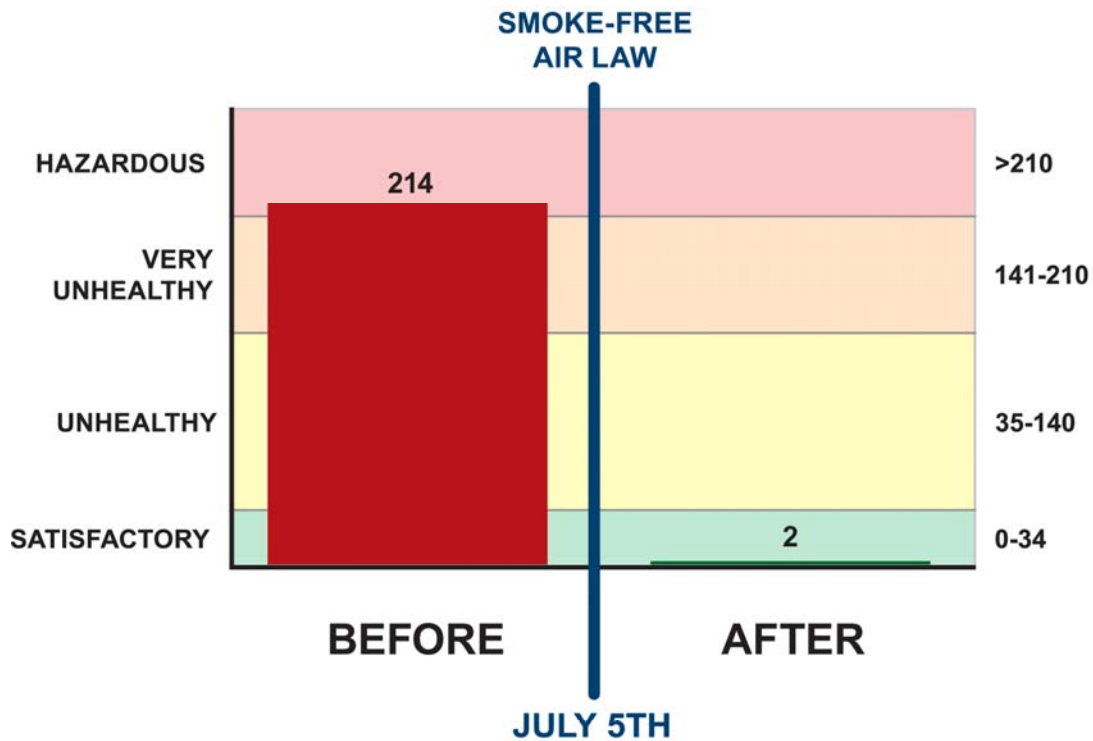


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INDOOR AIR QUALITY

Kewaunee County

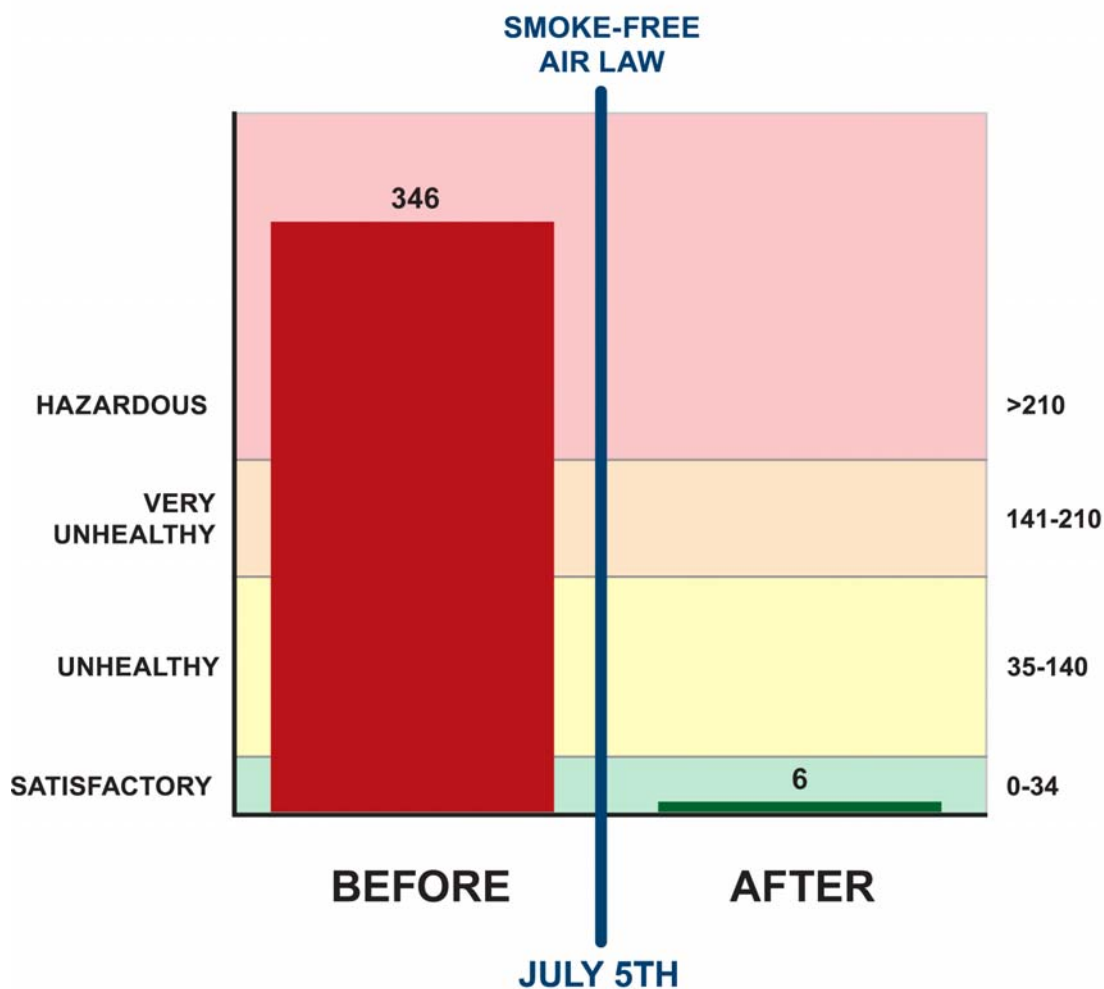


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INDOOR AIR QUALITY

La Crosse County

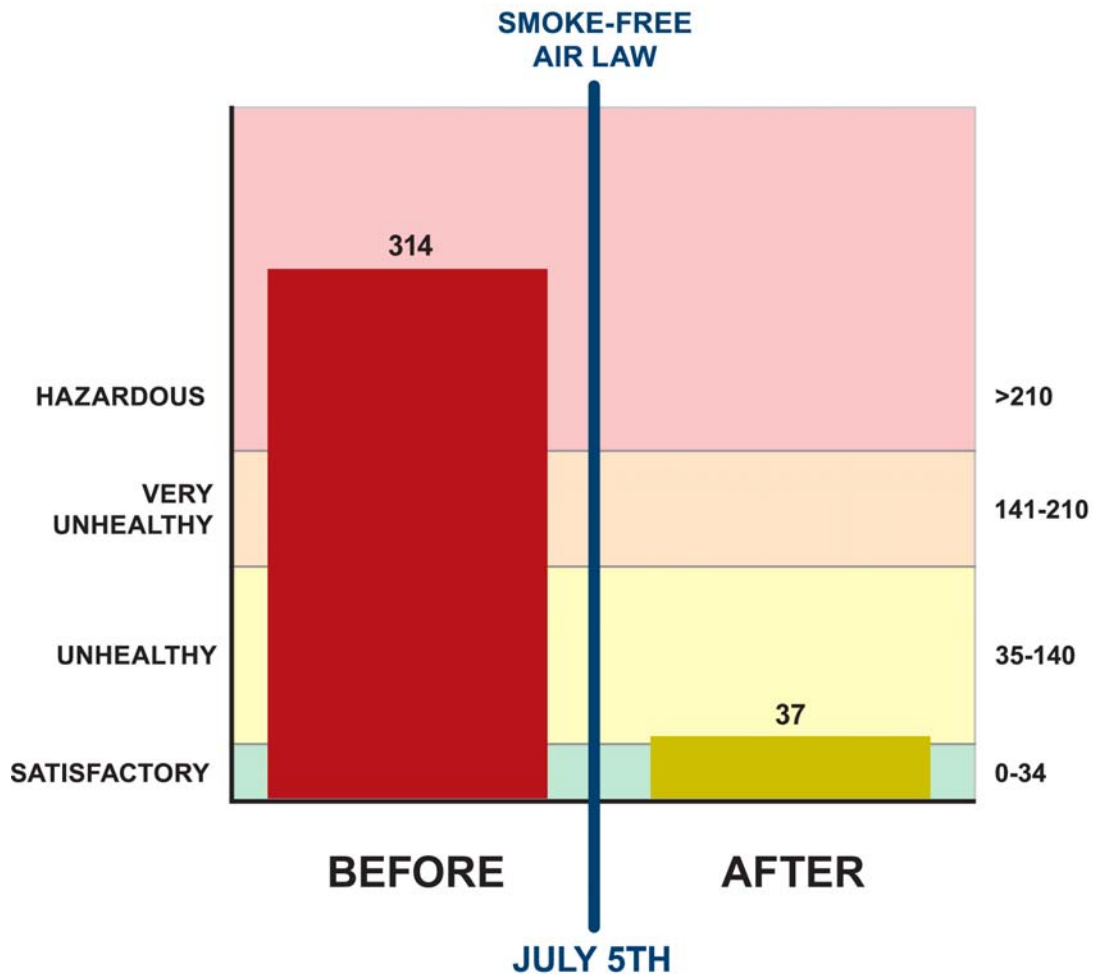


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INDOOR AIR QUALITY

Manitowoc County

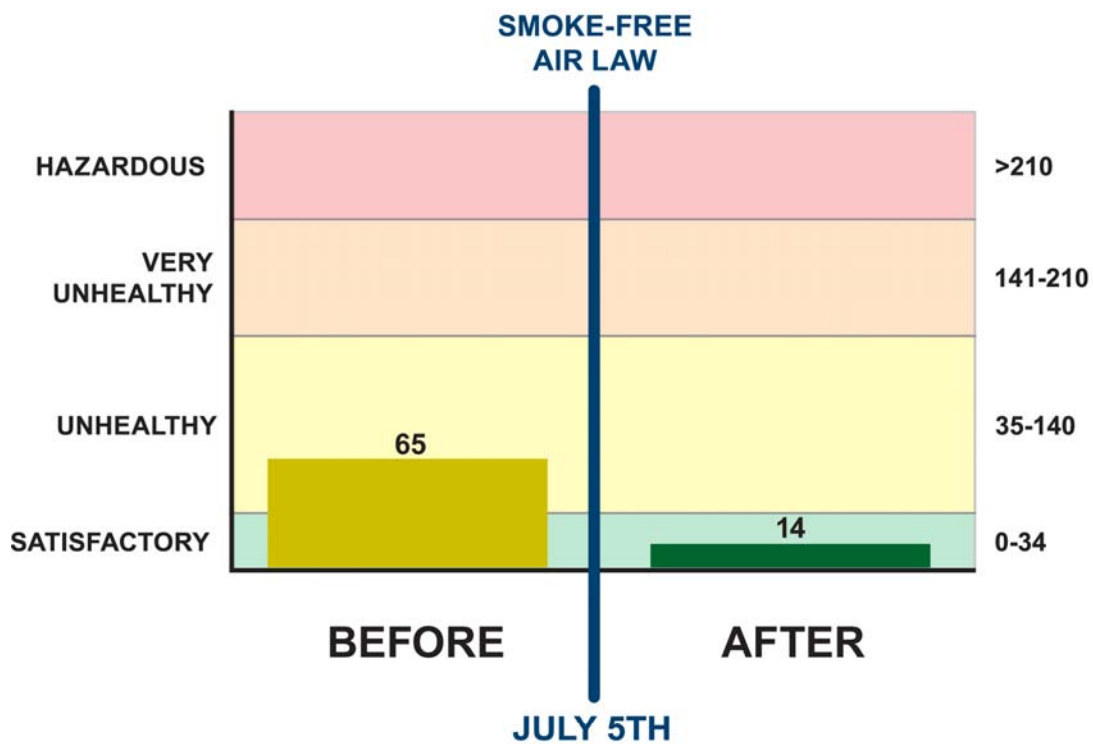


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INDOOR AIR QUALITY

Marquette County

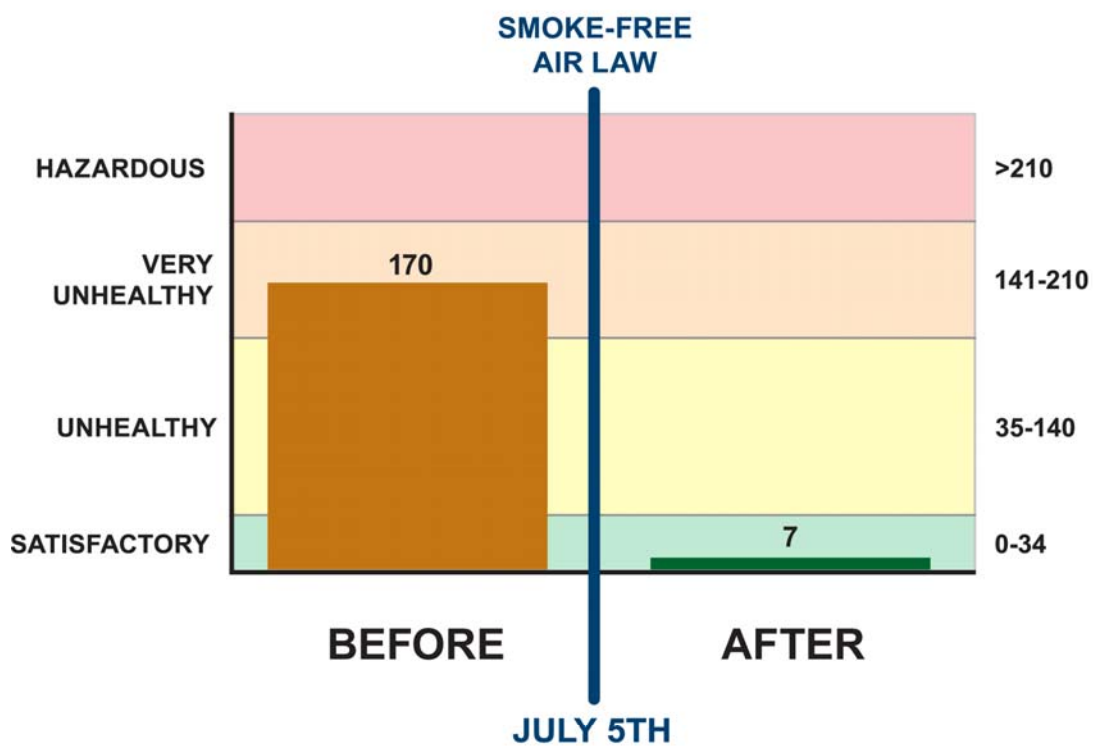


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INDOOR AIR QUALITY

Milwaukee & Ozaukee Counties

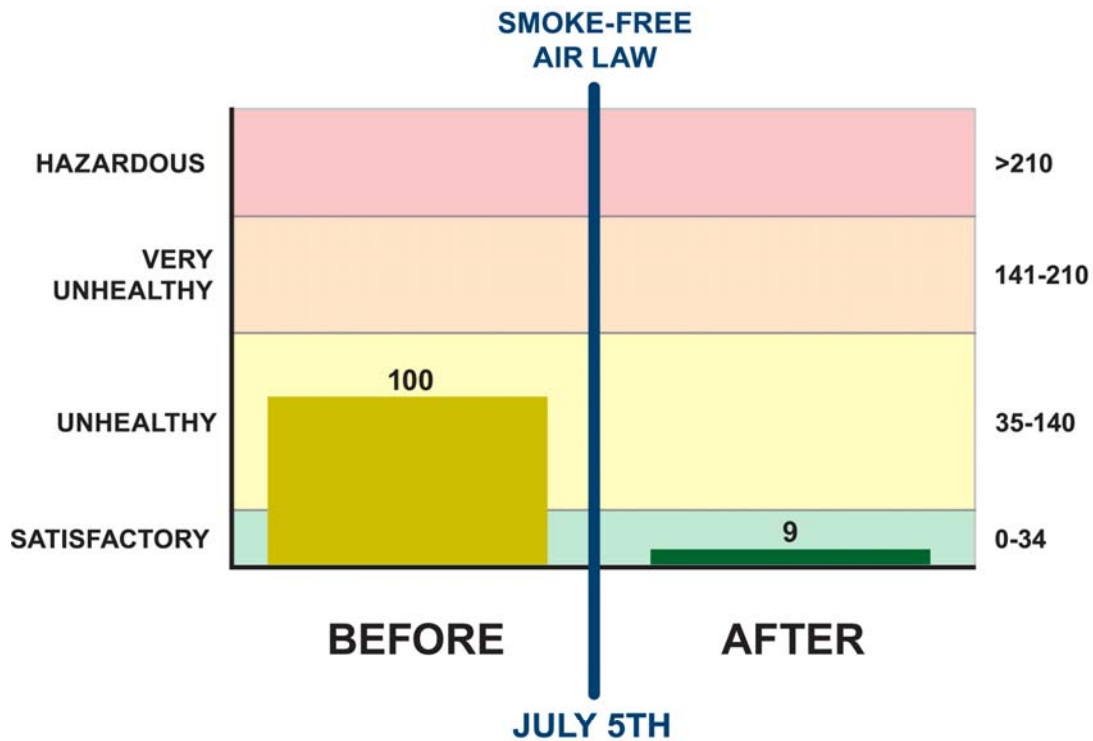


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INDOOR AIR QUALITY

Oneida & Lincoln Counties

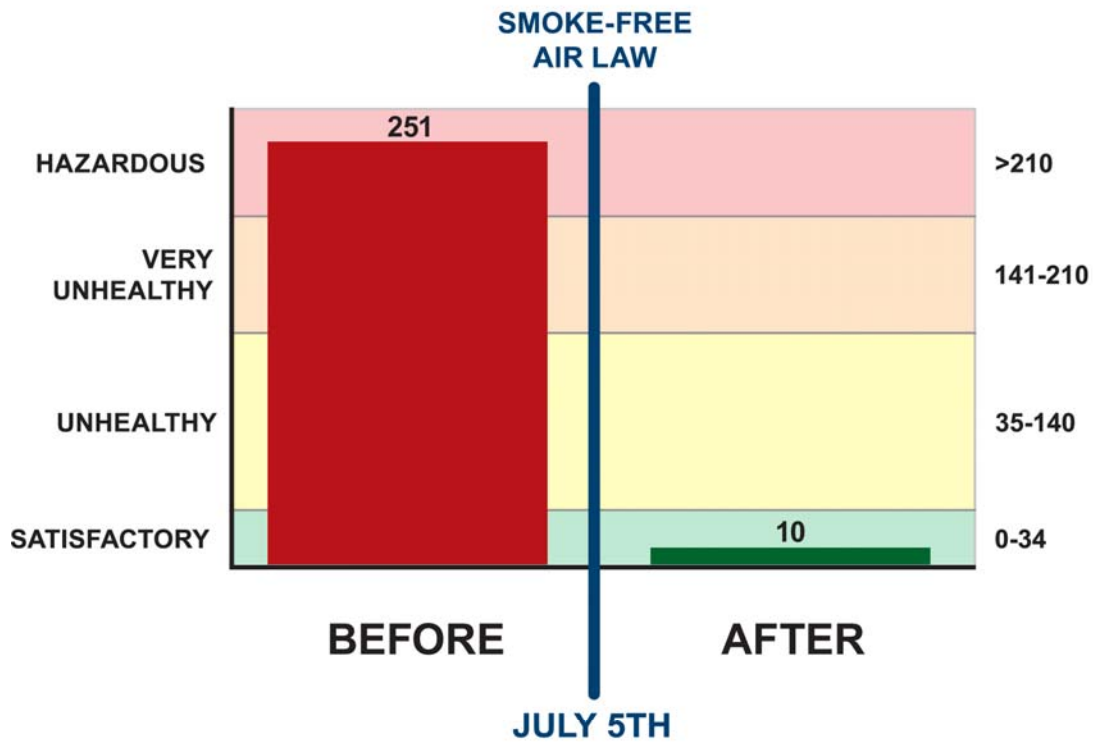


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INDOOR AIR QUALITY

Outagamie County

