AIR MANAGEMENT
PROGRAM GUIDANCE

Air Management Team

Wisconsin Department of Natural Resources
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"Guidance on Air Quality Background Concentrations"

January 1, 2017

This document is intended solely as guidance, and does not contain any mandatory requirements except where requirements found in statute or administrative rule are referenced. This guidance does not establish or affect legal rights or obligations, and is not finally determinative of any of the issues addressed. This guidance does not create any rights enforceable by any party in litigation with the State of Wisconsin or the Department of Natural Resources. Any regulatory decisions made by the Department of Natural Resources in any matter addressed by this guidance will be made by applying the governing statutes and administrative rules to the relevant facts.

APPROVED:

Gail E. Good

Gail E. Good, Director
Air Management Program

12-19-2016
Date

CORRESPONDENCE/MEMORANDUM

DATE: January 1, 2017

TO: Permit & Compliance Staff

FROM: Stationary Source Modeling Team

SUBJECT: Guidance on Background Concentrations[1]

INTRODUCTION

To be consistent with current federal and state ambient air standards, the Air Management Program has prepared the following update to the background concentrations, focusing on one hour (1-hr) sulfur dioxide (SO_2) and 1-hr nitrogen dioxide (NO_2). Background concentrations for 24-hour and annual SO_2 have been removed. Air Management is updating these values to be consistent with current federal and state ambient air standards.

The background concentrations listed in the following table are the values to be used for air dispersion modeling as of the date of this memorandum. WDNR can consider requests for alternate background concentrations if the source has installed an ambient monitor in an appropriate location and has a minimum of two (2) full years of data for the specific air pollutant(s). If the source has this data, WDNR will work with the source to develop source-specific background concentrations.

Wisconsin Background Concentrations
(All Concentrations in $\mu g/m^3$)

Pollutant	Time Period	High Value	Low Value
$PM_{2.5}$	24 Hour Annual	23.6 9.4	19.8 7.3
PM_{10}	24 Hour	47.0	29.4
Pb	Quarterly	0.02	0.01
SO_2	All Applicable	HROFDY & MONTH (*Table 1*)	HROFDY & MONTH (*Table 2*)
NO_2	All Applicable	HROFDY & MONTH (*Table 3*)	HROFDY & MONTH (*Table 4*)
CO	1 Hour 8 Hour	1,362.7 1,191.2	950.5 904.7

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Table 1

HIGH VALUE SO_2

HROFDY & MONTH Background Concentrations

(All Concentrations in $\mu g/m^3$)

