Appendix Y
Dispersion Modeling Analysis for Dayton Power & Light Stuart and Killen Stations 2010 SO_2 NAAQS Recommended Designation

Introduction

The United States Environmental Protection Agency (U.S. EPA) established a new National Ambient Air Quality Standard (NAAQS) for SO_2 on June 22, 2010, of 75 ppb, as the 99th percentile of maximum daily values, averaged over three years. In addition, U.S. EPA revoked the primary annual and 24-hour standards.

Pursuant to the third round of designations and in accordance with the August 21, *2015 Data Requirements Rule for the 2010 1-Hour Sulfur Dioxide (SO2) Primary National Ambient Air Quality Standard (NAAQS); Final Rule*, Ohio EPA is submitting a designation recommendation for the DP&L Stuart and DP&L Killen Stations source area. This document supports Ohio's recommended designation of the DP&L Stuart and DP&L Killen Stations source area based on refined dispersion modeling.

Per U.S. EPA's guidance (December 2013 *Draft SO_2 NAAQS Designations Modeling Technical Assistance Document* (herein referred to as "Modeling TAD")), "The primary objective of the modeling would be to determine whether an area currently meets the SO_2 NAAQS, and thereby indicate the designation process for the area". Ohio EPA is including this refined dispersion modeling analysis as a portion of the five-factor approach recommended by U.S. EPA in defining designation areas.

The dispersion modeling analysis was conducted for the 2012-2014 period, using actual hourly variable emissions from the DP&L Stuart Generating and DP&L Killen Generating Stations. DP&L Killen is located approximately 18 kilometers to the northeast of DP&L Stuart. This was done per the Modeling TAD, in which U.S. EPA recommends modeling the most recent 3 years of actual emissions. Spurlock Station is located to the northwest of the DP&L Stuart and DP&L Killen facilities, predominantly upwind, and although it is 29 kilometers away, emitted less than a quarter of the emissions analyzed for the area, and is not suspected to impact the analysis area, Ohio EPA elected to explicitly include the source in the modeling domain to maintain conservatism, using hourly-variable emissions from 2012-2014.

Temporally varying emissions were modeled to determine the contribution of emissions from these three sources in the modeling domain. Ohio EPA attempted to use variable emissions at the finest temporal scale available for each unit. Hourly variable emissions data for the 2012-2014 period were submitted to Ohio EPA by Dayton Power and Light, now part of AES Corporation (AES) in association with their air quality contractor, Trinity Consultants (Trinity) for all SO_2 sources at both the Stuart and Killen Generating Stations. Hourly emissions from Spurlock Station were taken from the U.S. EPA's Clean Air Markets Database. As described in Ohio's designation modeling protocol (Appendix B of the State of Ohio 2010 Revised Sulfur Dioxide National Ambient Air

Quality Standard, Recommended Area Designations, Round 3 submittal), Part 75 emissions reporting data was used for the majority of hourly emissions for DP&L Stuart and DP&L Killen Stations, with data substitutions for some hours, as described in the modeling protocol. Given the distance and predominant meteorology of the region, Ohio EPA elected not to obtain revised hourly emissions for Spurlock Station excluding Part 75 data substitutions, but used the data "as is".

Modeling Approach

Per U.S. EPA's Modeling TAD,

> "Since the purpose here pertains to designations, this guidance supports analyses of existing air quality rather than analyses of emissions limits necessary to provide for attainment. Consequently, the guidance in this TAD differs in selected respects from the guidance published in Appendix W. These differences include:
>
> - Placement of receptors only in areas where it is feasible to place a monitor vs. all ambient air locations (NSR, PSD, and SIP)
> - Use of the most recent 3 years of actual emissions (designations) vs. maximum allowable emissions (NSR, PSD, and SIP)
> - Use of 3 years of meteorological data (designations) vs. one to five years (NSR, PSD, and SIP)
> - Use of actual stack height for designations using actual emissions vs. Good Engineering Practice (GEP) stack height for other regulatory applications (NSR, PSD, and SIP)"

Ohio EPA incorporated the differences listed above and followed Appendix W guidance where applicable to modeling for designation purposes. The averaging period for the 2010 SO_2 NAAQS is the 99th percentile of the annual distribution of daily maximum 1-hr average concentration, averaged over three years. Per the Modeling TAD, three years of National Weather Service data is sufficient to allow the modeling to simulate a monitor. Thus, the modeled form of the standard is expressed as the 99th percentile of daily maximum 1-hr average concentrations averaged over three years (herein referred to as "design value") for the purposes of designation.

