Appendix N
Dispersion Modeling Analysis for W.H. Sammis Power Plant
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 First Energy W.H. Sammis Power Plant source area. This document supports Ohio's recommended designation of the W.H. Sammis source area based on refined dispersion modeling.

Per U.S. EPA's guidance (February 2016 *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 W.H. Sammis facility. This was done per the Modeling TAD, in which U.S. EPA recommends modeling the most recent 3 years of available actual emissions.

Temporally varying emissions were modeled to determine the contribution of emissions from each source in the modeling domain. Ohio EPA used variable emissions at the finest temporal scale available for each unit included in the modeling domain. Hourly variable emissions data for the 2012-2014 period were submitted to Ohio EPA by First Energy for all SO_2 sources at the W.H. Sammis Facility. 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, with data substitutions for some hours, as described in the modeling protocol.

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 maximum monitored daily values, 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 maximum daily values 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, submitted on July 1, 2016. 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 surface station #94823 located at the Greater Pittsburgh International Airport and the Pittsburgh, Pennsylvania upper air station (station #94823) also located at the Greater Pittsburgh International Airport were used in these analyses. These sites were determined to be representative of Jefferson County, OH and the W.H. Sammis facility. AERSURFACE was run using twelve sectors and monthly surface characteristics, centered on the location of the surface meteorological station. Monthly precipitation values, years 2012-2014 from the Greater Pittsburgh International Airport were compared to the 30 year climatological averages to inform monthly surface characteristics.

Composite wind-roses of annual trends and distribution of wind directions, years 2012-2014 for surface station #94823 are shown in Figure 1. This figure demonstrates that the predominant wind directions are from the south and southwest, with significant contributions from winds originating in the south.

