Background Concentration Data

Technical Support Document

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IOWA DEPARTMENT OF NATURAL RESOURCES

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Summary

Background concentrations in ambient air represent the contributions from natural sources, non-industrial human activities, and distant industrial facilities. The background concentrations are added to dispersion modeling results for comparison to the National Ambient Air Quality Standards (NAAQS). This technical support document (TSD) contains information supporting new default background concentrations, the use of alternative backgrounds, and new background ozone data to be used in a Tier 3 NO_2 analysis. The background concentrations data should be used in conjunction with the 2015-2019 meteorological data.

Default Background Concentrations

The Iowa Department of Natural Resources (DNR) provides default background concentrations that can be used in dispersion modeling analyses without the need for additional justification. Table 1 summarizes the default background concentrations, which have been re-calculated using 2017-2019 ambient air monitoring data. Where possible, the default background concentrations are based on the upper limit of the 95% confidence interval of the design concentrations at all non-source-oriented monitors across the state. Calculating the default concentrations in this way ensures that they will be conservatively representative of the entire state.

Table 1. Default Background Concentrations

Pollutant	Averaging Period	Concentration ($\mu g/m^3$)
PM_{10}	24-Hour	54
$PM_{2.5}$	24-Hour	20
	Annual	8.0
NO_2	1-Hour	Urban: 68* / Rural: 19*
	Annual	Urban: 12* / Rural: 4*
SO_2	1-Hour	5*
	3-Hour	5*
CO	1-Hour	5,200
	8-hour	2,300
Pb	3-Month Rolling Average	0

*The value shown here is the design value for a specific monitoring location. The upper limit of the 95% confidence interval could not be calculated because data was only available for one monitoring site.

Several monitors have been removed from service since the last time the default background concentrations were calculated. The number of areas where one or more PM_{10} monitors exist has decreased from 11 to 5. For CO, the number of areas has decreased from three to two. For NO_2, the number of urban areas has decreased from two to one. A smaller sample size of monitors can have an adverse impact on the stability of the calculated default background over time. As a result, the PM_{10} and CO default background concentrations have increased. In addition, when data for only a single monitoring site is available, it is not possible to calculate a confidence interval, so the design value for that site must be used. This is the case for SO_2 and for both the urban and rural NO_2 background concentrations.

The urban/rural delineation of NO_2 concentrations was originally evaluated in support of the default background concentrations released in 2015. That analysis indicated that Polk, Pottawattamie, and Scott Counties should be considered urban, and the remainder of the state should be considered rural, for the purposes of NO_2 background concentrations. There are no additional readily available data that would imply that the urban/rural delineation determined in that analysis should change significantly. The DNR is not proposing any revisions to the urban/rural delineation, and the original analysis is provided in Appendix A for reference. The content of the analysis has been updated for formatting and to include figures referenced from the old Background Concentration TSD. The data, analysis, and conclusions remain unchanged.

Default 24-hour and annual SO_2 background concentrations are not summarized above because the NAAQS for those averaging periods have been revoked in all areas in Iowa. However, there are some areas in the state where analyses of these standards may still be necessary. Specifically, in areas where a State Implementation Plan (SIP) is still in effect for those standards. The appropriate 24-hour and annual background concentrations to use in those cases are 3 and 1 $\mu g/m^3$ respectively.

Proposing Alternative Background Concentrations

The default background concentrations provided in Table 1 can be used for any location in the state of Iowa. However, they are conservative by design, allowing applicants to use them without additional justification. In some cases, an applicant may wish to propose a background concentration from site specific monitoring data that is more representative of their location.

The use of any alternative background concentration will require approval by the DNR. There are no specific criteria required for approval, and the information needed to adequately justify an alternate background will vary from case to case. The justification should be a well-reasoned weight-of-evidence approach that supports the chosen background concentration(s). The following are examples of the types of information that could be used to support an alternative background concentration:

- Monitor location
- Source of the data
- Proximity of chosen monitor to other sources of the applicable pollutant(s)
- Proximity of the facility in question to other sources of the applicable pollutant(s) (excluding any sources being explicitly modeled)
- Quantity of emissions of the applicable pollutant(s) in the vicinity of the chosen monitor
- Quantity of emissions of the applicable pollutant(s) in the vicinity of the facility in question (excluding any sources being explicitly modeled)
- Land use & topography
- Prevailing wind direction & local meteorology

There is no required screening distance when evaluating information from sources “in the vicinity.” However, distances ranging from a 10 km radius to county-wide are generally appropriate. The “significant concentration gradient” that EPA refers to in Appendix W would also be an appropriate method of determining a screening distance. In the event that specific guidance related to “significant concentration gradients” becomes available it should be used for this purpose. The following sources may be helpful in developing justification for an alternative background:

- Construction Permit Search
- Operating Permits
- Ambient Air Monitoring Data

Design values at specific monitors for PM_{10}, $PM_{2.5}$, and CO are provided below in tabular form accompanied by figures of the state that depict the monitor locations and design values for the period of 2017-2019. SO_2 data has not been included because the entire state is represented using the isolated monitor at Lake Sugema. Similarly, NO_2 data has not been provided because there is only a single monitor for urban areas (located in Des Moines) and a single monitor for rural areas (located at Lake Sugema).