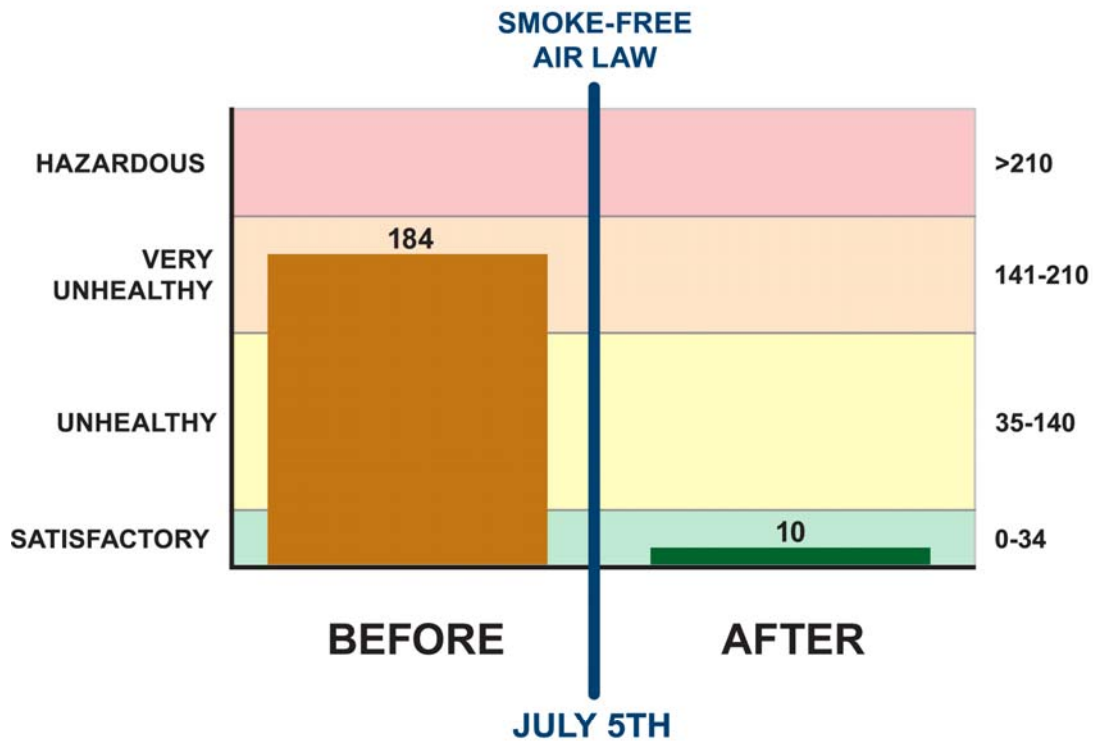


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INDOOR AIR QUALITY

Polk County

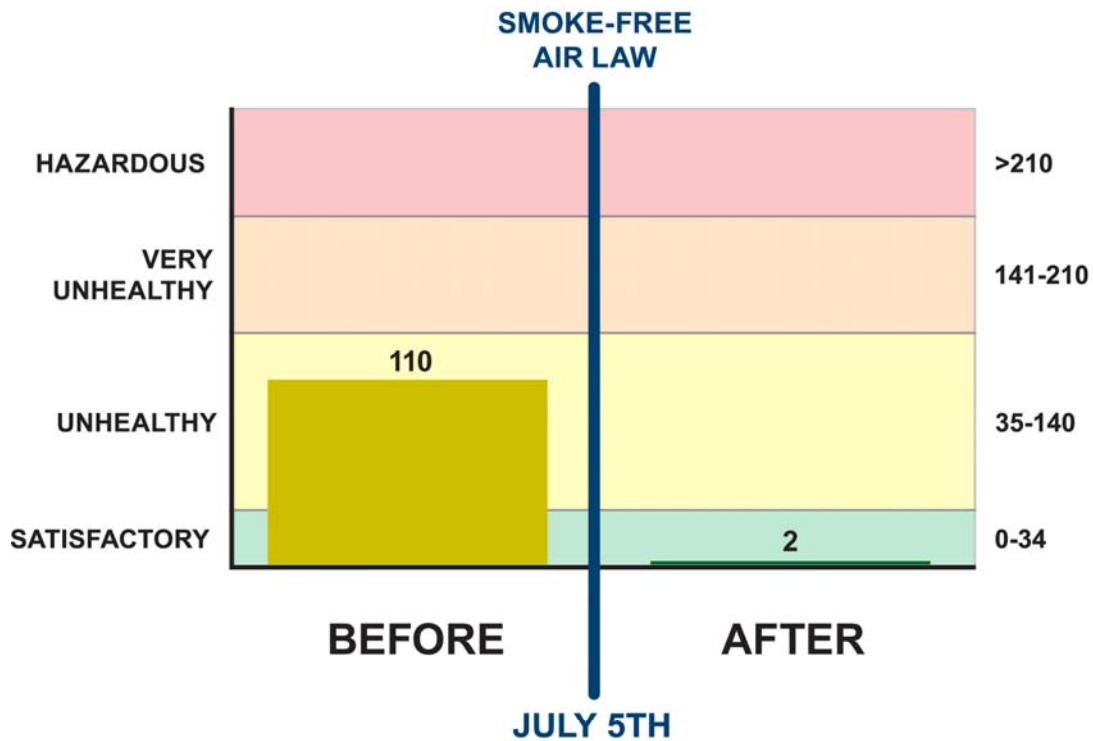


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The number above each column represents average air-quality level measured, classified as satisfactory, unhealthy, very unhealthy or hazardous based on the Department of Natural Resources' Ambient Air Quality Index, available at <http://www.airnow.gov/index.cfm>.

INDOOR AIR QUALITY

Richland & Juneau Counties

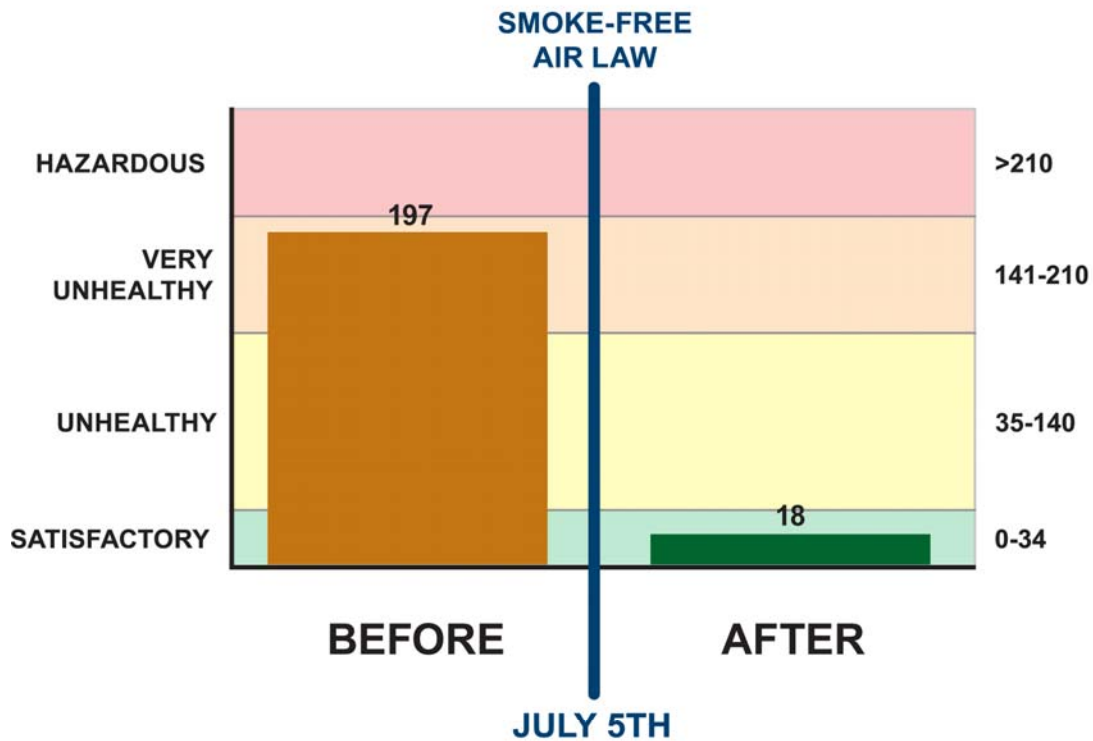


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The number above each column represents average air-quality level measured, classified as satisfactory, unhealthy, very unhealthy or hazardous based on the Department of Natural Resources' Ambient Air Quality Index, available at <http://www.airnow.gov/index.cfm>.

INDOOR AIR QUALITY

Rusk County

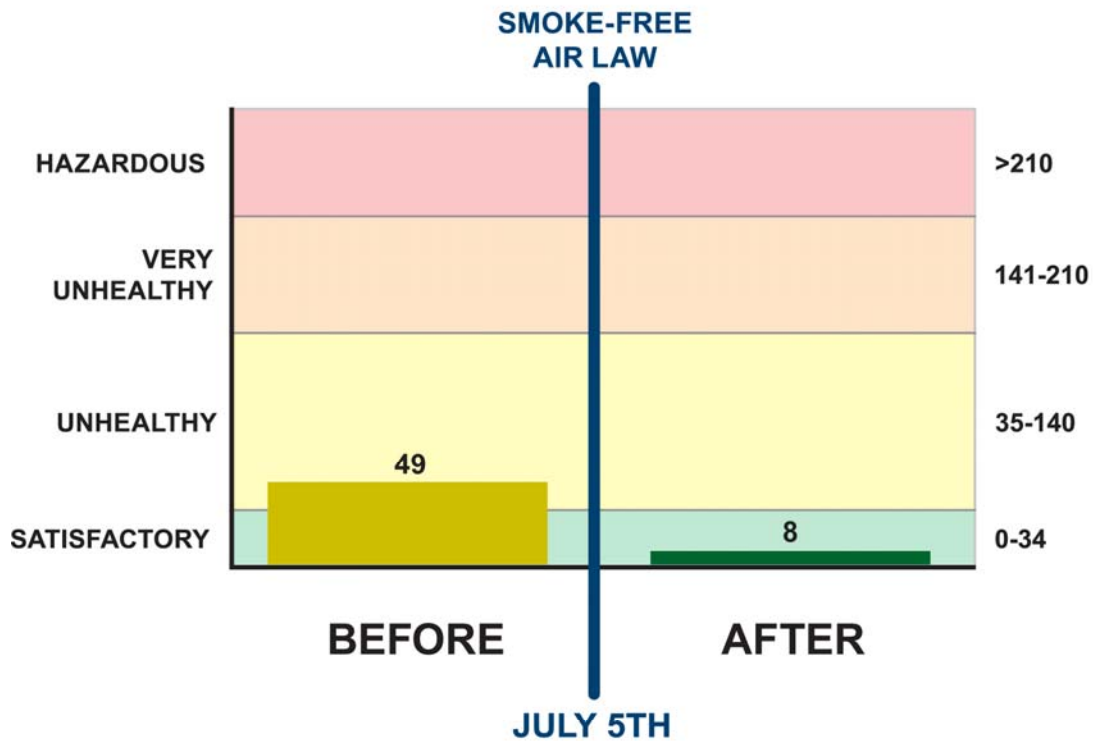