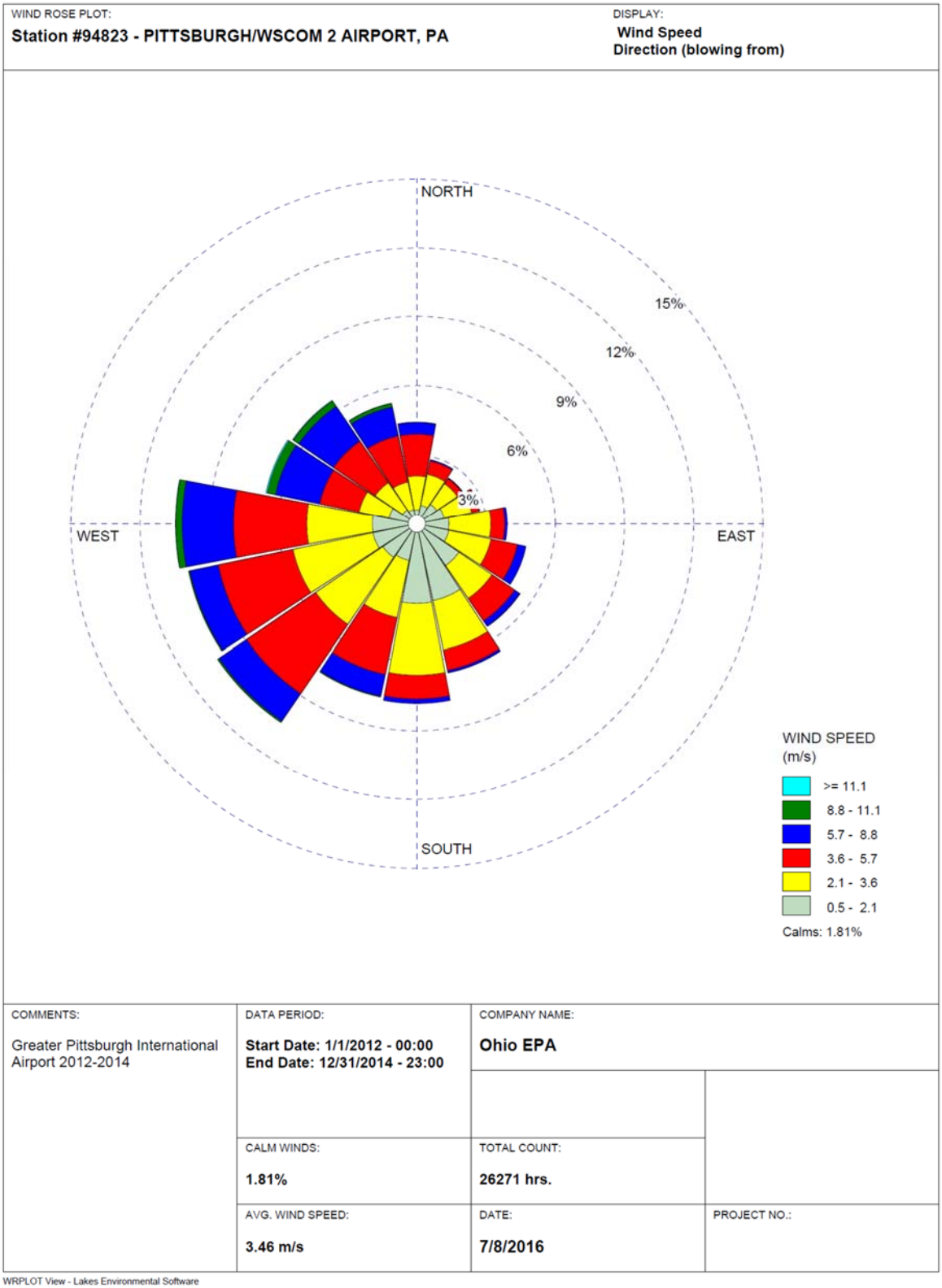

Figure 1: Wind roses, years 2012-2014, Pittsburgh met station.

The predominant wind directions were used, in part, to inform which facilities within 50 kilometers may potentially impact ambient SO_2 concentrations in the W.H. Sammis source area not accounted for by background and therefore necessitate inclusion in the dispersion modeling analysis. As shown in Figure 1, the predominant winds in the source area originate from the west and southwest. Figure 2 shows the location of all facilities located within 50 kilometers of the W.H. Sammis facility, as well as the composite wind rose, years 2012-2014, from the Pittsburgh meteorological station.

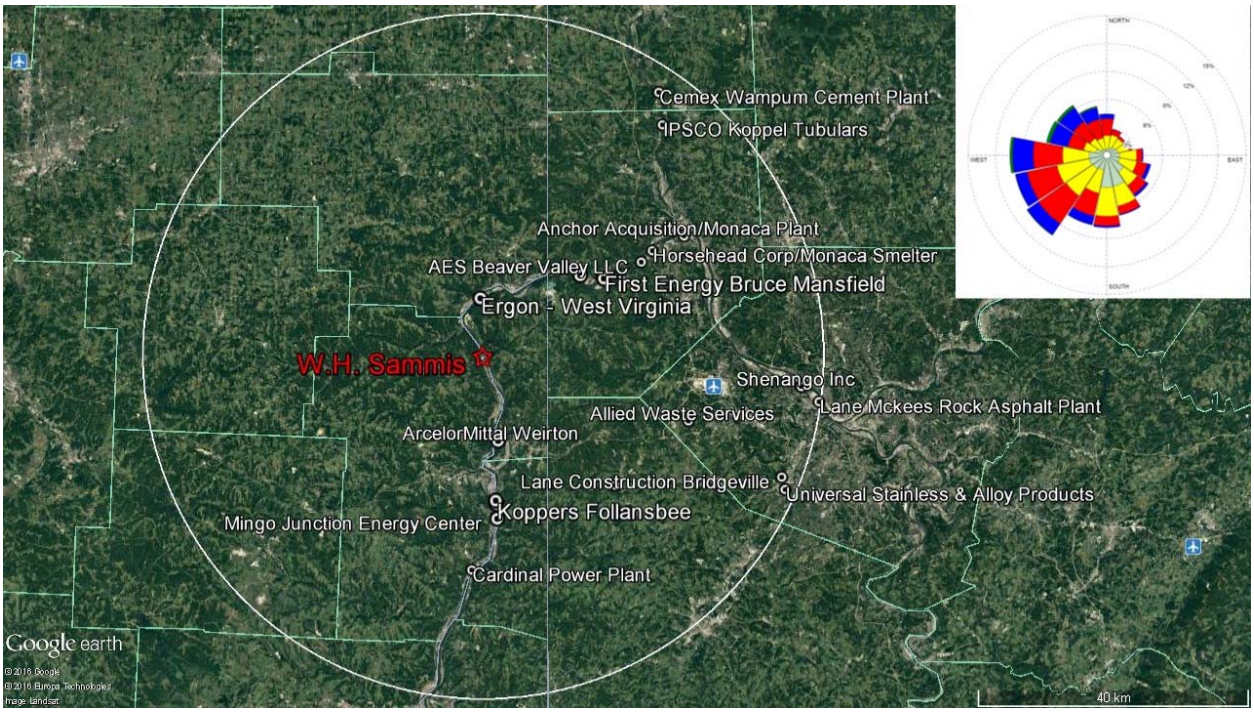

Figure 2: SO_2 sources in the W.H. Sammis source area, with 2012-2014 composite wind rose.