The recommended dispersion model for modeling for SO_2 designations is the American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD) modeling system. There are two input data processors that are regulatory components of the AERMOD modeling system: AERMET, a meteorological data preprocessor that incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concepts, and AERMAP, a terrain data preprocessor that incorporates complex terrain using United States Geological Survey (USGS) Digital Elevation Data. Additionally, Ohio EPA utilized the AERMINUTE module to incorporate 1-minute ASOS meteorological data into the hourly surface input file. Ohio EPA utilized the most up-to-date versions of AERMOD and the associated preprocessors available at the time of the attainment modeling analyses. These are as follows: AERMOD version 15181,

AERMET version 15181, AERMINUTE version 14337, and AERMAP version 11103. All dispersion modeling for this submittal was conducted following Ohio EPA's designations modeling protocol. AERMOD and all associated preprocessors were run in the default regulatory mode.

Meteorological Data

In order to generate meteorological input data for use with AERMOD, AERMET, along with AERMINUTE and AERSURFACE preprocessing for the modeling domain was conducted to generate the surface (.sfc) and profile (.pfl). Ohio EPA used the AERMINUTE pre-processing module. This module accepts as input 1-minute ASOS meteorological surface observations, calculates an hourly average for each hour in the modeled time period, and substitutes any missing values from the co-located ISHD surface data. Use of AERMINUTE reduces the number of calm hours present in the input files, and these enhanced hourly files are therefore considered more representative of local meteorological conditions.

Meteorological data from 2012-2014 from the Huntington, WV surface station (Station # 3860) located at the Huntington Tri-State Airport and the Wilmington, OH upper air station (Station # 13841) located at the Wilmington Airborne Airpark were used in these analyses. These sites were determined to be representative of Adams County, OH and the surrounding region. AERSURFACE was run using twelve sectors and monthly surface characteristics, centered on the location of the meteorological station. Monthly Bowen ratios were determined by comparing monthly precipitation values against the most recent 30-year precipitation values recorded at the Huntington surface station. A composite wind-rose of annual trends and distribution of wind directions, years 2012-2014 from the surface station are shown in Figure 1, below.