The Wisconsin Tobacco Prevention and Control Program measured air quality at several sites in more than 20 counties, including bars, restaurants and bowling alleys. Measurements were taken before and after July 5, 2010, the date the statewide smoke-free air law went into effect.

The number above each column represents average air-quality level measured, classified as satisfactory, unhealthy, very unhealthy or hazardous based on the Department of Natural Resources' Ambient Air Quality Index, available at <http://www.airnow.gov/index.cfm>.

INDOOR AIR QUALITY

St. Croix County

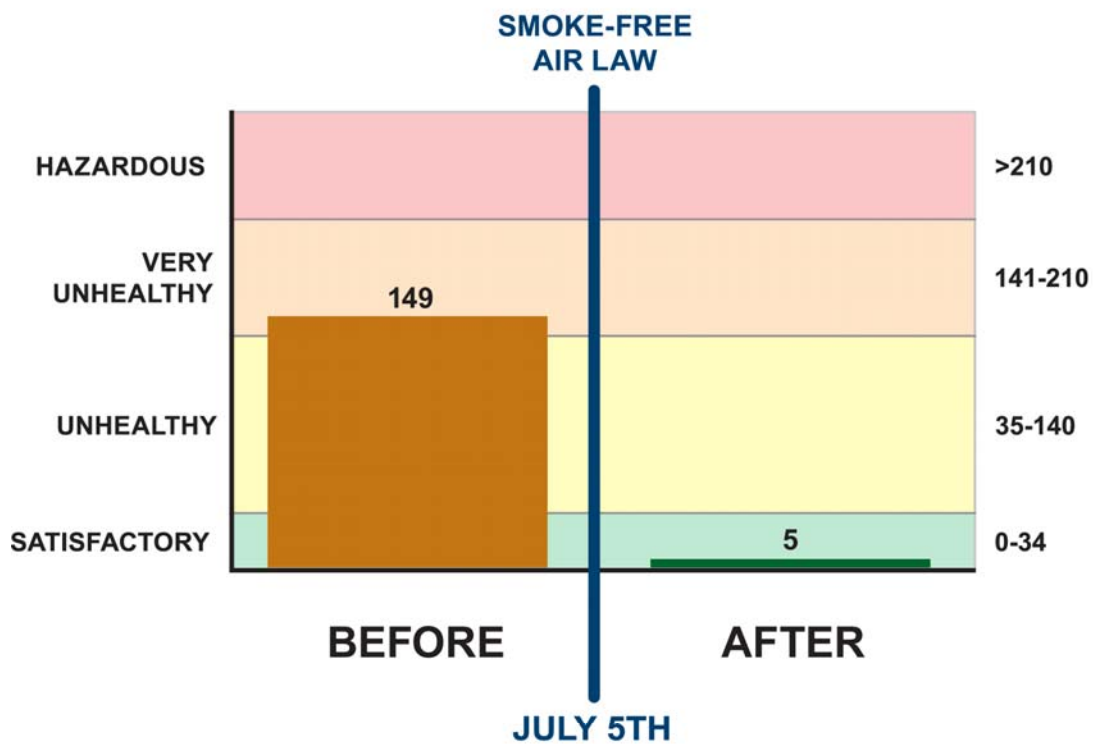


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The number above each column represents average air-quality level measured, classified as satisfactory, unhealthy, very unhealthy or hazardous based on the Department of Natural Resources' Ambient Air Quality Index, available at <http://www.airnow.gov/index.cfm>.