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 W.H. Sammis source area. The seasonal and hourly varying emissions are shown in Figure 3.

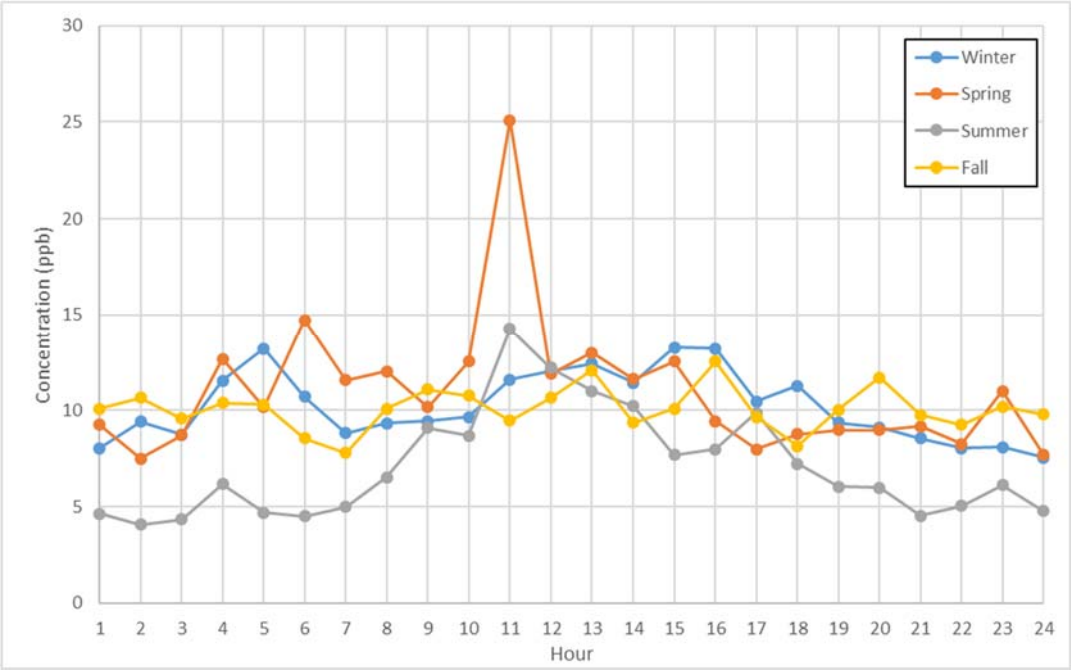

Figure 3: Hourly and seasonally variable SO_2 background, derived from air quality monitor 54-029-0005.

Emission Sources

The seven SO_2 emission sources at the W.H. Sammis facility were included in the designation modeling analysis as a single egress point. Four of these units are identical 1,822 MMBtu/hour dry-bottom coal-fired boilers, two are identical 6,066 MMBtu/hr dry-bottom coal-fired boilers, and one unit is a 3,000 MMBtu/hour dry-bottom coal-fired boiler. Variable emissions for all sources were combined to represent emissions from a single-stack egress point and were included in the model via AERMOD's 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. Ohio EPA accounted for background as a separate source in the model, to simplify the inclusion of the seasonal/hourly variable backgrounds used in the modeling domain. The relevant release point parameters for the egress point included in this analysis are presented in Table 1, below. The stack at the W.H. Sammis facility was treated as a point source. Ohio EPA, via outreach and consultation with First Energy, identified erroneous emissions data resulting from faults in the continuous emissions monitors at the facility, Part 75 data substitutions, and other sources of erroneous emissions data when preparing the HOUREMIS input file.