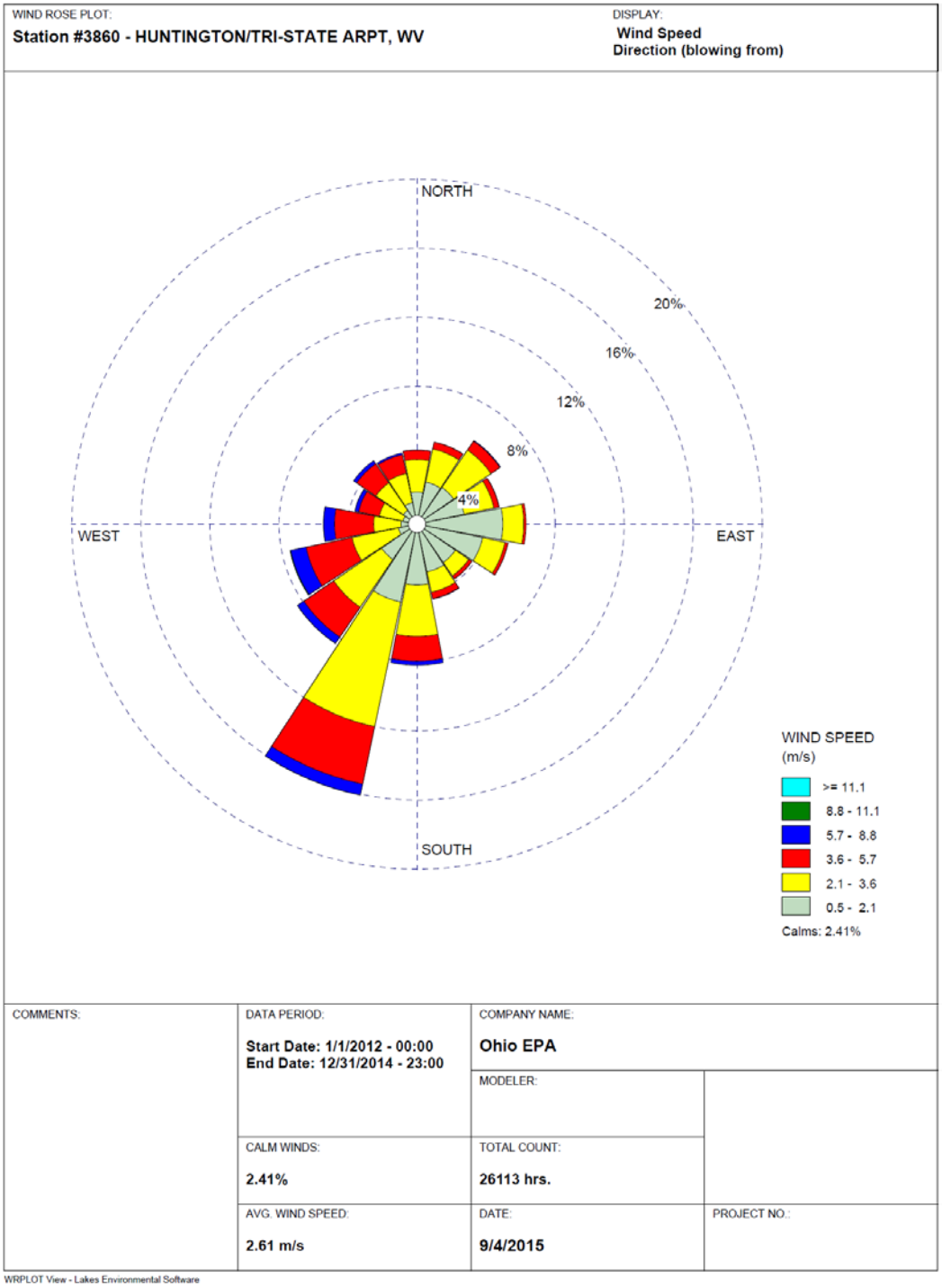

Figure 1: Wind rose, years 2012-2014, Huntington met station.

In this instance, Ohio EPA modeled approximately 99% of the total emissions in a 50 kilometer area. Thus, the impact of meteorology is somewhat diminished for this area. However, the wind direction data does indicate that the strong component of winds originating in the south-west would carry emissions from both the DP&L Stuart and Killen Stations to the location of ambient air quality monitor 39-001-0001. As discussed in Factor 1, the 2013-2015 design value at this monitor is 20 ppb, less than one-third of

the standard. The location of all facilities with emissions 1 TPY or greater within 50 kilometers of the DP&L Killen facility and a composite wind-rose, years 2012-2014, are shown in Figure 2.