	Hr 1	Hr 2	Hr 3	Hr 4	Hr 5	Hr 6	Hr 7	Hr 8	Hr 9	Hr 10	Hr 11	Hr 12	Hr 13	Hr 14	Hr 15	Hr 16	Hr 17	Hr 18	Hr 19	Hr 20	Hr 21	Hr 22	Hr 23	Hr 24
JAN	5.14	5.14	4.97	5.67	10.1	14.1	8.63	7.59	8.11	4.71	11.6	8.72	8.89	13.3	9.07	7.76	7.59	4.36	5.41	5.14	5.23	8.37	4.97	9.33
FEB	13.1	14.4	8.81	6.54	12.0	7.67	6.98	7.32	7.59	15.1	23.2	23.3	18.8	7.85	17.9	7.50	10.6	18.9	10.3	8.37	10.0	13.4	9.07	8.37
MAR	8.55	7.24	6.19	5.32	5.32	5.06	5.14	6.80	7.85	10.1	7.24	19.3	21.0	10.2	6.63	7.06	6.28	5.93	5.67	4.88	5.41	19.6	5.49	8.81
APR	6.19	6.19	5.84	4.27	3.66	8.98	6.02	9.24	5.06	4.80	7.06	5.32	5.06	8.89	8.81	8.20	6.80	7.06	5.93	5.49	7.24	4.88	6.19	8.46
MAY	9.16	7.67	6.45	5.76	5.76	7.06	7.50	16.7	10.2	9.77	17.6	11.0	10.6	12.0	13.3	15.5	9.50	13.8	9.68	7.59	6.98	6.10	6.98	9.16
JUN	8.28	5.49	5.23	5.67	5.76	5.58	5.84	6.71	7.59	10.2	8.81	9.07	8.63	11.6	17.0	13.6	12.0	10.6	12.3	9.33	7.67	7.32	7.50	7.24
JUL	6.71	8.72	6.71	5.41	5.49	8.20	7.76	9.68	18.1	6.98	8.28	6.80	6.37	6.98	7.06	8.63	8.46	13.6	11.6	5.41	5.49	6.28	7.76	9.33
AUG	4.97	3.92	3.92	4.45	4.97	6.63	5.49	8.89	12.0	6.19	9.33	15.8	8.89	7.06	9.24	6.54	6.19	11.7	4.88	6.28	5.84	5.23	5.76	4.01
SEP	5.67	5.32	4.80	5.41	5.49	4.71	7.32	7.94	14.0	19.7	11.2	8.89	7.59	9.59	7.15	7.15	8.89	7.41	6.37	6.80	5.67	4.27	4.53	5.32
OCT	7.85	8.55	6.02	4.80	5.23	4.80	7.41	9.24	7.32	6.45	8.63	10.6	6.98	6.28	6.63	6.80	7.41	7.85	5.06	5.41	6.28	8.72	8.55	8.02
NOV	5.23	6.10	13.4	10.9	9.77	7.94	5.76	7.50	9.50	6.89	6.71	9.85	7.76	7.24	5.84	8.28	5.93	6.71	6.10	7.59	8.55	8.11	6.02	4.71
DEC	6.80	7.94	6.10	6.71	5.93	6.37	7.24	9.50	8.98	8.63	8.55	6.37	6.71	7.94	5.76	8.89	6.19	6.45	9.94	8.20	7.24	5.32	4.62	5.67

Table 2

LOW VALUE SO_2

HROFDY & MONTH Background Concentrations

(All Concentrations in $\mu g/m^3$)

	Hr 1	Hr 2	Hr 3	Hr 4	Hr 5	Hr 6	Hr 7	Hr 8	Hr 9	Hr 10	Hr 11	Hr 12	Hr 13	Hr 14	Hr 15	Hr 16	Hr 17	Hr 18	Hr 19	Hr 20	Hr 21	Hr 22	Hr 23	Hr 24
JAN	5.32	8.02	8.02	6.37	6.28	4.27	4.27	4.80	6.19	6.45	10.5	14.1	11.3	12.0	9.16	7.59	6.02	7.50	6.10	5.84	5.32	6.54	5.32	5.32
FEB	5.06	6.45	6.45	8.81	9.85	10.9	10.7	11.3	13.3	10.2	8.81	9.42	9.94	9.42	8.98	7.67	7.59	6.28	6.10	5.41	6.63	6.71	6.71	6.37
MAR	4.80	6.02	5.06	4.71	4.27	4.27	4.36	4.71	6.10	8.81	9.50	8.98	9.77	8.72	7.85	8.02	9.16	7.24	5.84	4.88	4.97	3.84	4.97	5.23
APR	5.14	5.14	3.05	3.58	4.01	3.75	3.31	3.92	4.36	5.49	4.45	4.19	4.19	4.01	4.45	3.58	3.31	3.66	3.84	5.49	5.41	9.33	5.58	5.06
MAY	4.53	5.41	5.06	3.23	2.96	3.05	3.31	4.88	5.58	3.40	3.40	3.31	2.96	3.05	5.76	5.58	3.66	5.49	4.62	5.06	5.23	5.58	6.71	5.84
JUN	3.75	3.75	2.79	2.53	2.53	2.96	4.53	4.27	4.45	4.27	5.41	2.96	2.79	2.88	4.62	5.06	5.58	4.19	6.80	9.33	6.45	5.41	5.67	3.92
JUL	3.75	3.75	1.92	2.18	2.27	2.18	2.35	3.05	4.53	5.32	3.58	2.70	3.40	4.36	4.10	3.31	3.66	3.14	2.53	2.09	3.23	9.42	13.8	9.33
AUG	3.49	3.75	1.92	1.83	1.40	2.09	1.92	3.31	6.19	8.20	5.67	5.23	3.23	2.44	2.18	1.92	2.09	3.31	3.40	3.14	3.23	2.70	3.75	2.27
SEP	3.75	4.88	4.27	3.58	2.88	3.75	4.53	4.97	5.23	7.24	6.19	5.58	5.49	6.28	6.19	5.06	5.06	4.45	4.62	5.93	4.53	4.19	4.36	4.71
OCT	5.14	5.67	3.58	3.40	3.58	3.31	3.58	3.92	4.27	5.32	3.66	5.14	3.49	3.31	3.75	5.06	4.88	3.58	3.84	3.05	2.79	3.05	3.49	4.36
NOV	2.35	2.62	2.27	2.18	2.27	2.35	2.18	2.35	2.70	3.14	3.49	3.14	3.40	3.84	5.58	3.84	4.53	4.36	4.45	5.06	2.96	2.62	2.53	2.35
DEC	2.53	2.53	2.09	2.44	2.62	2.62	2.53	2.18	2.18	3.23	4.01	5.06	4.27	4.01	5.14	10.6	6.02	5.84	3.40	2.79	3.58	3.05	3.05	2.88