These data may be helpful when proposing alternative background concentrations. However, when more recent data become available, they should be used. The most recent data are available on the DNR’s ambient monitoring website.

Particulate Matter (10 microns or less)

Table 2. PM_{10} Monitor Design Values (2017-2019)

City/Site	24-hour (µg/m^3)
Cedar Rapids	50
Council Buffs	54
Davenport	37
Des Moines	43
Lake Sugema	40

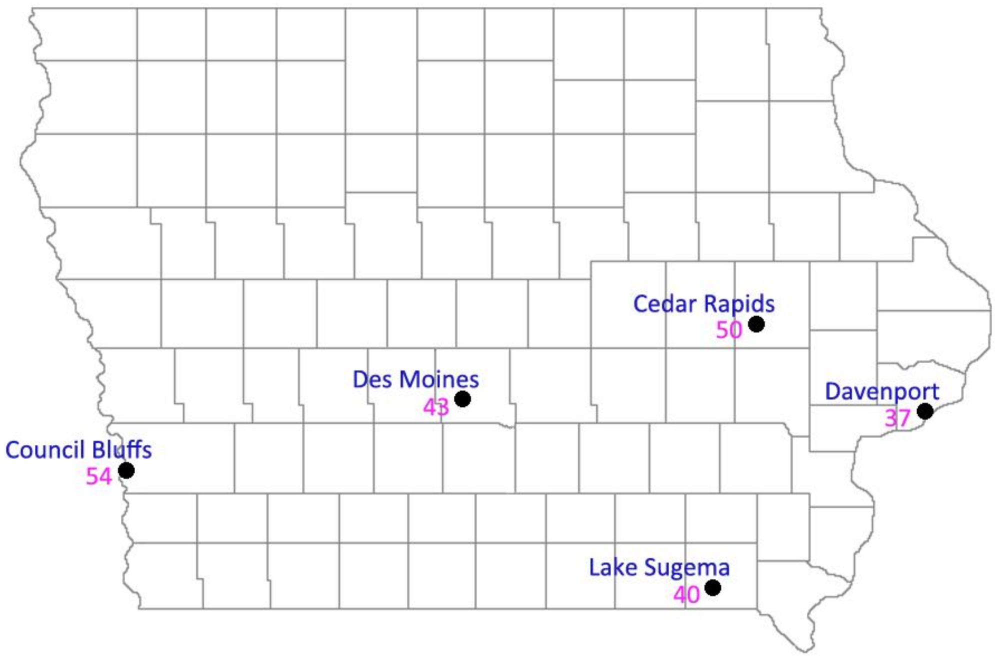


Figure 1. PM_{10} 24-hour Design Values (2017-2019)

Particulate Matter (2.5 microns or less)

Table 3. $PM_{2.5}$ Monitor Design Values (2017-2019)

City/State	24-hour ($\mu g/m^3$)	Annual ($\mu g/m^3$)
Cedar Rapids	20	8.0
Clinton	20	7.9
Council Bluffs	20	8.1
Davenport	21*	8.2*
Des Moines	18*	7.3*
Emmetsburg	18	6.7
Iowa City	19	7.6
Keokuk	18	8.4
Lake Sugema	16	7.0
Muscatine	18	7.6
Sioux City	20	7.8
Viking Lake State Park	16	6.6
Waterloo	20	7.8
*Average of design concentrations from multiple monitors at this location.		