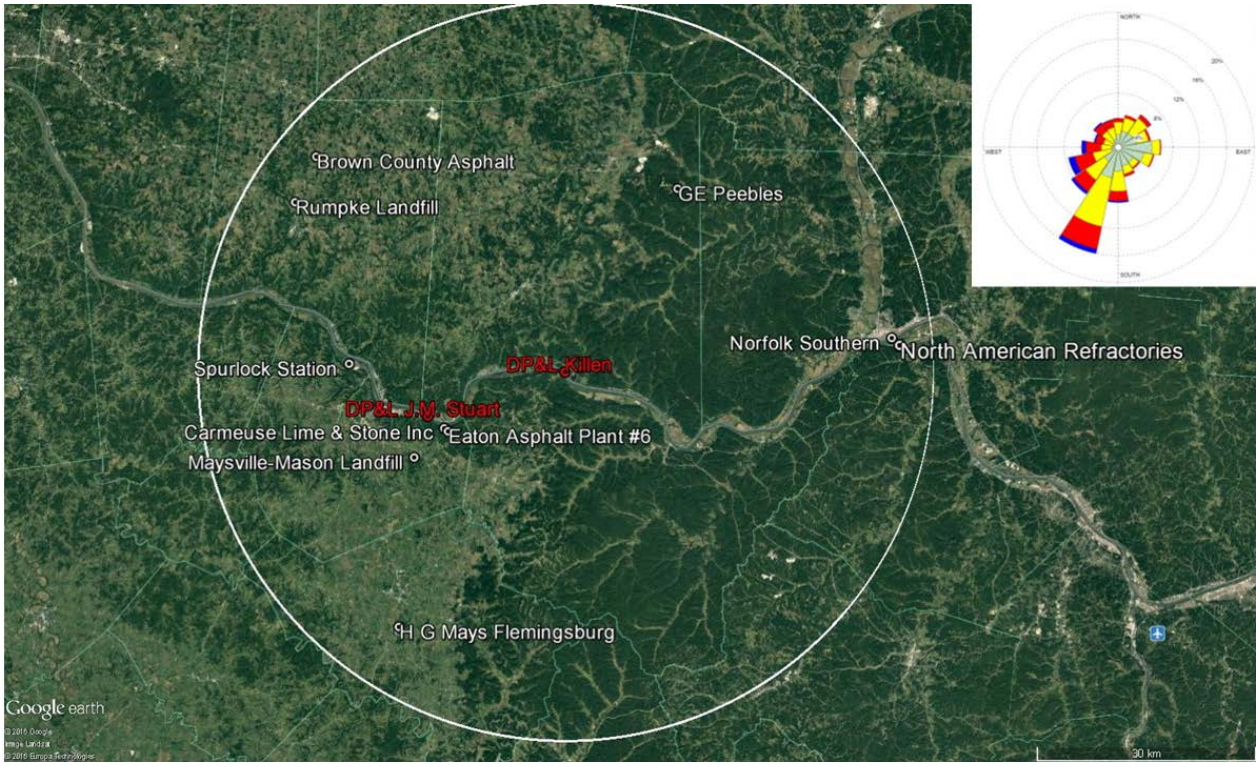

Figure 2: Sources within 50 km of the DP&L Killen facility and Huntington wind rose, 2012-2014.

Ohio concludes that the primary sources of SO_2 in Adams County and the larger region are the DP&L Stuart and Killen facilities. In addition, Ohio EPA included Spurlock Station as an explicitly modeled source. Spurlock Station is located to the northwest of the DP&L Stuart and DP& L Killen facilities. Although it is 29 km away, emitted less than a quarter of the emissions analyzed for the area, and, based on the predominant wind directions of the area, is not suspected to impact the analysis area, Ohio EPA elected to explicitly include the source in the modeling to be conservative. The impact of those facilities in Figure 2 not explicitly modeled or shutdown prior to promulgation of a designation are represented adequately and conservatively by the background concentration included in the Factor 1 modeling analysis.

Background

Ohio EPA applied background concentrations of SO_2 to all modeled results under all scenarios. As described in Appendix O of the State of Ohio 2010 Revised Sulfur Dioxide National Ambient Air Quality Standard, Recommended Area Designations, Round 3 submittal, Ohio EPA utilized a seasonally and hourly variable background for

the source area, derived from data recorded at the Adams County monitor, 39-001-0001. The seasonal and hourly varying emissions are shown in Figure 3.

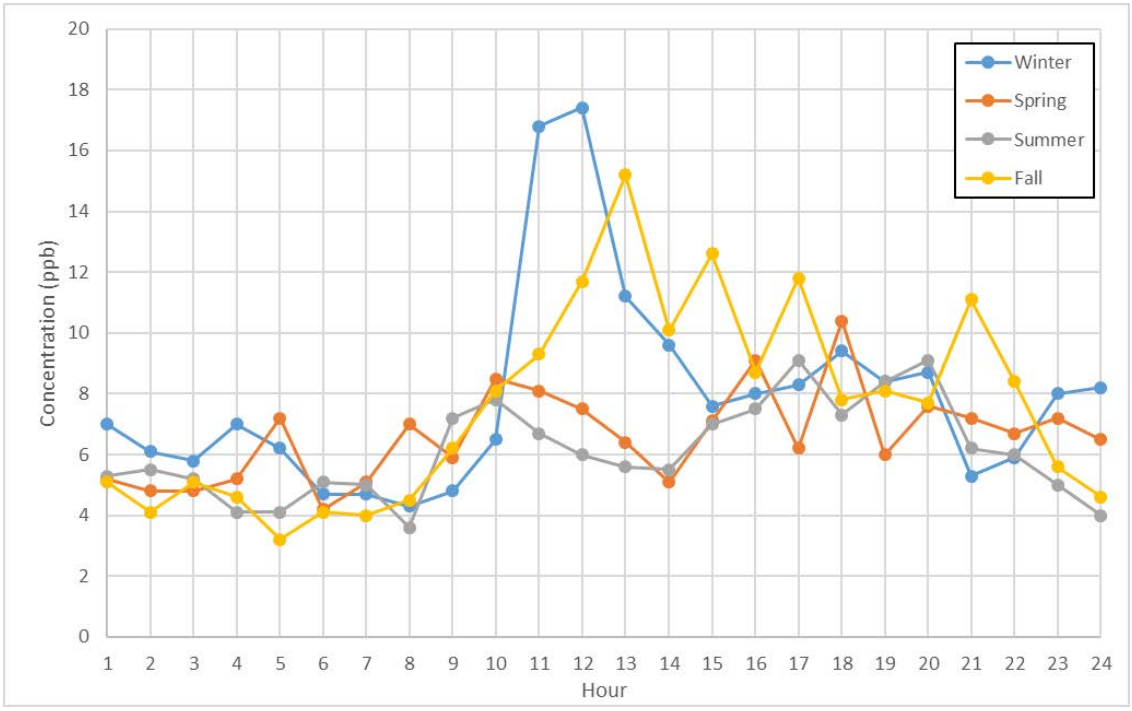

Figure 3: Hourly and seasonally variable SO_2 background, derived from air quality monitor 39-001-0001.