INDOOR AIR QUALITY

Washington County

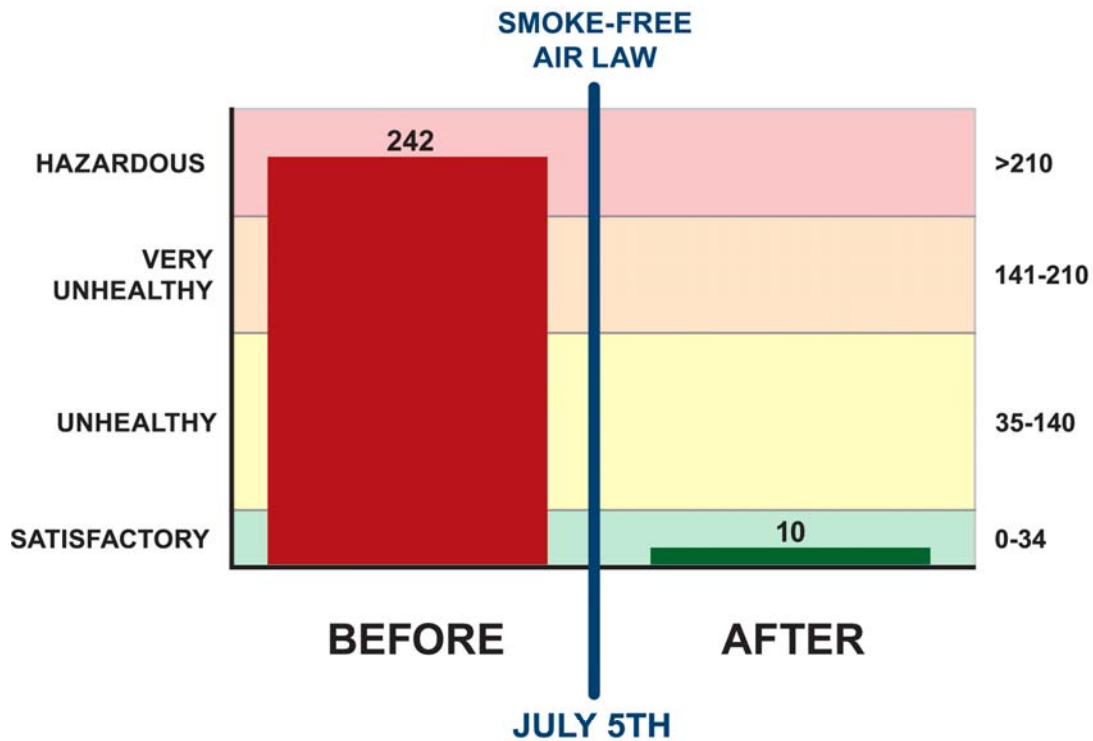


The Wisconsin Tobacco Prevention and Control Program measured air quality at several sites in more than 20 counties, including bars, restaurants and bowling alleys. Measurements were taken before and after July 5, 2010, the date the statewide smoke-free air law went into effect.

The number above each column represents average air-quality level measured, classified as satisfactory, unhealthy, very unhealthy or hazardous based on the Department of Natural Resources' Ambient Air Quality Index, available at <http://www.airnow.gov/index.cfm>.

INDOOR AIR QUALITY

Waukesha County

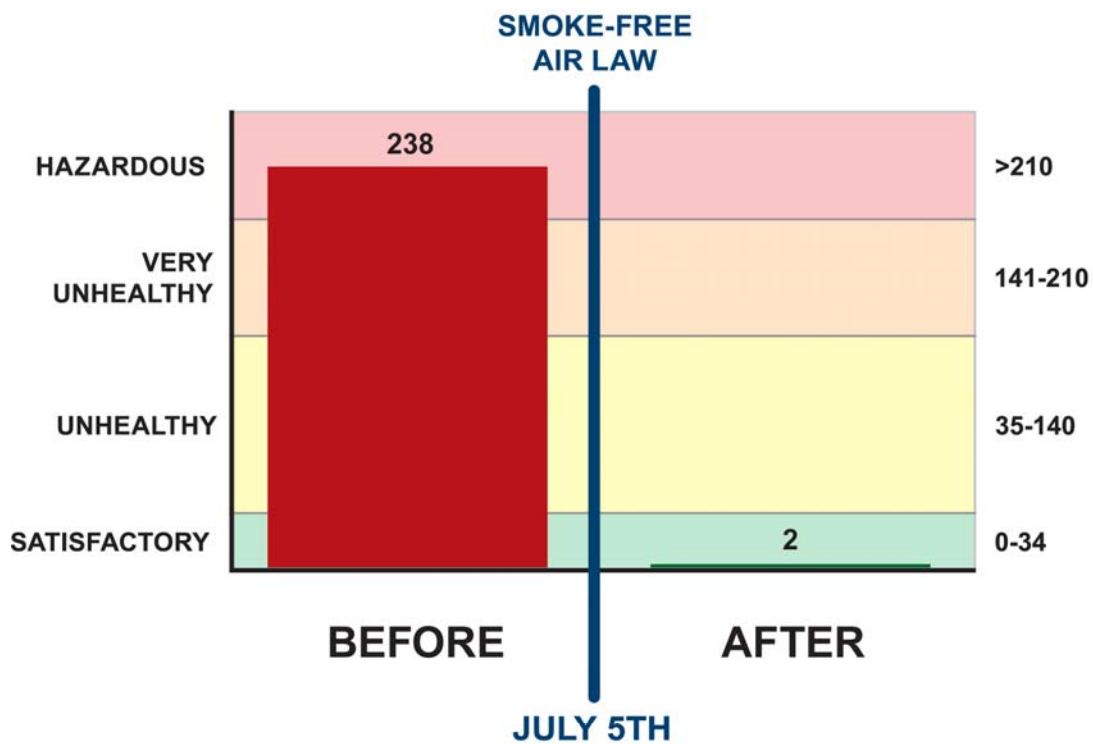


The Wisconsin Tobacco Prevention and Control Program measured air quality at several sites in more than 20 counties, including bars, restaurants and bowling alleys. Measurements were taken before and after July 5, 2010, the date the statewide smoke-free air law went into effect.

The number above each column represents average air-quality level measured, classified as satisfactory, unhealthy, very unhealthy or hazardous based on the Department of Natural Resources' Ambient Air Quality Index, available at <http://www.airnow.gov/index.cfm>.

INDOOR AIR QUALITY

Winnebago County

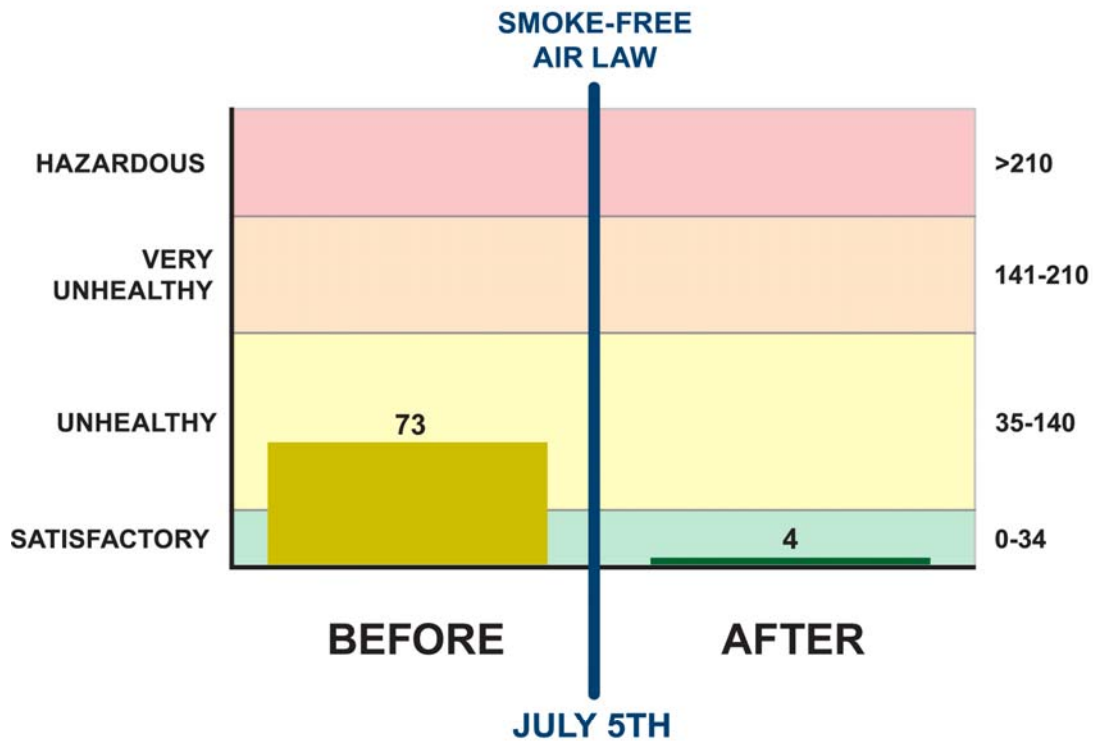


The Wisconsin Tobacco Prevention and Control Program measured air quality at several sites in more than 20 counties, including bars, restaurants and bowling alleys. Measurements were taken before and after July 5, 2010, the date the statewide smoke-free air law went into effect.

The number above each column represents average air-quality level measured, classified as satisfactory, unhealthy, very unhealthy or hazardous based on the Department of Natural Resources' Ambient Air Quality Index, available at <http://www.airnow.gov/index.cfm>.

INDOOR AIR QUALITY

Wood & Portage Counties

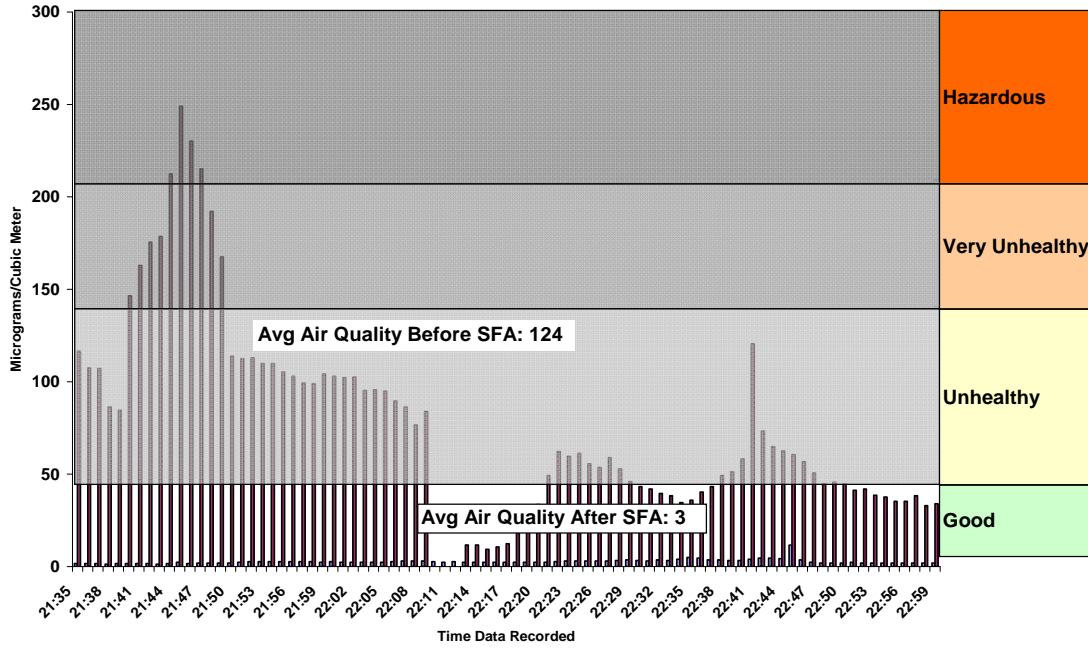


The Wisconsin Tobacco Prevention and Control Program measured air quality at several sites in more than 20 counties, including bars, restaurants and bowling alleys. Measurements were taken before and after July 5, 2010, the date the statewide smoke-free air law went into effect.