Table 3

HIGH VALUE NO_2

HROFDY & MONTH Background Concentrations

(All Concentrations in $\mu g/m^3$)

	Hr 1	Hr 2	Hr 3	Hr 4	Hr 5	Hr 6	Hr 7	Hr 8	Hr 9	Hr 10	Hr 11	Hr 12	Hr 13	Hr 14	Hr 15	Hr 16	Hr 17	Hr 18	Hr 19	Hr 20	Hr 21	Hr 22	Hr 23	Hr 24
JAN	62.4	58.8	66.2	53.8	65.7	66.4	68.6	69.4	70.5	49.4	39.1	36.5	38.2	37.3	41.0	44.1	51.7	56.8	61.4	63.0	65.7	66.5	61.5	67.2
FEB	80.7	78.2	81.5	81.7	74.4	78.4	80.0	76.8	60.0	61.7	57.8	46.7	44.9	39.0	41.2	43.5	53.0	61.7	65.4	68.0	77.1	76.3	76.3	77.6
MAR	79.6	78.4	81.5	81.6	78.1	79.6	79.1	73.0	49.6	43.7	34.5	39.5	37.2	35.5	34.2	33.7	36.2	42.4	41.9	63.4	79.8	79.6	68.5	76.6
APR	77.5	69.4	52.3	66.4	64.7	73.9	67.7	56.8	34.8	24.2	23.0	21.3	22.0	23.0	35.4	28.1	30.0	26.8	32.7	43.6	56.0	63.0	68.2	72.9
MAY	64.2	58.6	65.9	64.3	63.5	57.0	62.2	54.7	45.4	49.6	29.3	30.6	26.4	35.9	25.5	25.9	26.0	26.1	32.8	40.5	54.5	51.2	57.5	65.2
JUN	68.6	47.8	48.4	42.3	43.4	45.7	45.9	45.4	34.2	31.0	29.1	24.1	54.2	24.6	29.3	36.5	28.1	24.6	34.3	34.4	65.5	76.2	73.1	70.6
JUL	49.8	41.4	45.7	49.5	43.8	46.7	48.3	38.7	33.2	18.5	22.5	21.8	25.9	21.5	21.0	18.2	20.0	22.3	25.4	39.4	52.0	48.3	52.3	50.3
AUG	55.0	49.3	47.9	45.1	45.3	50.8	44.6	41.2	35.5	21.9	25.7	27.4	31.6	25.8	38.9	39.9	43.9	33.3	32.1	53.1	57.8	60.5	56.9	54.8
SEP	53.2	42.7	48.3	48.2	49.3	51.6	53.6	58.2	47.8	42.2	24.9	23.7	27.6	31.8	33.1	27.6	29.9	35.0	50.8	53.8	60.4	67.9	63.4	56.7
OCT	51.4	28.7	46.8	47.6	46.5	49.8	50.0	54.6	49.9	36.2	31.9	31.5	32.0	35.7	30.6	33.2	40.5	50.6	55.0	59.2	56.5	46.5	47.1	59.2
NOV	57.3	32.1	57.7	56.1	54.6	60.3	62.6	64.7	60.7	51.3	37.4	34.3	35.0	35.7	42.7	48.0	55.4	54.6	63.7	60.3	62.9	62.7	62.2	61.4
DEC	50.3	34.5	39.8	40.7	43.9	45.7	54.1	63.1	60.2	62.2	49.3	34.2	32.9	32.9	36.2	44.8	52.0	55.5	58.0	57.2	55.3	53.6	55.6	49.6