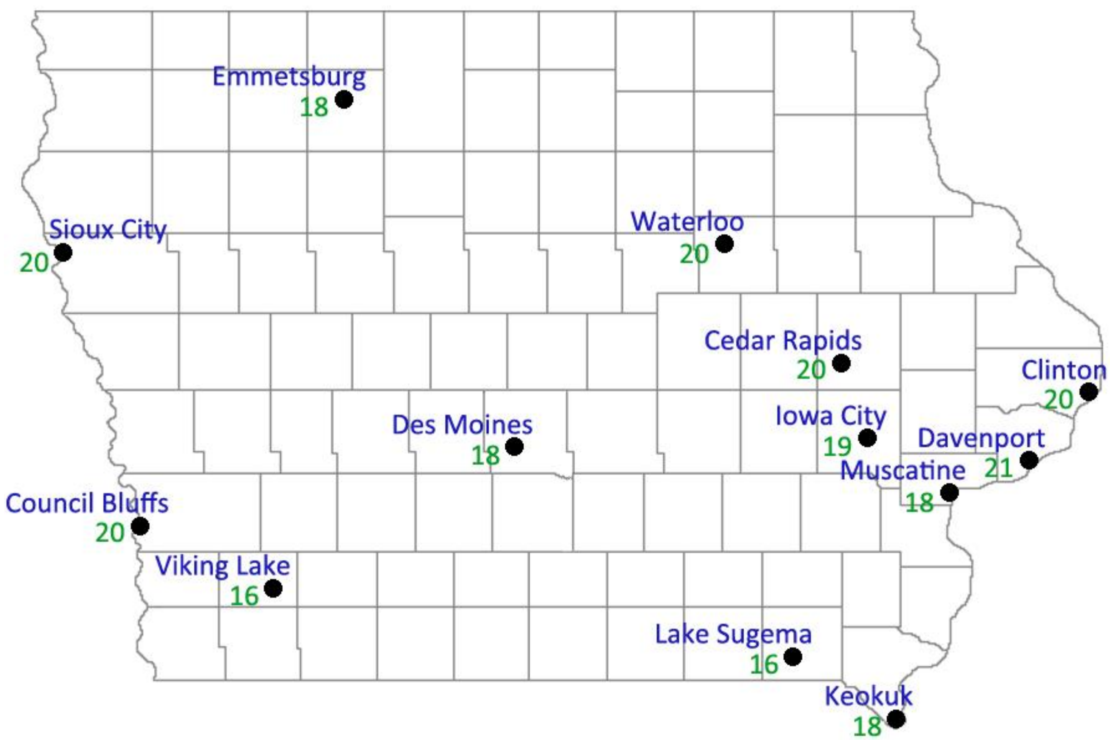


Figure 2. $PM_{2.5}$ 24-hour Design Values (2017-2019)

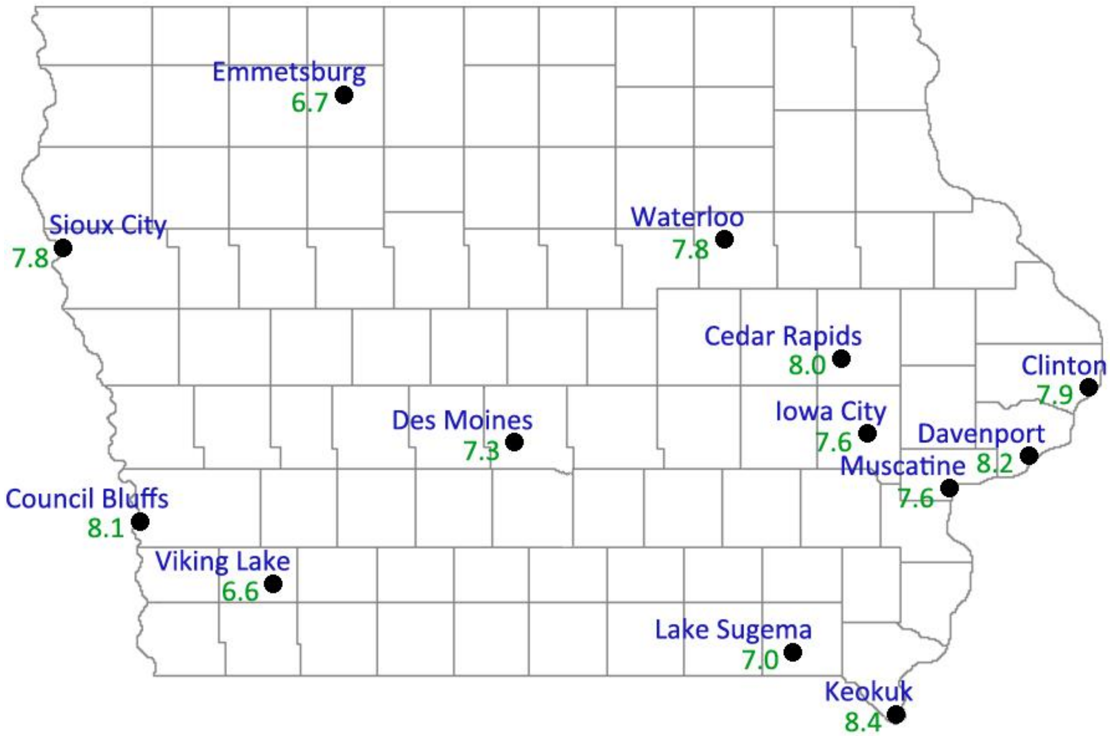


Figure 3. $PM_{2.5}$ Annual Design Values (2017-2019)

Seasonal background concentrations were also calculated for the 24-hour averaging period at each site. The approach in Section IV.3 and Appendix E of EPA's [Guidance for $PM_{2.5}$ Permit Modeling] (May 20, 2014) was used to determine the seasonal concentrations for each site. The seasonal values for sites with multiple monitors (Davenport and Des Moines) were averaged to arrive at a single value. Table 4 summarizes the seasonal concentrations for all 13 sites.