Emission Sources

The DP&L Killen facility has one unit and one stack. The single unit in operation at DP&L Killen (Unit 2) exhausts through the single stack at the facility. DP&L Stuart, on the other hand, has four units each serviced by a flue in the combined main stack and an individual bypass dry stack per unit. Each unit at DP&L Stuart exhausts through a distinct stack during bypass operation. However, during normal operation, each boiler's exhaust is routed to a single stack (the wet stack) with four flues, each boiler having a distinct flue. Due to the proximity of the normal operation flues (wet stack) to each other (less than one flue diameter apart in each case), their associated plumes will likely combine near the stack tip and enhanced buoyancy plumes will form. As such, additional calculations for plume combination are also used to define stack emissions and flows for a series of potential various configurations of "combined stacks" (one flue, two flues, three flues or four flues operating in a given hour). "Combined flues" in this wet stack are identified in the model and represent either two units in operation, three units in operation, or four units in operation with their equivalent diameters, flows, and emissions calculated with respect to the number in operation. These combined stacks are all located in the same location; the center point of the four flues. A full description of the derivation of stack and emission parameters is provided in Appendix Z of the State of Ohio 2010 Revised Sulfur Dioxide National Ambient Air Quality Standard, Recommended Area Designations, Round 3 submittal.

Variable emissions for all sources were included in the model via the HOUREMIS input pathway, years 2012-2014. Ohio EPA utilized the 1-hour SO_2 design value output option internal to the AERMOD code to simplify post processing and eliminate the need to generate large hourly output files. The relevant release point parameters for the emission units included in the analysis are presented in Table 1, below. All emissions sources included in the modeling were treated as point sources. With the inclusion of Spurlock Station in this modeling analysis, 99% of emissions within 50 kilometers of the DP&L Killen facility were explicitly modeled.

	Source ID	Easting (X)	Northing (Y)	Base Elevation	Stack Height	Temperature	Exit Velocity	Stack Diameter	SO2
		(m)	(m)	(m)	(m)	(K)	(m/s)	(m)	(lb/hr)
Stuart Station	UNIT1_W	265541.2	4279843.6	161.74	243.84	Variable	Variable	7.9248	Variable
	UNIT2_W	265537.4	4279835.3	161.8	243.84	Variable	Variable	7.9248	Variable
	UNIT3_W	265529.2	4279839.4	161.8	243.84	Variable	Variable	7.9248	Variable
	UNIT4_W	265533.4	4279847.8	161.82	243.84	Variable	Variable	7.9248	Variable
	UNIT1_B	265661.7	4279842.1	161.54	243.84	Variable	Variable	5.7912	Variable
	UNIT2_B	265594.1	4279875	161.68	243.84	Variable	Variable	5.7912	Variable
	UNIT3_B	265528.6	4279913.4	161.58	243.84	Variable	Variable	5.7912	Variable
	UNIT4_B	265455	4279952.3	161.63	243.84	Variable	Variable	5.7912	Variable
	COMB2	265535.3	4279841.7	161.78	243.84	Variable	Variable	11.23	Variable
	COMB3	265535.3	4279841.7	161.78	243.84	Variable	Variable	13.76	Variable
	COMB4	265535.3	4279841.7	161.78	243.84	Variable	Variable	15.89	Variable
Killen Station	UNIT2_K	284256.2	4285315.8	162.23	274.32	Variable	Variable	8.8392	Variable
Spurlock Station	SPUR1	255089.9	4287386	162.35	245.36	424.26	32.64	4.572	Variable
	SPUR2	255033.5	4287331	163.08	245.36	424.26	32.64	4.572	Variable
	SPUR3	255088.1	4287294	162.72	198.12	333.15	16.00	4.572	Variable
	SPUR4	254989.1	4287268.6	163.63	219.46	333.15	16.00	4.877	Variable

Table 1: Modeled source parameters, Stuart, Killen, and Spurlock Stations, 2012-2014