Table 4

LOW VALUE NO_2

HROFDY & MONTH Background Concentrations

(All Concentrations in $\mu g/m^3$)

	Hr 1	Hr 2	Hr 3	Hr 4	Hr 5	Hr 6	Hr 7	Hr 8	Hr 9	Hr 10	Hr 11	Hr 12	Hr 13	Hr 14	Hr 15	Hr 16	Hr 17	Hr 18	Hr 19	Hr 20	Hr 21	Hr 22	Hr 23	Hr 24
JAN	14.6	12.9	14.4	19.4	21.9	20.1	19.4	18.8	18.2	16.3	14.8	13.7	13.7	13.3	13.9	16.3	15.0	14.8	16.4	15.8	14.5	14.8	14.8	15.0
FEB	14.7	15.5	16.0	11.9	13.9	13.9	15.0	15.1	13.9	14.2	13.5	14.5	14.1	12.8	12.9	12.7	13.0	13.1	17.2	19.4	18.2	17.8	15.2	14.7
MAR	12.9	11.9	12.9	8.15	10.6	10.3	11.3	11.5	11.5	11.0	11.5	11.7	11.5	11.5	12.1	14.1	15.3	14.5	15.4	12.8	12.4	14.8	14.2	13.4
APR	10.2	10.1	9.09	6.27	6.96	8.90	9.27	8.71	7.96	8.27	7.83	8.15	8.46	11.5	6.96	8.02	10.3	10.2	9.21	10.0	9.90	9.53	11.4	10.8
MAY	7.71	5.89	7.46	5.64	7.08	8.59	7.39	7.14	5.89	5.58	6.02	5.83	5.08	5.01	4.57	7.33	5.77	5.64	5.95	7.52	6.96	8.27	7.65	7.96
JUN	8.08	7.39	6.27	8.08	8.08	9.46	9.21	8.33	8.77	9.21	8.77	8.96	8.77	8.77	8.21	8.40	8.84	10.4	11.6	11.5	9.96	8.71	9.27	9.53
JUL	7.90	10.3	6.89	7.83	7.77	8.15	10.7	9.02	9.27	8.59	8.90	8.84	9.84	8.21	8.65	7.46	9.65	12.4	14.4	13.2	10.8	9.84	8.59	9.65
AUG	10.3	8.40	6.02	9.71	9.90	10.7	8.96	10.5	9.02	8.90	7.77	7.52	6.77	7.65	8.02	6.71	7.83	7.65	9.90	12.2	11.9	11.4	8.90	11.3
SEP	5.83	6.89	6.58	4.32	5.39	6.64	6.71	6.45	6.39	6.08	6.02	6.14	6.08	6.77	10.6	7.21	7.52	6.39	5.89	6.71	5.83	9.09	7.02	6.71
OCT	9.90	9.71	9.71	6.33	7.33	8.90	8.21	8.08	7.71	7.02	7.27	7.33	7.08	7.02	7.27	7.46	8.21	8.21	8.27	7.77	10.7	9.84	10.5	9.65
NOV	14.4	13.5	12.5	8.15	6.89	8.71	10.0	9.84	9.71	9.78	9.21	9.09	8.96	8.40	9.21	11.2	11.6	12.9	13.0	12.9	14.5	13.6	14.0	14.5
DEC	15.9	15.9	18.4	21.8	15.6	11.2	9.27	9.34	8.84	9.02	8.52	7.90	8.02	8.21	8.71	9.59	10.5	11.8	11.6	13.3	14.8	13.7	13.2	13.9