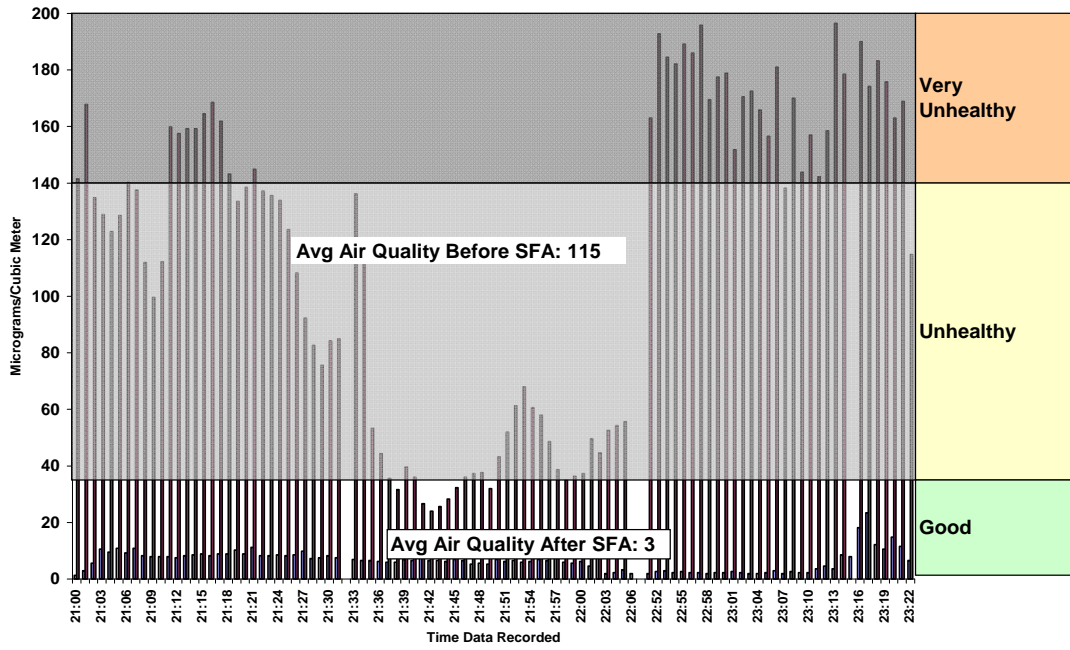
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Appendix B