Examination of a composite wind rose (Figure 1), years 2012-2014, from the Huntington meteorological station would indicate that the predominant wind directions are unlikely to carry emissions from sources other than the DP&L Stuart and DP&L Killen facilities, and Spurlock Station into the source area beyond what is accounted for in a conservative background. Ohio EPA inventoried all SO_2 sources with 2014 emissions greater than or equal to 1 TPY in the following Ohio Counties: Brown, Adams, and Scioto. This area of Ohio borders Kentucky and, based on a 50-kilometer buffer around both the Stuart and Killen Stations, Ohio EPA considered sources located in Robertson, Fleming, Carter, Greenup, Rowan, Mason, and Lewis Counties in Kentucky. Emissions data indicated that there were no significant sources of SO_2 in Pike County in Ohio, nor were there significant sources located in Robertson, Lewis, Rowan, and Carter Counties in Kentucky. This analysis of a 50-kilometer buffer also indicated that the only additional significant source was Spurlock Station, which was explicitly modeled although due to emissions levels and distance it was presumed unlikely to impact the area. This inventory, inclusive of 2014 SO_2 emissions and distance from Killen Station are summarized in Table 2.

State	County	Facility ID	Facility Name	2014 SO2 Emissions (TPY)	Distance from DP&L Killen (km)
OH	Adams	0701000060	DP&L, Killen Generating Station	13,095.30	--
OH	Adams	0701000007	DP&L, J.M. Stuart Generating Station	10,768.40	19.5
OH	Adams	0701000001	G. E. Aircraft Engines: Peebles Facility	2.90	29
			Adams Total	***23,866.60***	
OH	Scioto	0773000040	Norfolk Southern Railway	1.56	44
			Scioto Total	***1.56***	
OH	Brown	0708000069	Brown County Asphalt	2.97	43
OH	Brown	0708000033	Rumpke Landfill - Brown County	2.35	41
			Brown Total	***5.32***	
KY	Greenup	2108900008	North American Refractories	3.92	45
			Greenup Total	***3.92***	
KY	Fleming	2106900013	H G Mays – Flemingsburg	11.67	41

State	County	Facility ID	Facility Name	2014 SO2 Emissions (TPY)	Distance from DP&L Killen (km)
			Fleming Total	***11.67***	
KY	Mason	2116100009	H L Spurlock Power Station	4,689.30	29
KY	Mason	2116100010	Carmeuse Lime & Stone Inc	253.89	18
KY	Mason	2116100039	Maysville-Mason Co Landfill	2.09	24
KY	Mason	2116100041	Eaton Asphalt Paving Co - Plant #6	2.78	18
			Mason Total	***4,948.06***	
			Grand Total within 50 km of DP&L Killen	***28,837.13***	

Table 2: SO2 sources and 2014 emissions, DP&L Stuart and Killen Station source area.

Ohio EPA explicitly modeled Spurlock Station, as well as the DP&L Stuart and Killen facilities. These facilities represent 28,552 tons of SO_2, or 99% of SO_2 emissions in the 50-kilometer area analyzed.

Analysis

The designation modeling analysis consisted of a single modeling run, years 2012-2014. The results of this analysis are to be used to inform the designation process for the area surrounding the DP&L Stuart and Killen facilities.

Receptors

A total of 89,253 receptors were included in the modeling domain. 50 meters spacing was used along the fenceline of both the DP&L Stuart and DP&L Killen facilities, and a 50 meters spacing to 1 km from the fenceline was used. The large, dense grid around the facility was informed by screen modeling to ensure that the point of maximum impact would be located within this dense grid. 100 meters spacing was used within 3 km of the fenceline, 250 meters spacing was used to 5 km from the fenceline, and a 500 meters spacing was used to 7 km from the fenceline. Beyond 7 km, a 1000 meters spacing was used to 10 km distant, and a 5000 meters spacing was used to 50 km. A discrete receptor was also included at the location of the monitor, 39-001-0001. Figure 4 shows the location of the facilities (center) as well as the receptor grid used.