IMPLEMENTATION

Beginning November 1, 2016, permits where a modeling analysis is performed for either SO_2 or NO_2 will be evaluated with the background concentrations noted in this memo for all applicable time periods. This includes both 1-hour and annual NO_2, and 1-hr and 3-hr SO_2. If necessary, the values can also apply to the obsolete 24-hr and annual SO_2 standards. Permits already in public comment or waiting to be issued can be re-evaluated for modeling on a case-by-case basis to determine if the updated background concentrations can be applied to determine a new emission limit. This potentially could add time to the permit process, depending on the change to the proposed limit.

The regulatory dispersion model AERMOD allows for the inclusion of background concentrations using the BACKGRND keyword on the SO (Source) pathway. Background concentrations can be specified for different time periods, such as hour of day, day of week, and month. The SO_2 and NO_2 background concentrations can be entered using the MHRDOW background flag parameter using the same hour of day and month values for weekdays, Saturdays, and Sundays.

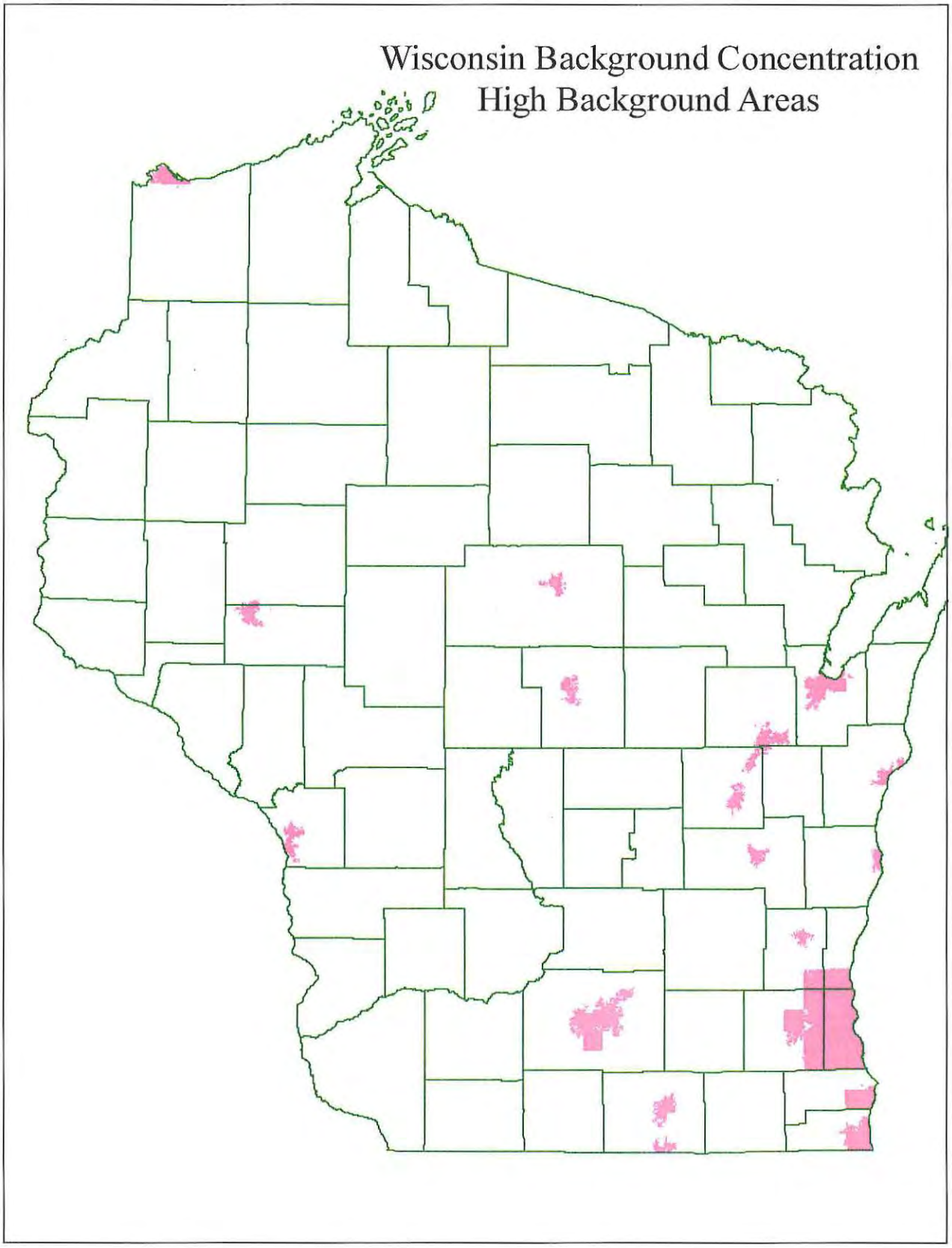
In addition, the BACKUNIT keyword should also be used to indicate values are in $\mu g/m^3$, rather than the default value of ppb, and the BACKGRND (or BACKGROUND) parameter included in each source group, as well as the case of source group ALL.