Table 4. Seasonal $PM_{2.5}$ 24-hr Site-Specific Background Concentrations (2017-2019)

Site	Concentration (µg/m^3)			
	Winter	**Spring**	**Summer**	**Autumn**
Cedar Rapids	20	19	19	18
Clinton	20	17	16	19
Council Bluffs	19	17	18	14
Davenport	21	17	18	19
Des Moines	18	15	16	15
Emmetsburg	15	18	13	15
Iowa City	19	18	17	17
Keokuk	17	17	16	17
Lake Sugema	16	13	14	15
Muscatine	18	17	15	14
Sioux City	19	17	18	12
Viking Lake State Park	16	12	15	12
Waterloo	20	17	17	16

The use of these seasonal background concentrations should be acceptable in most cases. However, per section 3.3.8.2 of the User's Guide for the AMS/EPA Regulatory Model – AERMOD (dated August 2019), background concentrations that are input into the model may be underestimated in short-term averaging periods if calm winds are present during the period being evaluated. This will be evaluated on a case-by-case basis, and if it is found that the background contribution is under-estimated the analysis may need to be reevaluated.

Carbon Monoxide

Table 5. CO Monitor Design Values (2017-2019)

City/State	1-hour (µg/m^3)	8-hour (µg/m^3)
Davenport	1166	727
Des Moines	1754	944

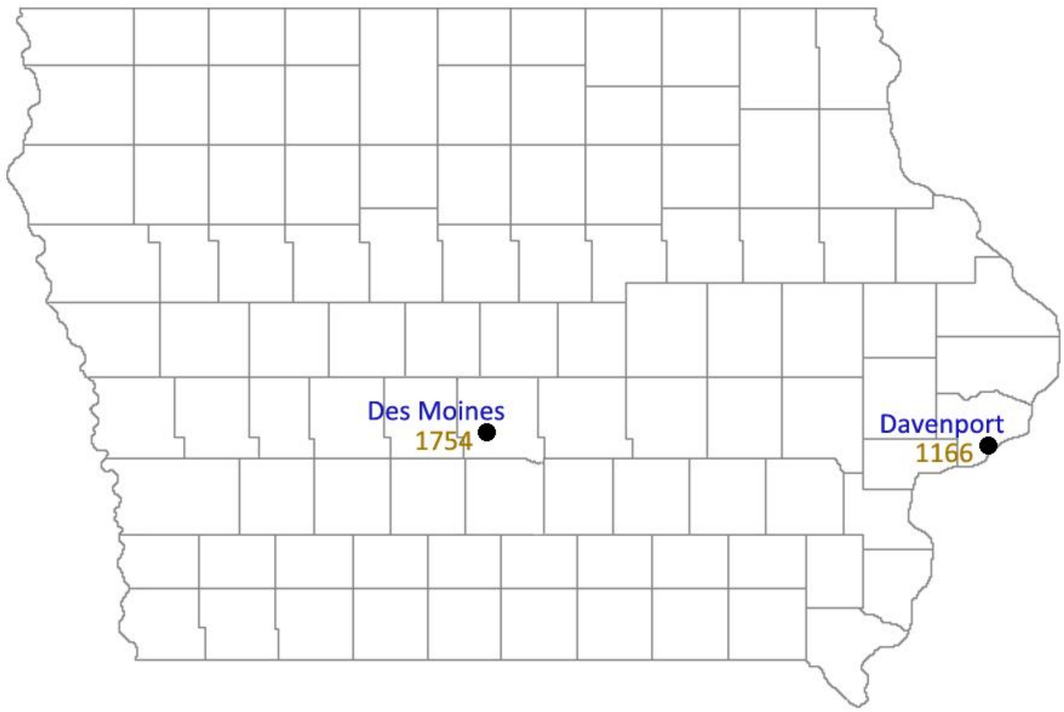


Figure 4. CO 1-hour Design Values (2017-2019)