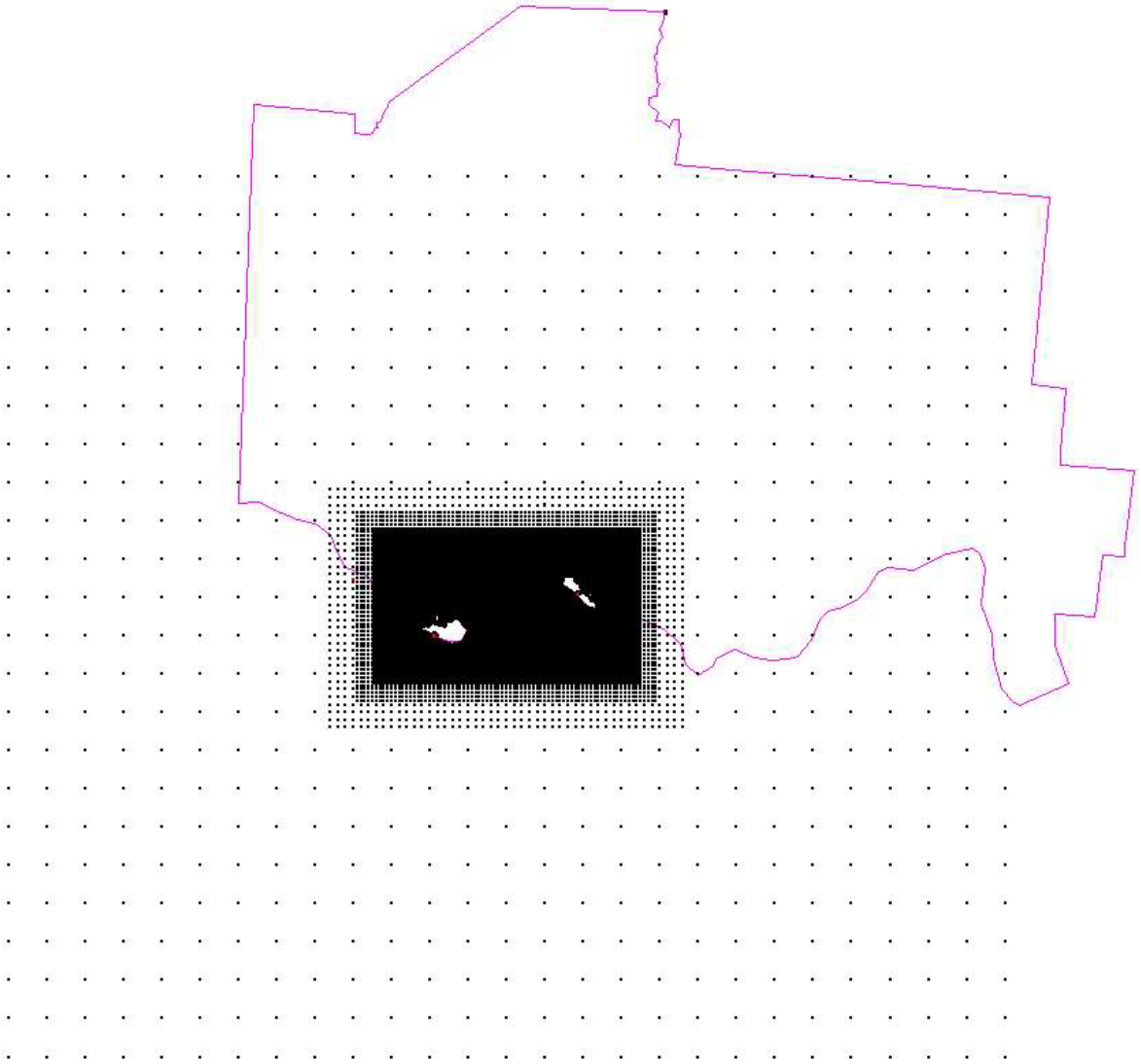

Figure 4: Receptor grid, facilities, and boundaries of those Ohio counties in Ohio included in the recommended designations area, DP&L Stuart and Killen source area.

Results

The dispersion modeling analysis evaluated the impact of the DP&L Stuart, DP&L Killen, and Spurlock facilities as a design value when modeled using hourly variable SO_2 emissions. Any maximum impact exceeding 196.2 $\mu g/m^3$ would represent a modeled exceedance. For this analysis, the maximum modeled 3-year design value, years 2012-2014 and inclusive of background, was 186.26472 $\mu g/m^3$, or 71.2 ppb. Thus, no exceedance of the standard was modeled. The results of this analysis are

shown in Figure 5. Note that for clarity, only design values of 150 μg/m^3 or greater, inclusive of background, are displayed.