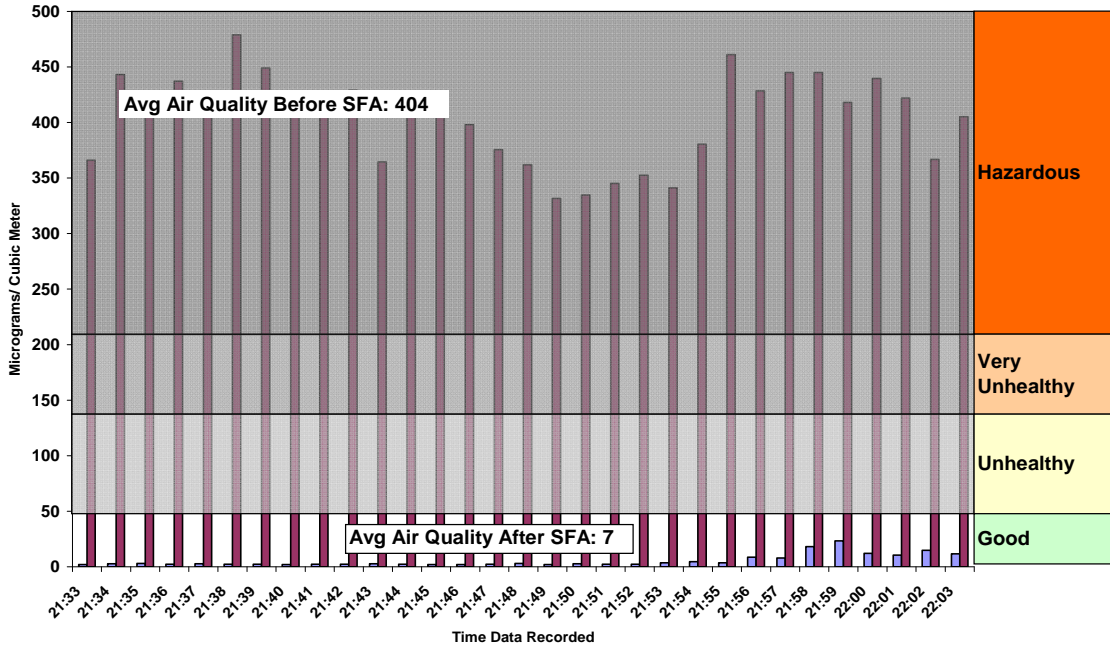
Adams County



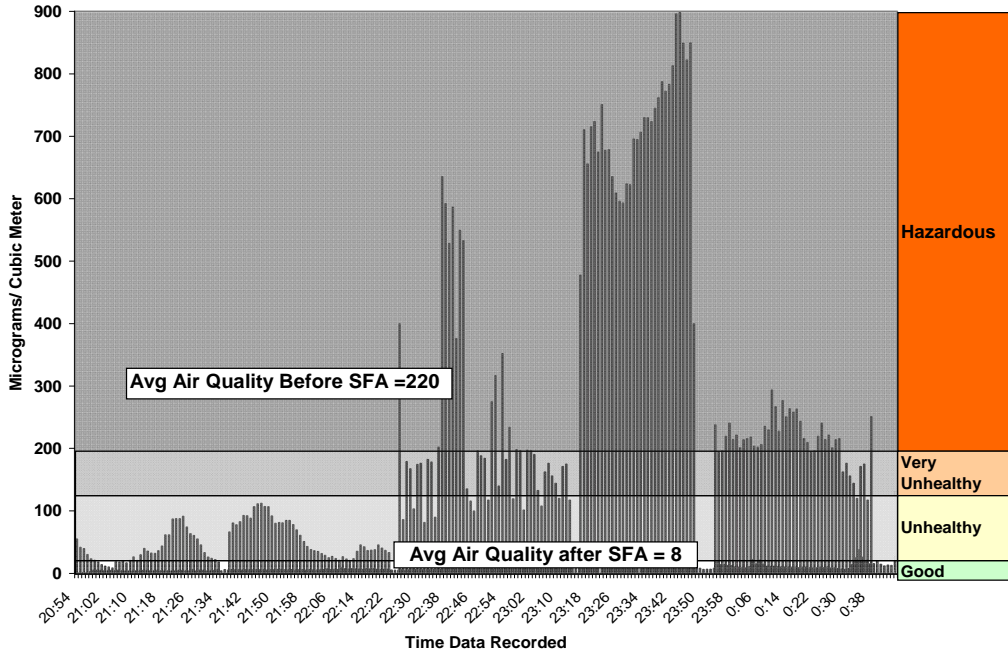
Ashland County



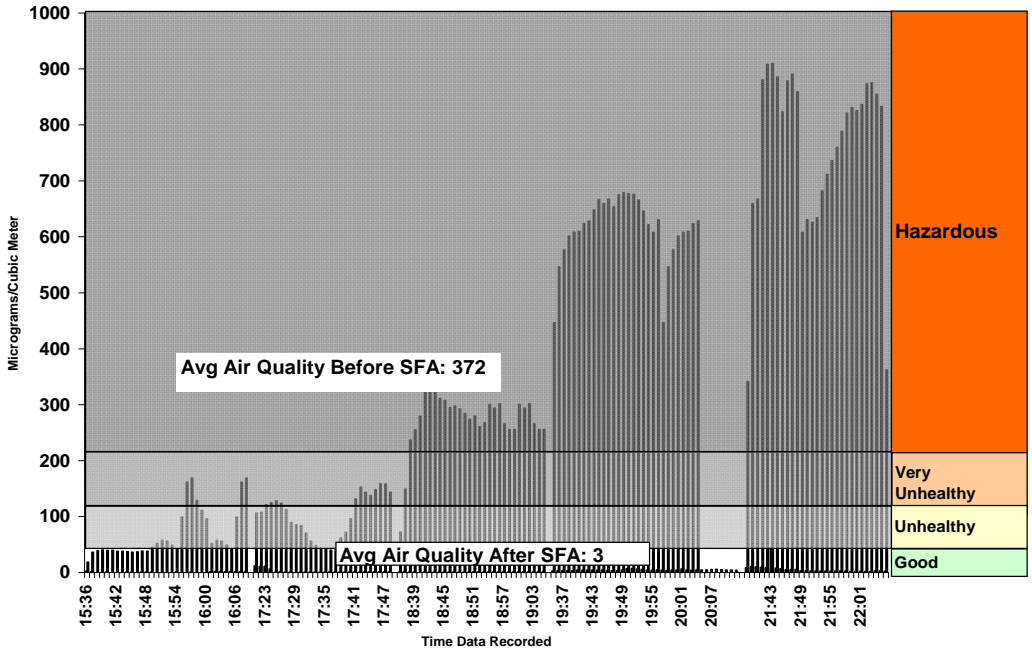
Bayfield County



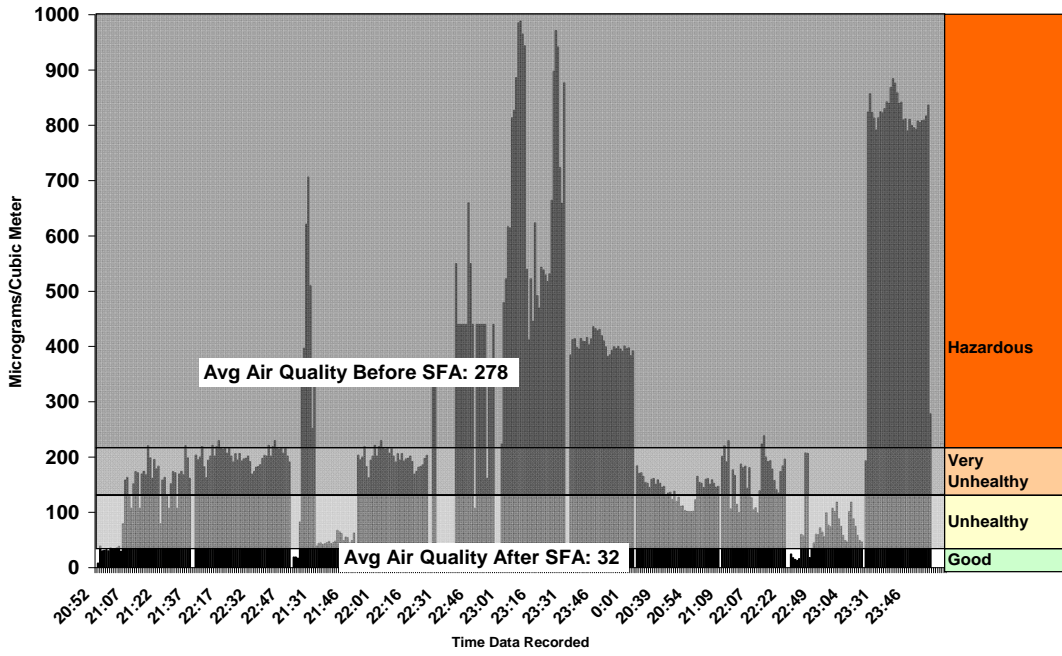
Brown County



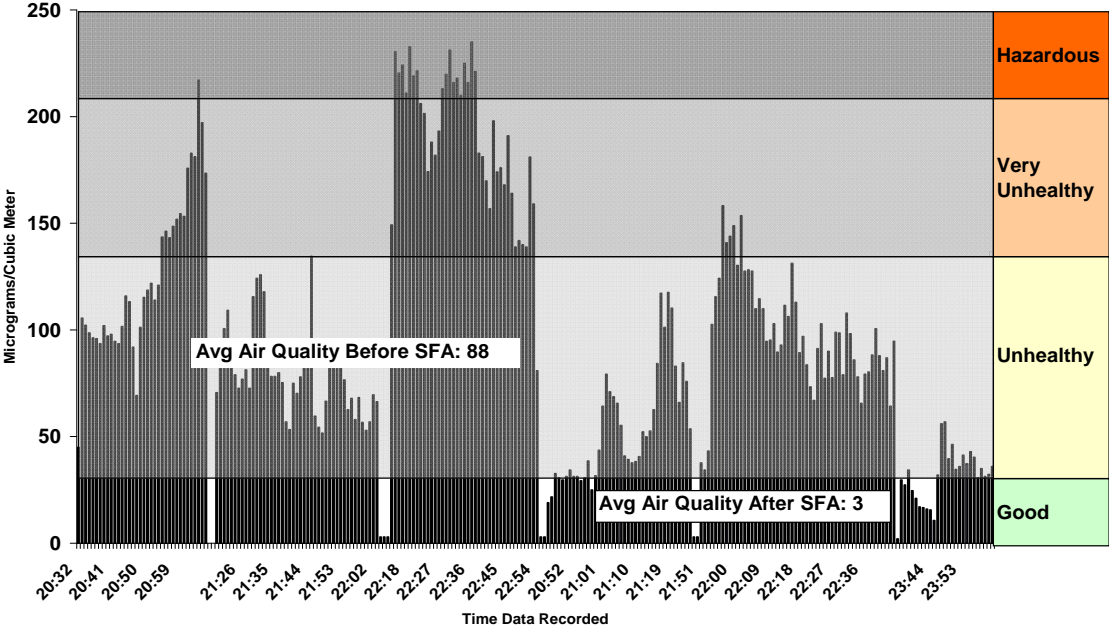
Dodge and Jefferson Counties



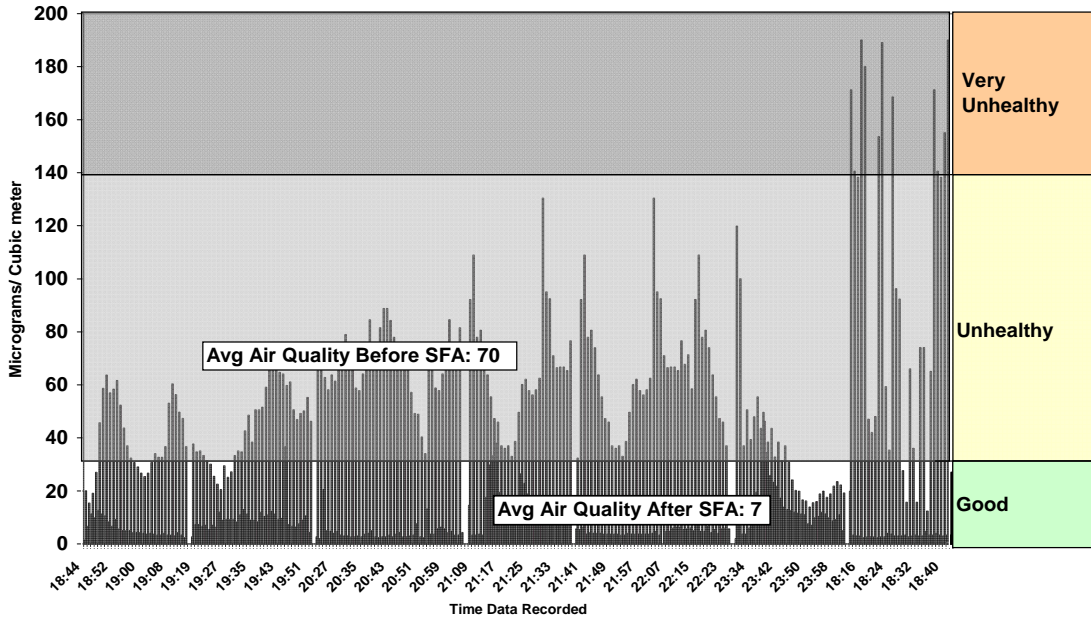
Douglas County



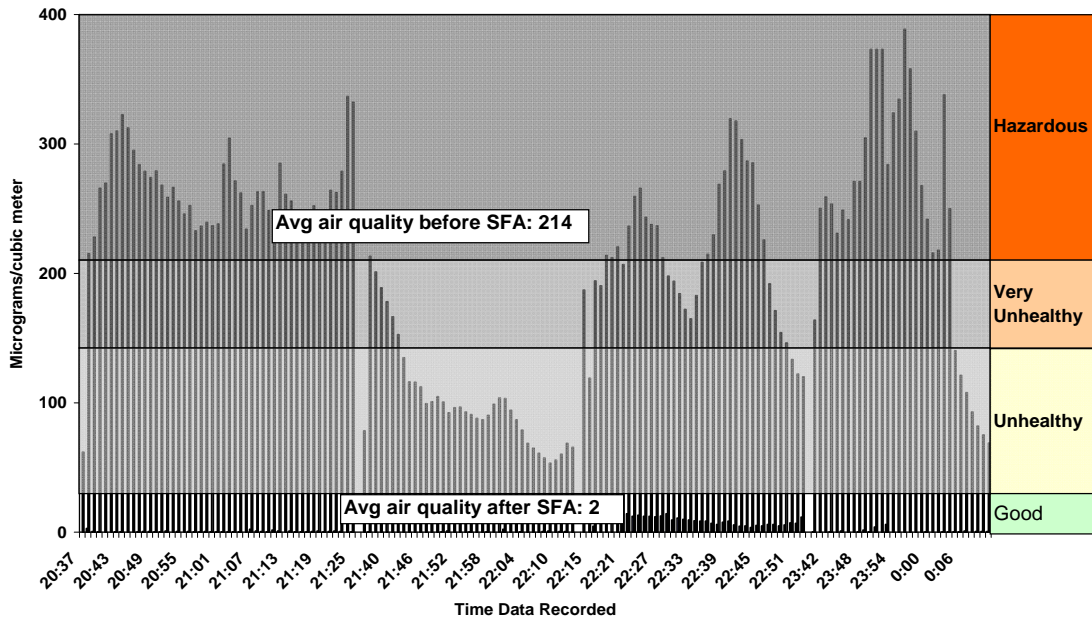
Juneau and Richland Counties