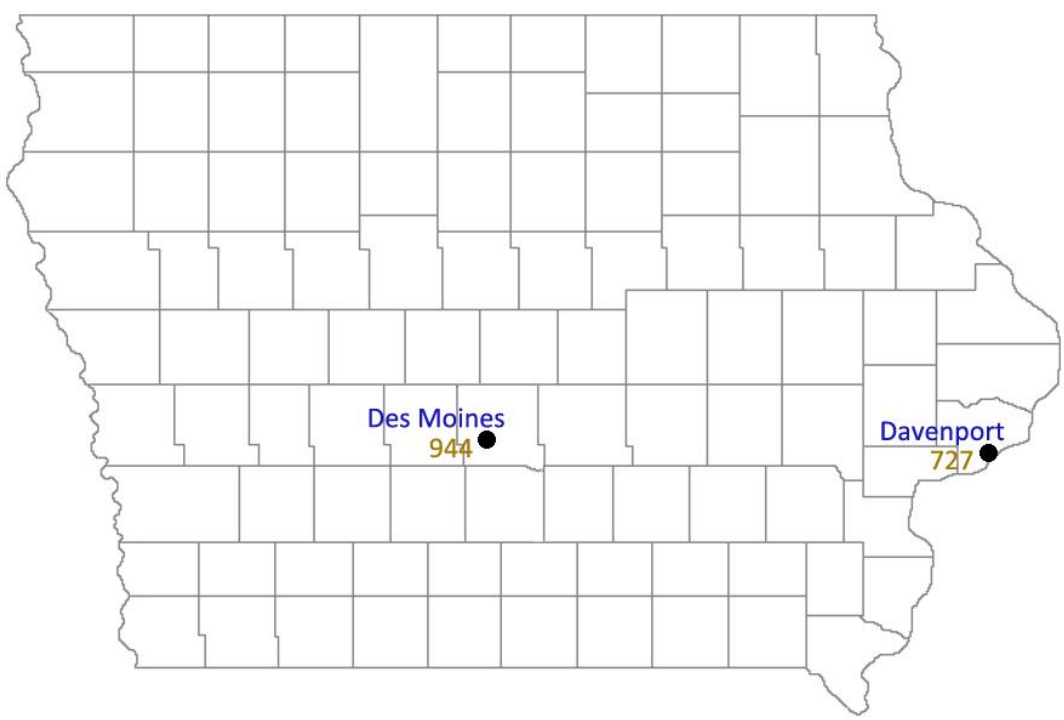


Figure 5. CO 8-hour Design Values (2017-2019)

Appendix A - Establishing NO_2 Urban & Rural Delineation using CAMx

Purpose

Modeled NO_2 concentrations produced by the Comprehensive Air Quality Model with Extensions (CAMx) model were used to identify an appropriate geographical delineation between urban and rural background concentrations. The modeled NO_2 concentrations were produced from an annual simulation covering the year 2011.

Model Inputs

CAMx is an Eulerian photochemical dispersion model that allows for integrated "one-atmosphere" assessments of gaseous and particulate air pollution over many scales ranging from sub-urban to continental. The CAMx modeling domain covered the entire continental U.S., but emphasis was placed on grid cells over Iowa. The resolution of the domain was 12 km, which is much finer than the ambient air observation network. The annual simulation used model-ready emissions data from EPA's 2011 modeling platform. Meteorological inputs were incorporated from an annual 2011 simulation evaluated by the DNR and conducted by the EPA using the Weather Research and Forecasting (WRF) meteorological model.

Methodology

The urban and rural areas were delineated using predicted NO_2 concentration gradients from CAMx. There are two monitors located in urban areas: Des Moines and Davenport (see Figure A-1 and Figure A-2). Both monitors are located within the urban area but far enough away from major industry to provide an accurate representation of an urban background concentration. There is one monitor location in a rural area: Lake Sugema (see Figure A-1 and Figure A-2). This monitor is an accurate representation of a rural background concentration.

Figure A-1. NO_2 1-Hour Design Values

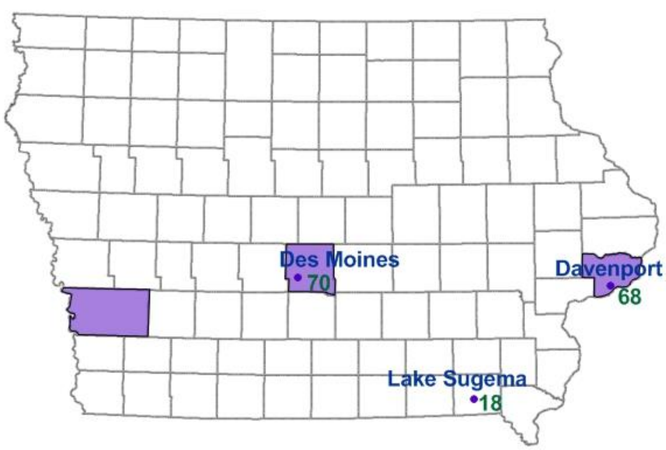
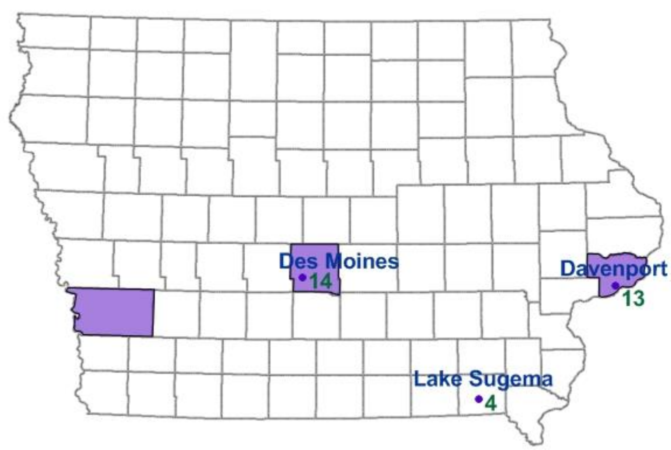


Figure A-2. NO_2 Annual Design Values



The concentrations generated from CAMx data were processed at each grid cell to produce the total NO_2 concentrations for the 1-hour NO_2 standard. The data represented the predicted 98^{th} percentile daily maximum 1-hour concentrations from CAMx. The 1-hour concentrations were chosen instead of the annual concentrations because the purpose of this analysis was to define the gradients between urban and rural areas of the state. The short-term concentrations provide a more appropriate metric for depicting the localized influences. Figure A-3 shows the final analyzed NO_2 concentration field.