METHODOLOGY

Geographic Areas

To determine the proper population threshold separating higher background concentrations areas from lower, all cities and villages in Wisconsin were examined using the 2010 decennial U.S. Census data. Cities and villages with populations of 25,000 residents were identified. Areas with lower population generally have less industry, fewer residential emissions, and less traffic, so higher background concentrations would not be appropriate.

Many of the larger cities in Wisconsin have neighboring suburbs that, when combined, are considered one metropolitan area. Legally and administratively, these cities and villages are separate entities but for the purposes of background concentrations these areas are considered as one contiguous region. The year 2010 U.S. Census data was again consulted and a list was created of all cities and villages immediately adjacent to a larger city or village (i.e. one with population of 25 000 people or more). For the purposes of this document, if the population density of the neighboring city or village is more than half the population density of the main city or village, then it is considered a portion of the main city or village. Also, if the larger city or village surrounds another city or village, the surrounded entity was considered a portion of the main city or village. This total area is then assigned the higher background concentration. Using this method, the following map and table were developed to show in what areas the higher background concentration are to be used and in what areas the lower concentration are to be used.


Wisconsin Background Concentration
High Background Areas

Cities and villages can change their boundaries (e.g. through annexation), so the figure is not an official indicator of the proper background concentrations to use. The following table lists all the areas where the higher background concentrations must be used. If a given area expands due to annexation or incorporation, the higher background concentration values would apply to the additional (i.e. annexed, incorporated) area.

High Background Areas in Wisconsin	
Main City	Additional Incorporated (City or Village) Areas
Superior	-
Eau Claire	-
Wausau	Schofield
Stevens Point	Plover, Whiting
La Crosse	Onalaska
Green Bay	Ashwaubenon, Allouez, De Pere
Appleton	Menasha, Neenah, Little Chute, Kimberly, Combined Locks, Kaukauna
Manitowoc	Two Rivers
Oshkosh	-
Fond du Lac	North Fond du Lac
Sheboygan	-
West Bend	-
Madison	Middleton, Shorewood Hills, McFarland, Maple Bluff, Sun Prairie, Monona, Fitchburg
Janesville	-
Beloit	-
Kenosha	Pleasant Prairie
Racine	Mount Pleasant, Sturtevant
Milwaukee	St. Francis, Cudahy, South Milwaukee, Oak Creek, Franklin, Greenfield, Greendale, Hales Corners, West Allis, West Milwaukee, Wauwatosa, Shorewood, Glendale, Whitefish Bay, Brown Deer, Fox Point, River Hills, Bayside, Menomonee Falls, Butler, Lannon, Brookfield, Elm Grove, New Berlin, Muskego, Germantown, Mequon, Theinsville, Pewaukee (city & village), Waukesha