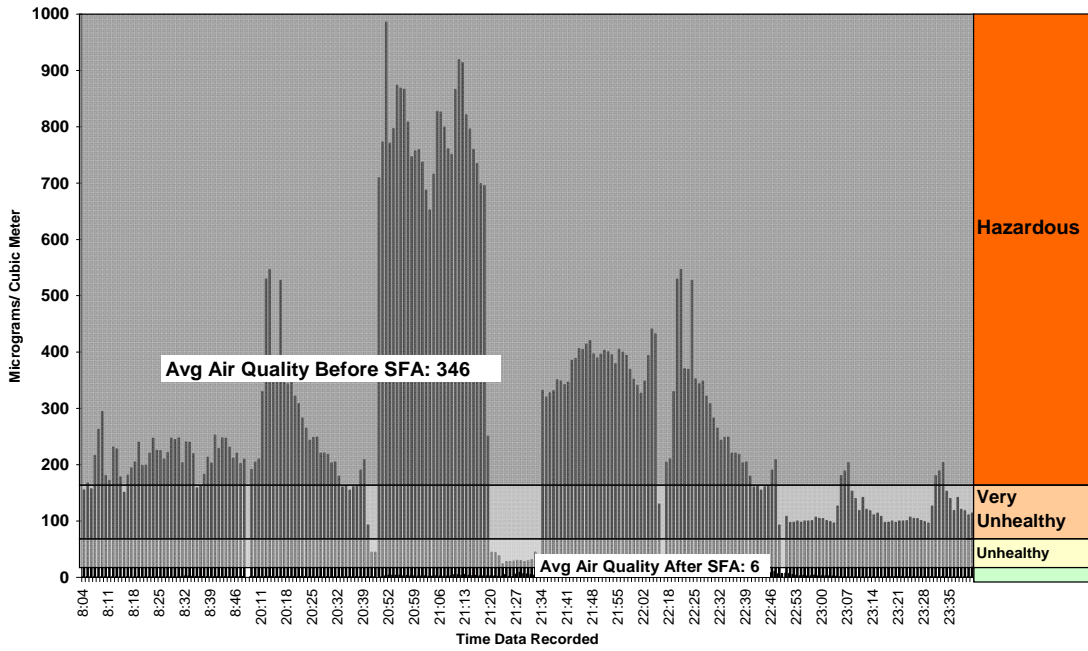
Kenosha and Racine Counties



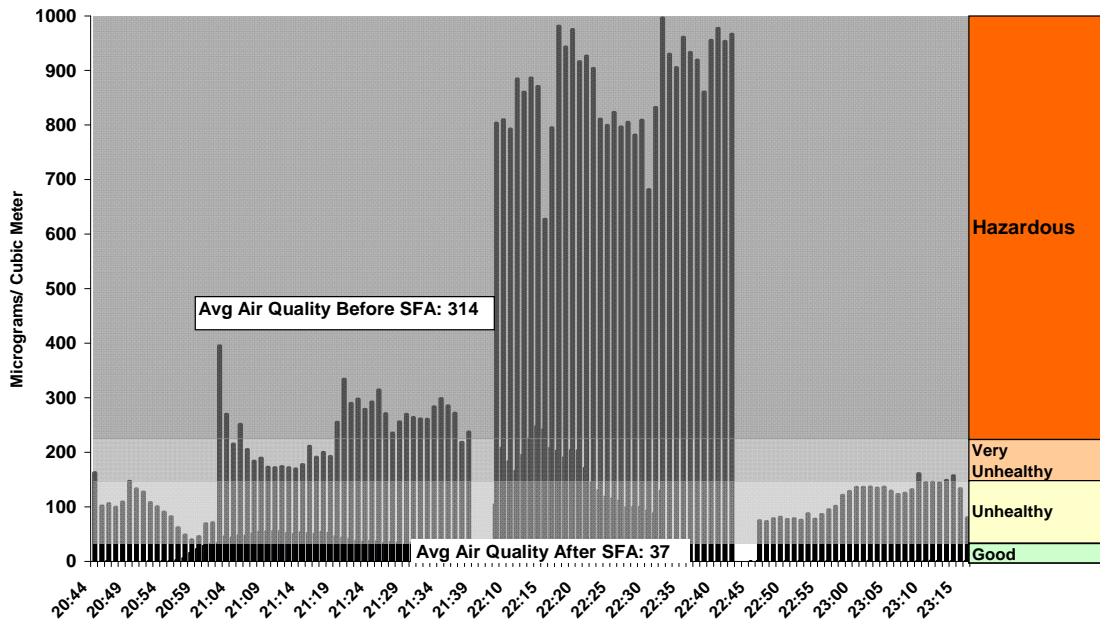
Kewaunee County



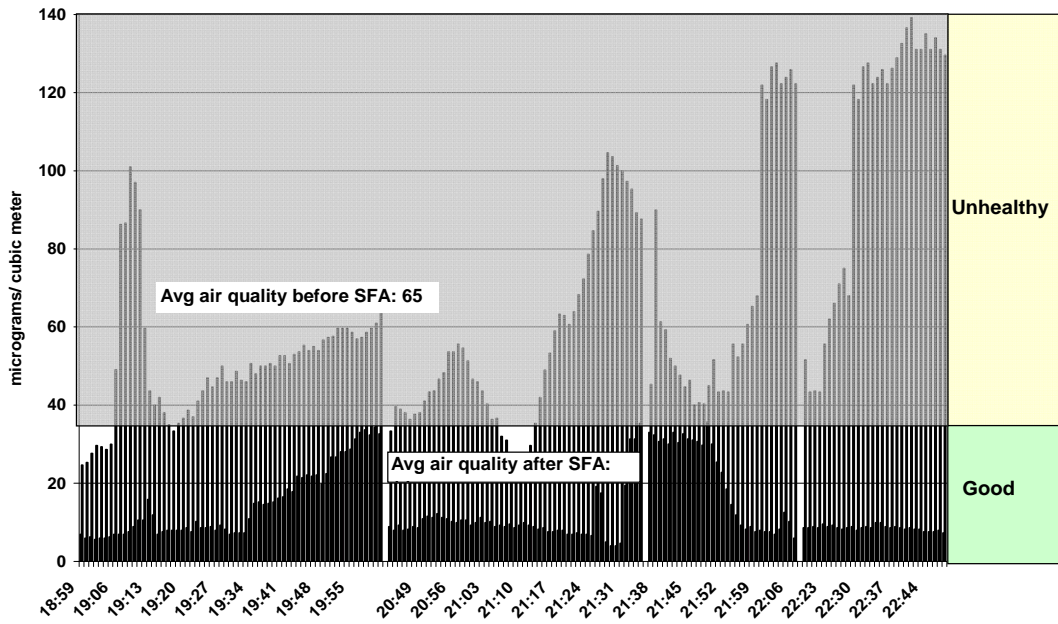
La Crosse County



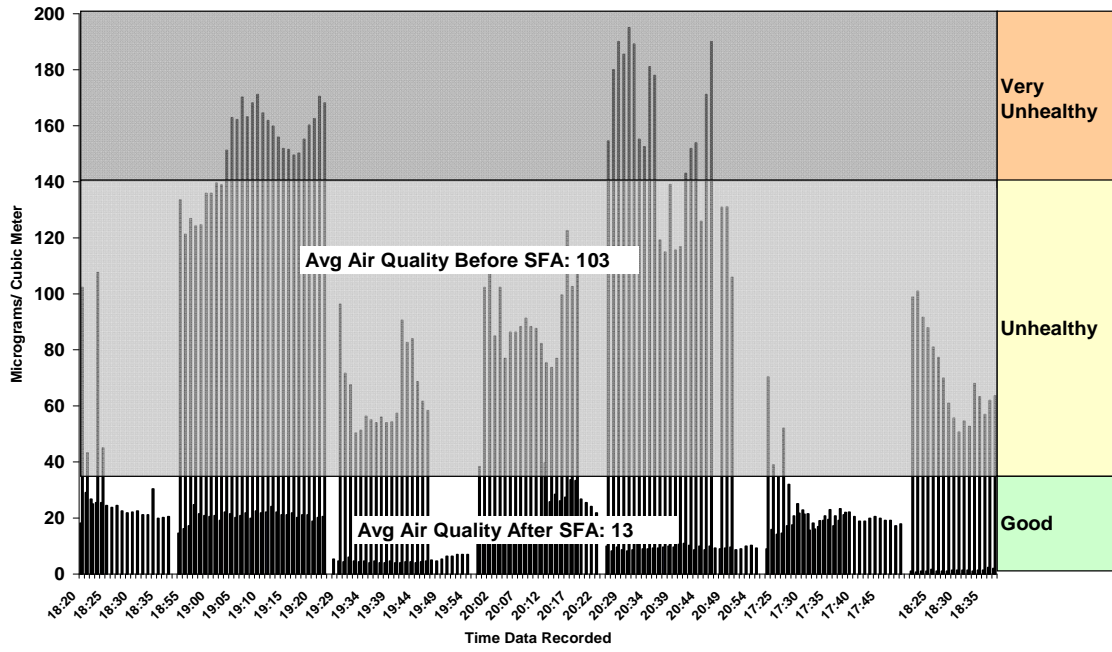
Manitowoc County



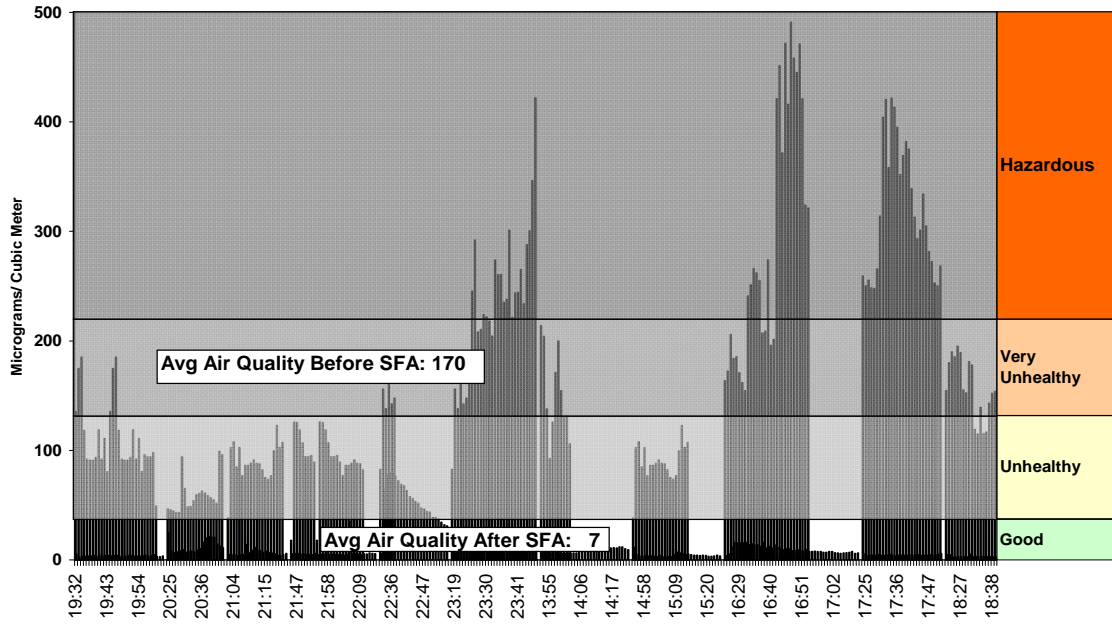
Marquette County



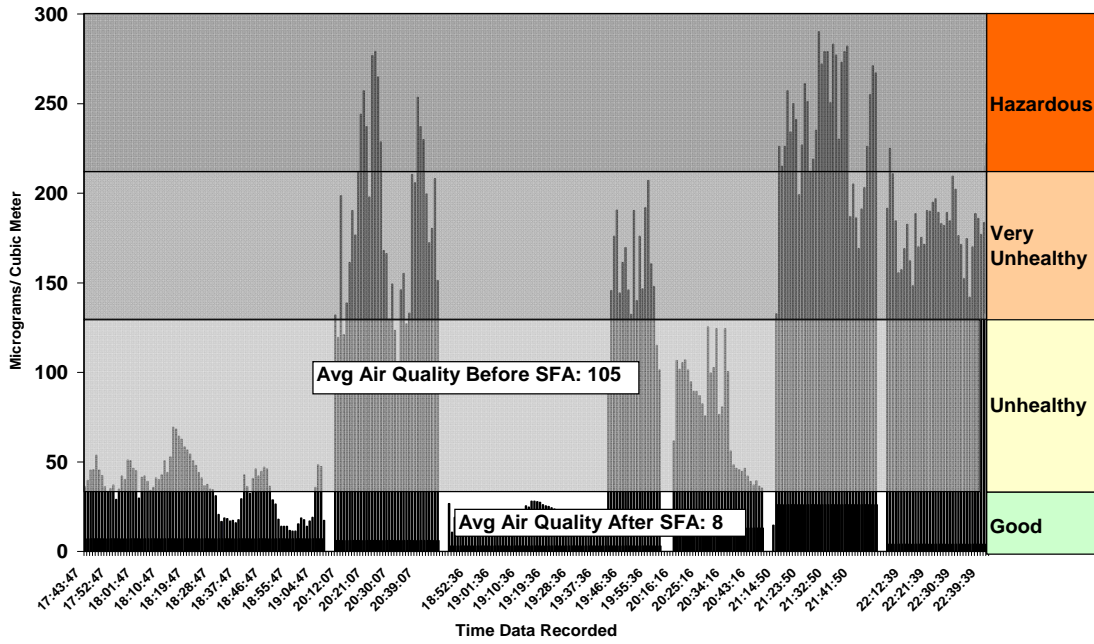
Milwaukee City



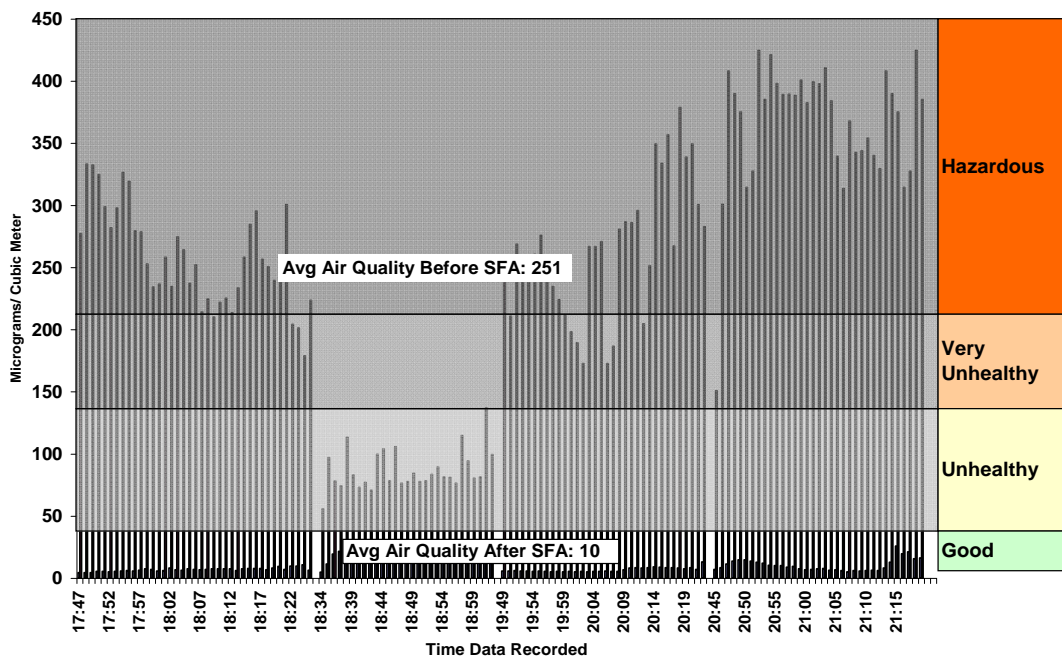
Milwaukee and Ozaukee