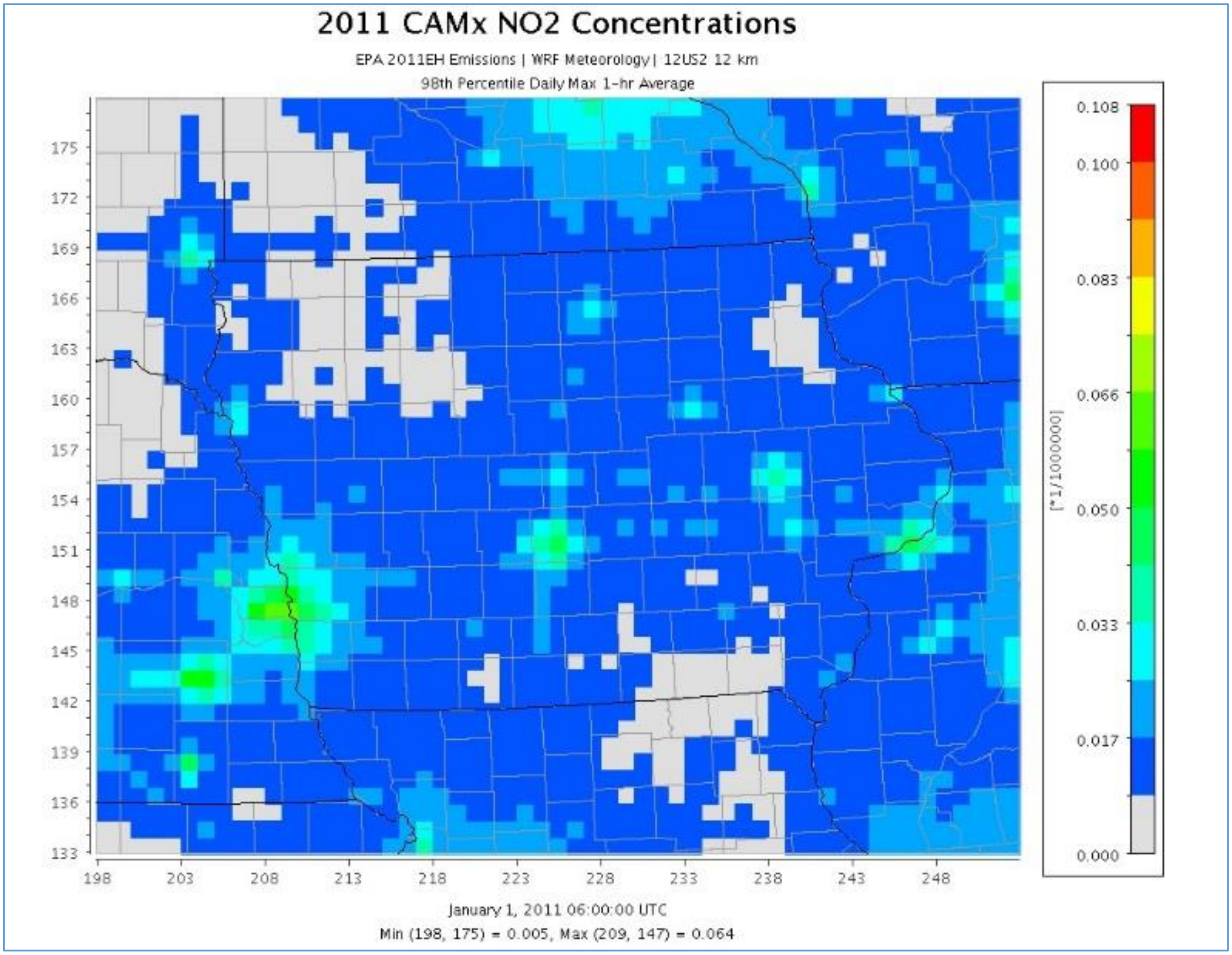


Figure A-3. Modeled NO_2 1-hour Concentrations (in parts per million) over Iowa

The predicted model concentrations at both the urban and rural sites were determined using the Golden Software Surfer graphing program (version 12.8). Table A-1 compares the modeled NO_2 concentrations to the monitored NO_2 concentrations.

Table A-1. Comparison of Modeled vs. Monitored Design Values

Location	Monitor Design Value (µg/m^3)	Model Design Value (µg/m^3)
Davenport (urban)	68	73
Des Moines (urban)	70	81
Lake Sugema (Rural)	18	13

The upper confidence limit (95%) of the two urban model design values (73 & 81 µg/m^3) was calculated at 126 µg/m^3. This upper confidence limit was used to represent the urban NO_2 concentration level. The modeled design value at Lake Sugema (13 µg/m^3) was used to represent the rural NO_2 concentration level. The average of these urban and rural concentrations (70 µg/m^3) was used to divide the state into urban and rural regions by plotting lines across the state connecting all areas with a concentration equal to the average of 70 µg/m^3. The resulting urban/rural delineation is depicted in Figure A-4 by a dark black line.