Notes

- The designated areas are based on the corporate boundaries of the city or village, not the ZIP code.
- If the emission sources of a facility are located within the corporate boundaries of an area listed in the table, the high background concentrations should be used.
- If emission sources for a modeling analysis lay both inside and outside of an area listed in the table, or the corporate boundaries are uncertain, the high background concentrations should be used.

Background Concentration Value Determination

Five years of PM_{10} and CO monitoring data was obtained, along with the monitoring objective and land use in the vicinity of the monitor. The data was organized into the monitoring objective categories of 'population exposure' and 'general/background', and into the land use categories of 'urban residential', 'suburban residential', and 'urban commercial' where applicable. In reviewing the data it was noted that many of the monitor locations were actually close to industrial facilities, regardless of the land use data category. For the short-term standards the higher background values were derived from the arithmetic mean of the 98th percentile data from the 'population exposure' category. For the lower background concentration areas, the short-term values were derived from the arithmetic mean of the 98th percentile data from the 'general/background' category. For both the high and low areas, the annual background concentrations were calculated from the arithmetic mean of the annual impacts from either set of monitors.

For lead (Pb), WDNR monitoring is source-specific and the filer-based method makes it difficult to assess wind direction-specific concentrations. Qualitative review of special study and tribal lead monitor data collected outside of urban areas show concentrations less than 0.01 $\mu g/m^3$. After discussion with WDNR air monitoring staff, the low background value was assigned as 0.01 $\mu g/m^3$. To account for distant and nearby emission sources if lead not explicitly modeled, the high lead background value was doubled to 0.02 $\mu g/m^3$.

Ambient $PM_{2.5}$ concentrations are more evenly distributed across Wisconsin due to the regional nature of the pollutant, so background concentrations were calculated by separating the monitors based on location. The 2011-2013 98th percentile daily values and annual values were averaged for all monitors located in either the high geographic area or the low geographic area.

Temporally varying background monitored concentrations were developed for NO_2 and SO_2 following the methodology presented in USEPA's August 2016 *SO_2 NAAQS Designations Modeling Technical Assistance Document*, and USEPA's March 1, 2011 memorandum, *Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-hour NO2 Ambient Air Quality Standard*. The first highest hour-of-day and month value was used.

Due to the limited number of monitoring locations, the high background concentration for both SO_2 and NO_2 is derived from the 2013-2015 WDNR Southeast Region monitor in the City of Milwaukee. There is one large facility located 3.5 kilometers south-southwest of the monitor, so hourly meteorological data was used to remove the influence of that facility from the monitor data distribution. Prior to summarization, monitored concentrations were removed from any hour where the average wind direction was within +/- 15 degrees of the radial connecting the monitor location and the facility. After accounting for missing data and hours where wind was blowing from the exclusion sector, approximately 86% of the 2013-2015 NO_2 data were used to create the background and 88% of the 2013-2015 SO_2 data remained to create the background.

Low background concentration for SO_2 is derived from the 2013-2015 Horicon monitor in Dodge County. There are no major emission sources near the Horicon site, and the site uses high sensitivity equipment to detect low SO_2 concentrations. The average and maximum low values are less than the average and maximum high values for all years. Low background concentration for NO_2 is derived by combining hourly data from the three nearest rural monitor locations, the seasonal monitor in Manitowoc County, WI, a year-round monitor in Van Buren County, IA, and a year-round monitor Missaukee County, MI. To produce an unbiased estimate of low background, prior to summarization, the highest value from any location was selected for each hour. Comparing the Van Buren County data to Manitowoc, the average difference in NO_2 concentration was 0.9 $\mu g/m^3$ and the average difference between Missaukee and Manitowoc was 1.2 $\mu g/m^3$.