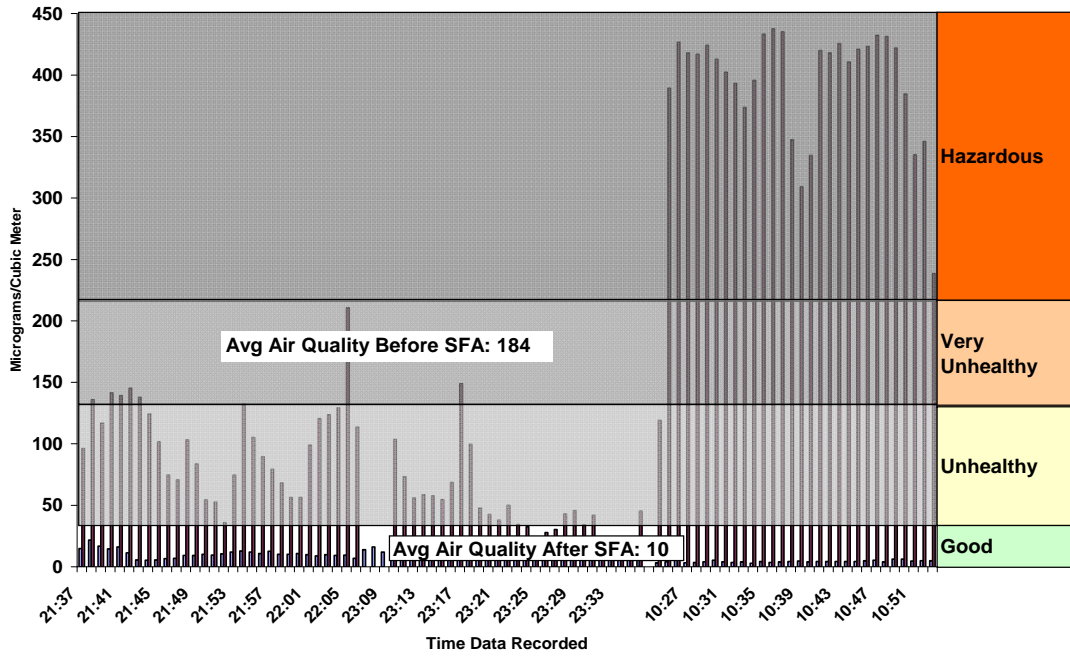
Oneida and Lincoln Counties



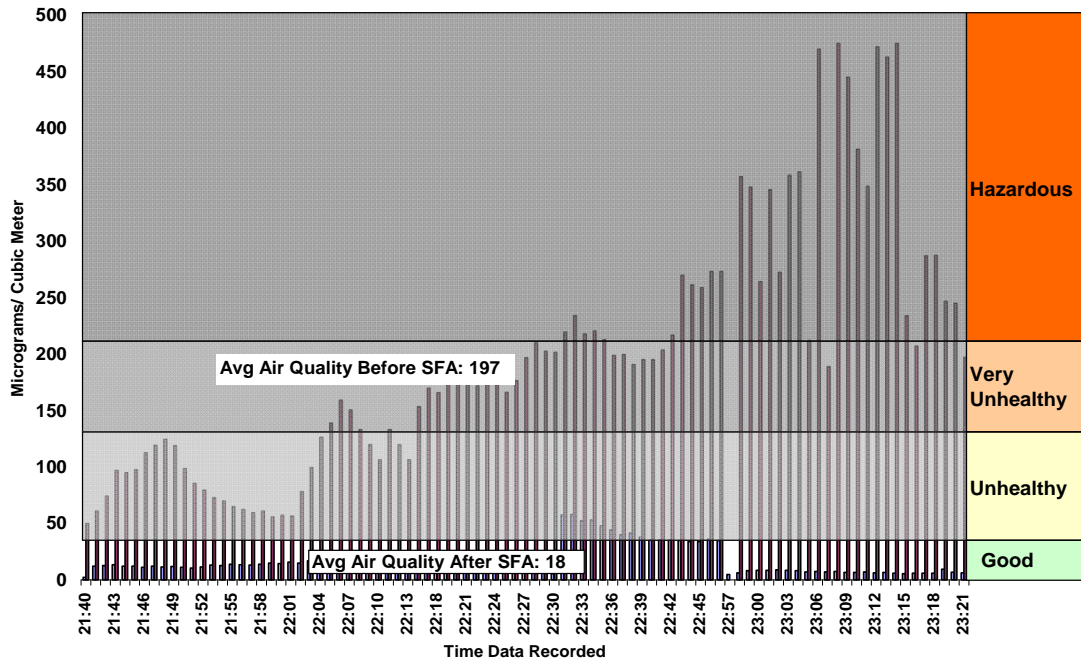
Outagamie County



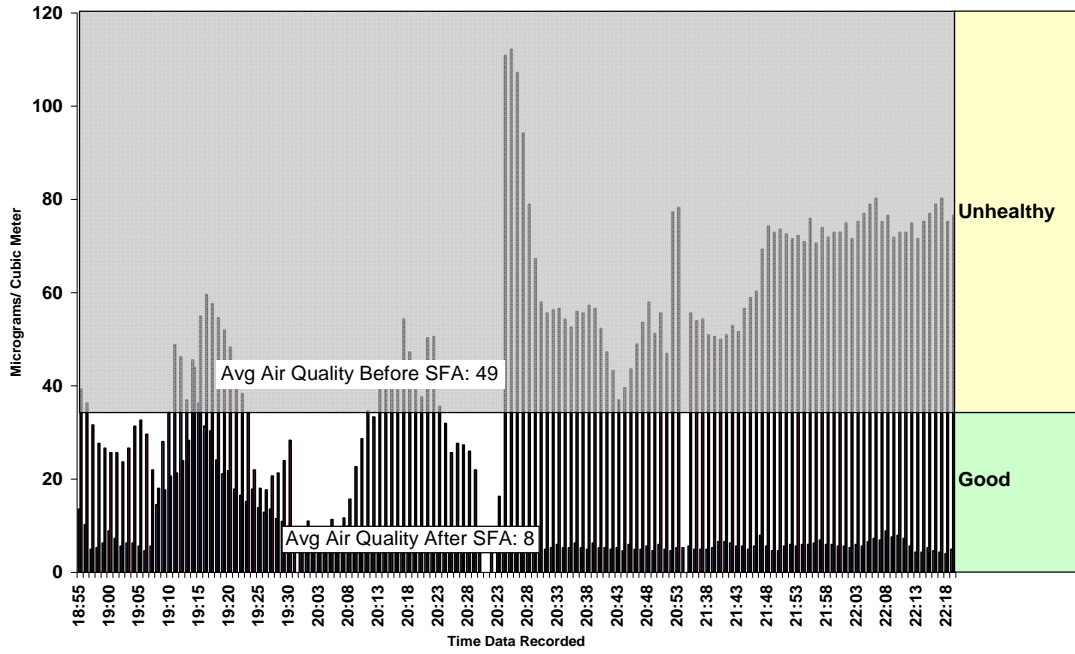
Polk County



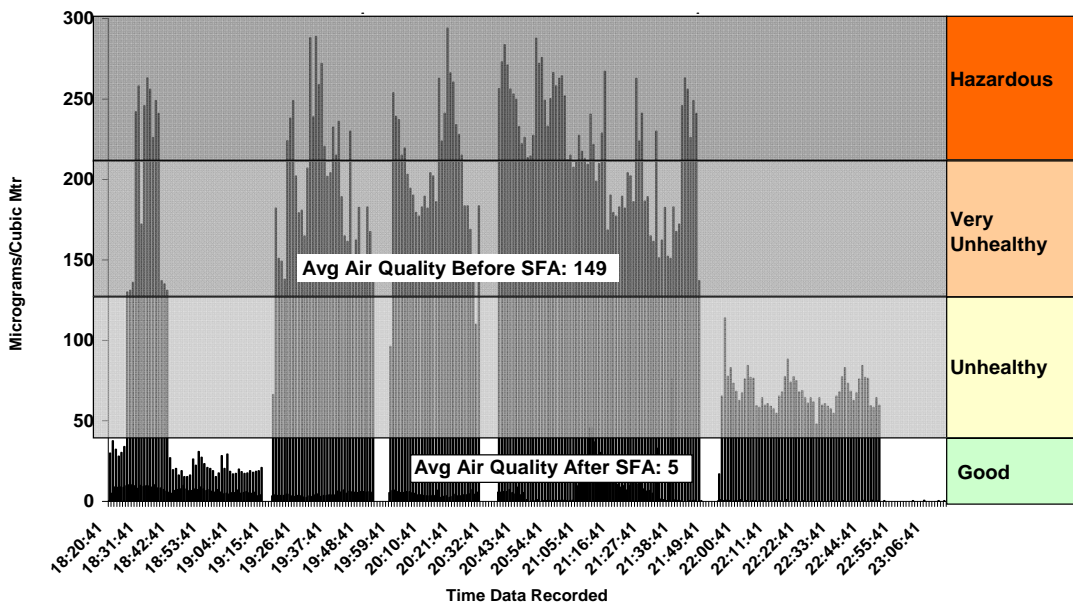
Rusk County



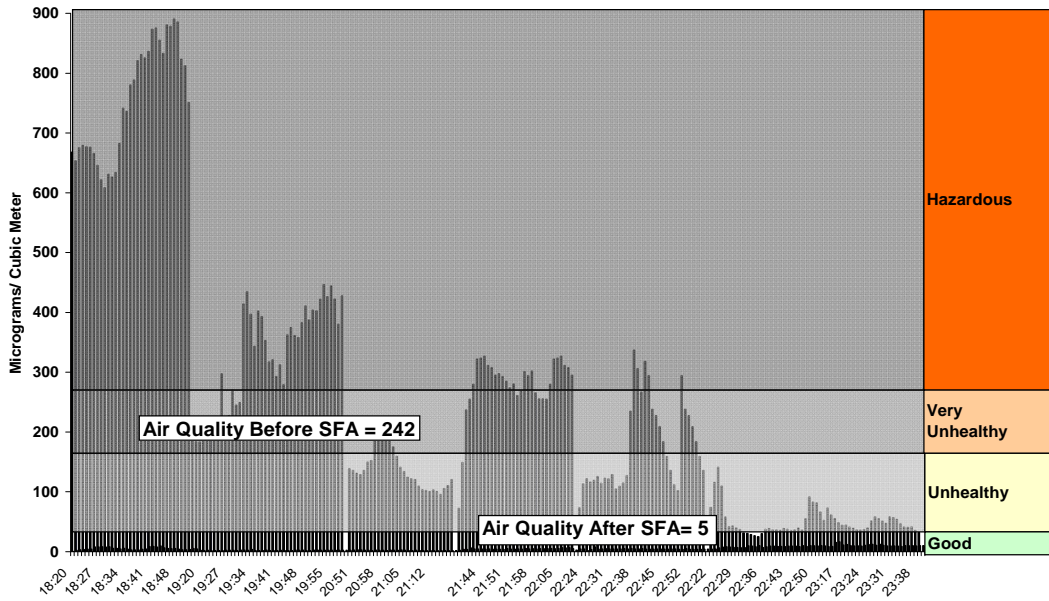
St. Croix County



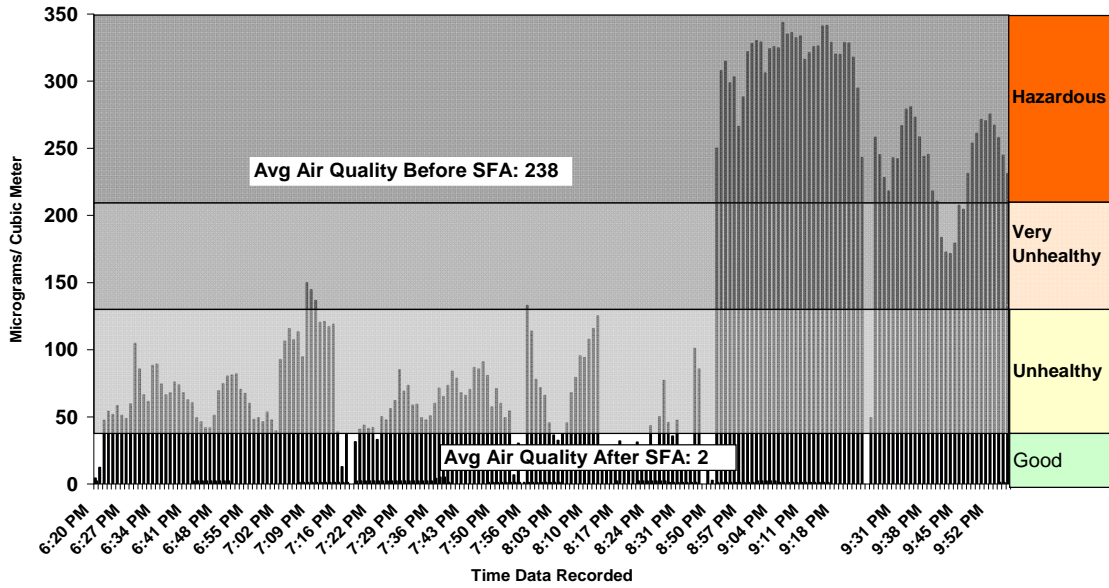
Washington County



Waukesha County



Winnebago County



Wood and Portage Counties