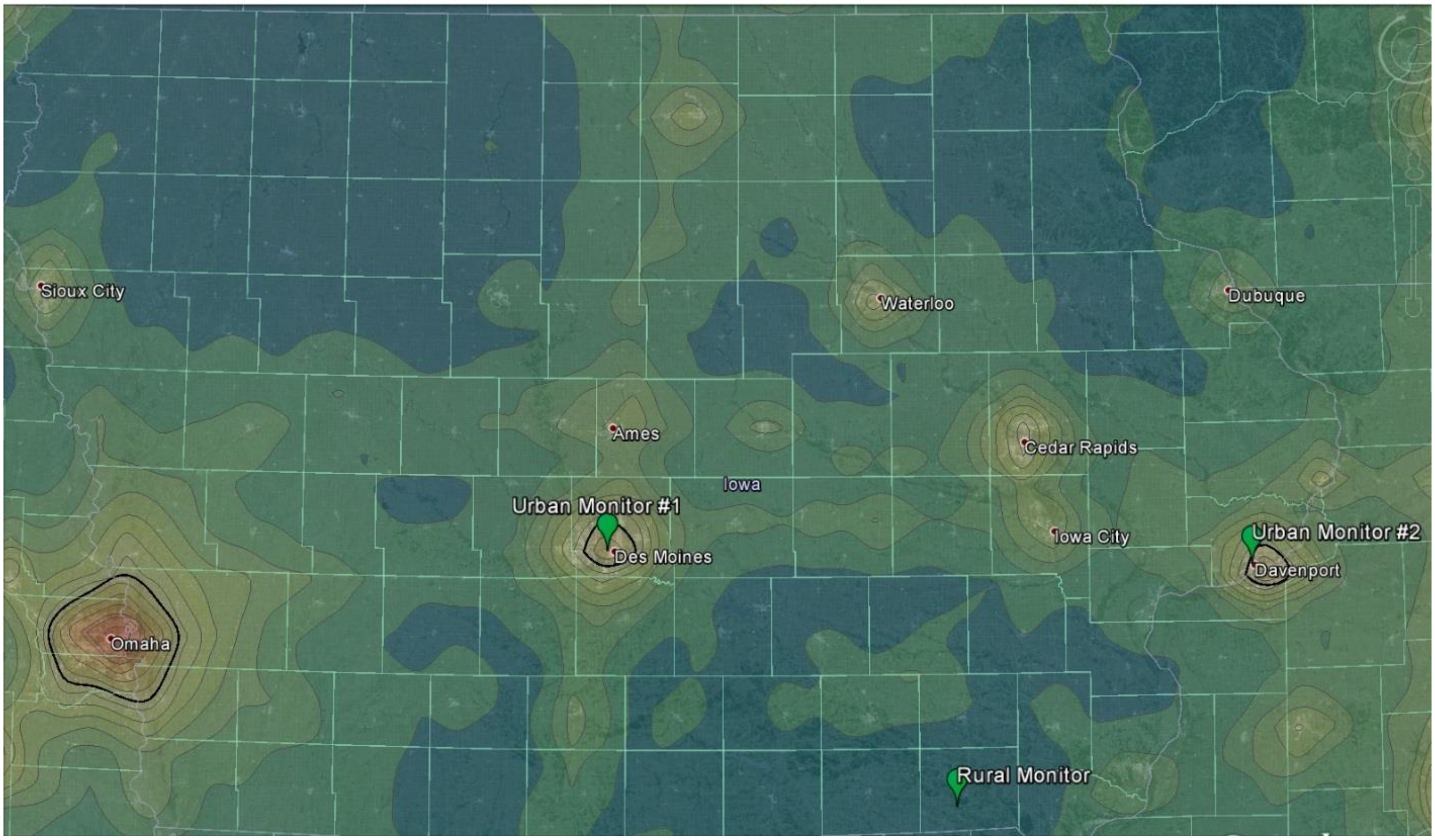


Figure A-4. Urban/Rural Delineation (black line = 70 µg/m³)

Default NO_2 Background Concentrations by County

In order to simplify the implementation of the default background concentrations it was decided to limit the extent of the areas represented by the urban background to the county in which the urban influence originates. The default urban background counties are:

- Polk
- Pottawattamie
- Scott

For all three locations the urban influence does not extend over the entire county in which it originated. In cases where a project occurs in a default urban background county, the Department will consider a rural background if the location can be shown to be outside the urban influence area in the data. A Google Earth KML file is provided on the website so that applicants can zoom in to a specific area to make this determination. All other counties are considered rural even if the black line partially crosses into the county.

Appendix B - Statewide Default Ozone Background Data

In 2013, an ozone data sensitivity analysis was conducted by the DNR which concluded that the spatial variation of ozone concentrations observed across Iowa did not significantly affect the NO_2 concentrations predicted by AERMOD. This conclusion supported making a statewide ozone background file.