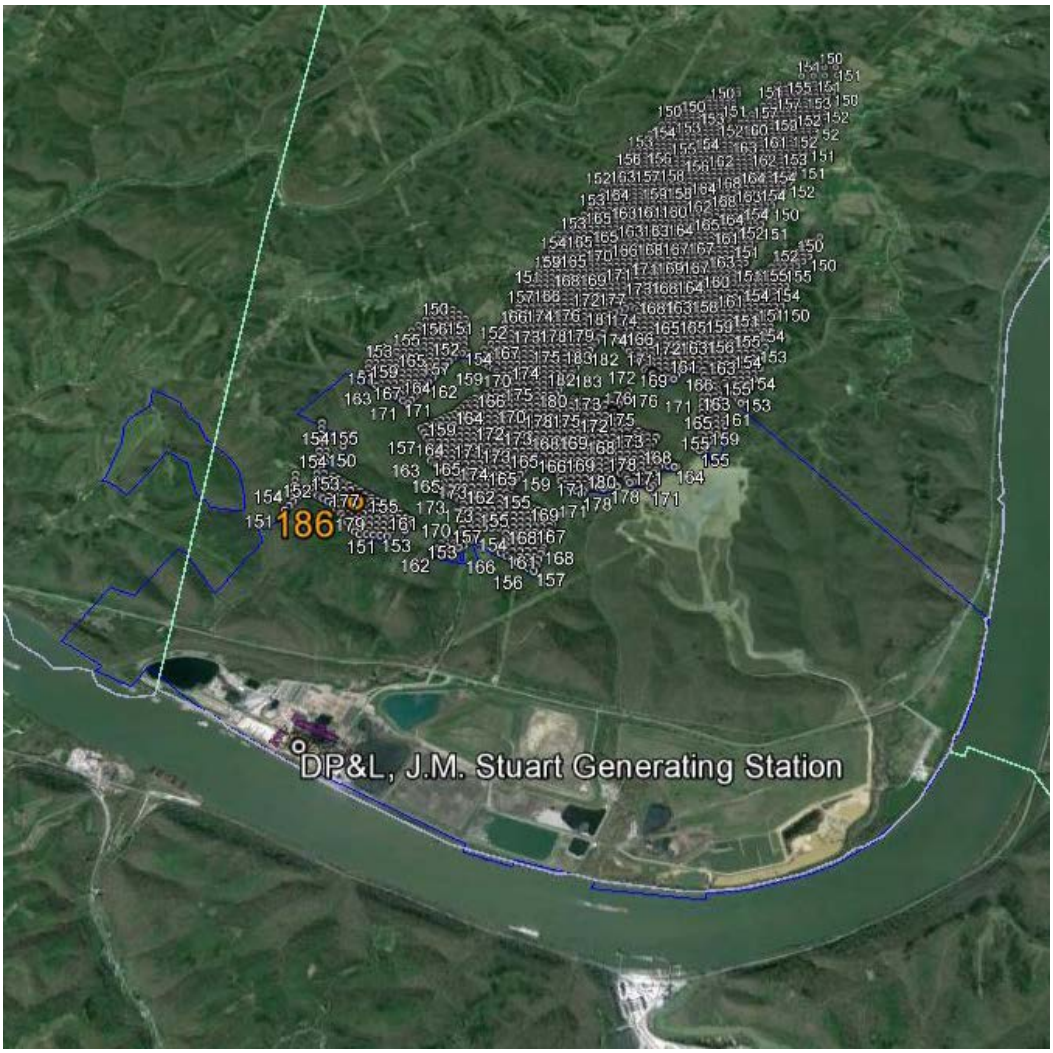

Figure 5: Maximum SO_2 impacts, DP&L Stuart and Killen, 2012-2014. Concentrations are shown in μg/m^3 including background.

The maximum modeled 3-year design value concentration, 186.26472 μg/m^3, or 71.2 ppb, including background, was modeled approximately 1.9 kilometers to the north of the largest egress point of the DP&L Stuart facility. Modeled 3-year design values greater than or equal to 150 μg/m^3 did not extend beyond 7.5 kilometers from the DP&L Stuart facility. The highest modeled concentrations were modeled near to the DP&L Stuart facility. Emissions from the DP&L Stuart facility contribute approximately 87% to the maximum modeled design value.

The dispersion modeling analysis for the designation of the area surrounding the DP&L Stuart and Killen facilities, including emissions from Spurlock Station and a seasonally

varying background demonstrates no modeled exceedances of the 2010 SO_2 standard based on the 2012-2014 period. Dispersion modeling performed with the AERMOD model accounts for multiple aspects of the five-factor analysis emphasized by U.S. EPA in designating areas. As such, Ohio EPA asserts that the modeling results presented here should carry significant weight in the designation process.