The ozone data is intended for use in the 1-hour NO_2 modeling analyses when the tier 3 Ozone Limiting Method (OLM) or Plume Volume Molar Ratio Method (PVMRM) is utilized in AERMOD. OLM and PVMRM are screening methods used to estimate the conversion of NO to NO_2.

The DNR has generated a background ozone concentration file for use anywhere in the state for the time period coinciding with the 2015-2019 meteorological dataset. Please note that the data are in ppb.

The file provided above is an average of the ozone monitor data collected from 17 sites across the state. Note that two of these locations have two ozone monitors within the same area. Both monitors within the same area were averaged first, before averaging across all sites. This was done to avoid a bias towards a site with more than one monitor. Over the five years of data (2015-2019) there were 153 hours where data was missing at every site, with the largest gap being 10 hours. Linear interpolation was used to fill gaps up to two hours long. For longer gaps a conservative estimate was used by sorting the entire data set by month-of-year and hour-of-day, and then filling each hour with the maximum value for that particular hour/month combination.

Figure B-1 depicts the distribution of ozone concentrations in the 2010-2014 and the 2015-2019 data sets. They have very similar distributions, and the average concentrations and maximum concentrations are the same (28 ppb and 72 ppb respectively). This supports the continued use of a statewide ozone data set.

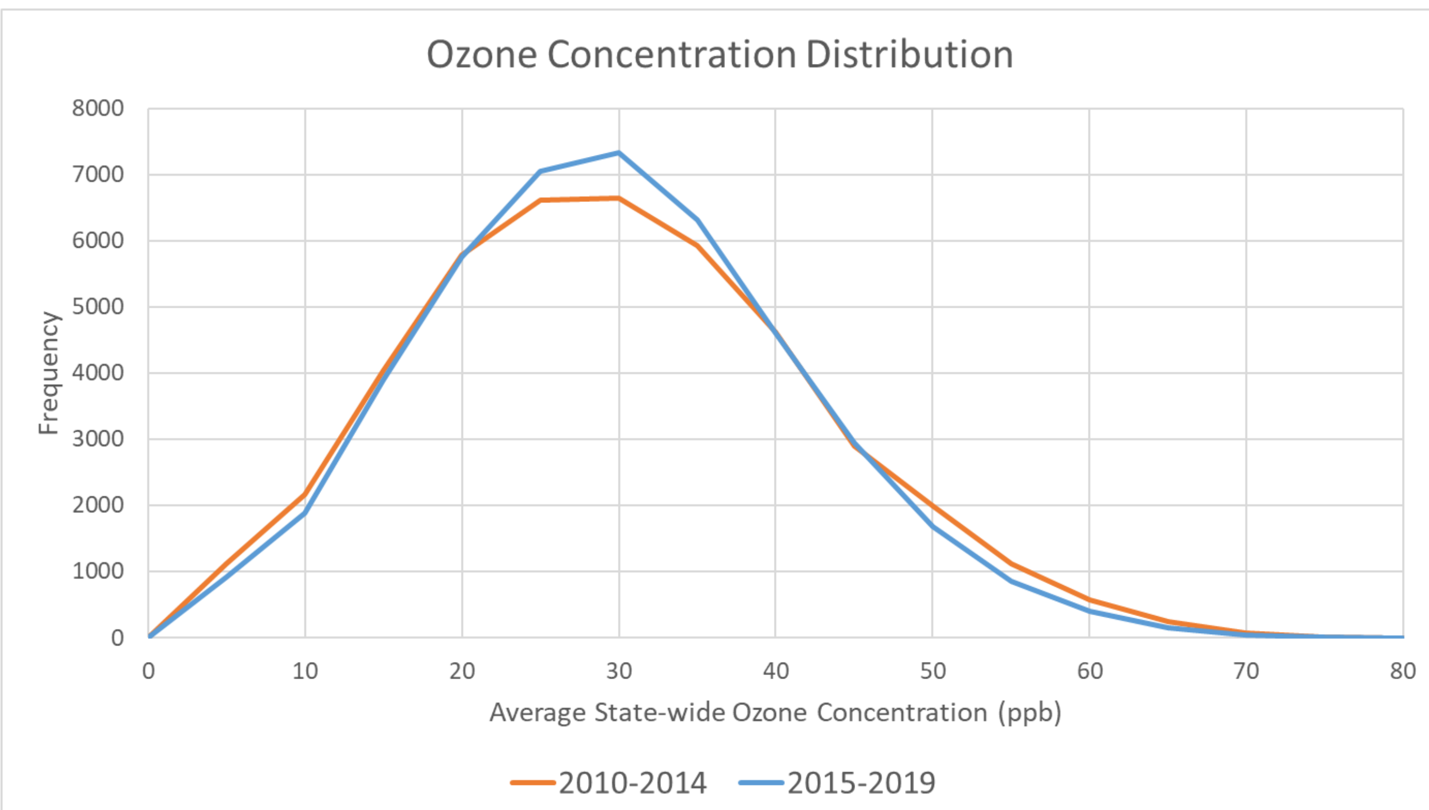


Figure B-1. Histograms of Old and New Ozone Data