Source ID	Source Description	Easting (X)	Northing (Y)	Base Elevation	Stack Height	Stack Diameter	Temperature	Exit Velocity	SO2
		(m)	(m)	(m)	(m)	(m)	(K)	(m/s)	(g/s)
SAMM	Coal-fired boilers B007-B013	531123	4486526	210.39	259.08	16.8859	Variable	Variable	Variable

Table 1: Modeled source parameters, W.H. Sammis source area, 2012-2014

The emission stack at the W.H. Sammis facility serves all seven of the facility's coal-fired boilers. The stack itself is comprised of 3 flues, each with a radius of 16 feet. The combined total area of these flues were used to derive an overall exit velocity and were represented in the modeling analysis as a single emission point with a diameter of 55.4 feet.

It should be noted that although the portion of the source area represented by the current Steubenville, OH-WV nonattainment area was not included in the modeling domain as Ohio EPA is not making recommendations on designations for this already designated area and impacts within this nonattainment area, and the potential for impacts from sources outside this nonattainment area on the nonattainment area were previously analyzed by Ohio EPA in prior submittals. However, for this analysis, Ohio EPA considered the potential for sources within the Steubenville, OH-WV nonattainment area to impact the W.H. Sammis source area.

Table 2 presents 2014 SO_2 emissions for all sources greater than 1 TPY of SO_2 within 50 kilometers of W.H. Sammis. The largest source of 2014 SO_2 emissions in the W.H. Sammis source area is the First Energy Bruce Mansfield facility (19,784 tons). This facility is located approximately 21 kilometers to the northeast of the W.H. Sammis plant, and emissions from this source are unlikely to cause a significant concentration gradient above that of background in the areas impacted by emissions from the W.H. Sammis facility, given the distance between the facilities and the prevailing winds of the source area (Figure 3). Modeling results, as discussed in the Analysis section of this document indicate that the maximum 3-year design value impacts at a distance of 21 kilometers in a northeasterly direction are approximately 17 mg/m^3 (~7 ppb), without background. This would indicate that the possibility emissions from the W.H. Sammis facility interact with emissions from the Bruce Mansfield plant in a manner sufficient to model an exceedance is low. Further, Ohio EPA understands that the ambient impacts of the Bruce Mansfield plant will be characterized by the Pennsylvania Department of Environmental Protection in accordance with the DRR.

The next largest SO_2 source in the W.H. Sammis source area is the Cardinal Plant, located 31 kilometers to the south of W.H. Sammis. This facility emitted 10,661 tons of SO_2 emissions in 2014. At this distance, it is unlikely that emissions from Cardinal, as well as those facilities located in Brooke County, West Virginia, would be sufficient to cause a concentration gradient beyond what is accounted for in the conservative background applied in the modeling analysis. In addition, the potential interaction of the W.H.Sammis Plant with the Cardinal Plant, and other sources in the Steubenville, OH-WV nonattainment area, were considered as part of State of Ohio Nonattainment Area State Implementation Plan and Demonstration of Attainment for 1-hour SO_2 Nonattainment Areas.

Lastly, the nearest source to the W.H. Sammis facility, Ergon-West Virginia, Inc., is located approximately 8.5 kilometers to the north of the W.H. Sammis facility in Hancock County, West Virginia. This facility emitted 19.3 tons of SO_2 in 2014, and is not anticipated to impact concentrations beyond what is accounted for in background.

Similarly, the Jewel Acquisition/Midland facility is located approximately 18 kilometers to the northeast, and emitted 179.7 tons of SO_2 in 2014. Given the distance and low emissions of this facility, it is unlikely that hourly impacts beyond what is accounted for in background would occur. The remaining sources detailed in Table 2 are located too distant and/or have emissions sufficiently low enough to not be considered in the modeling beyond what is accounted for in the conservative background applied in the modeling analysis.

Therefore, it was determined the only source necessitating inclusion in the modeling analysis was the W.H. Sammis facility and the remaining sources are represented via the background concentrations.

State	County	Facility ID	Facility Name	2014 SO2 Emissions (TPY)	Distance from W.H. Sammis (km)
OH	Jefferson	0641160017	W.H. Sammis Plant	10,263	--
OH	Jefferson	0641050002	Cardinal Power Plant	10,661	31
			Jefferson Total	***20,924***	
WV	Brooke	54-009-00001	Koppers Follansbee	99.8	21
WV	Brooke	54-009-00002	Mountain State Carbon, LLC	366.7	21
			Brooke Total	***466.5***	
WV	Hancock	54-029-00001	ArcelorMittal Weirton	1.04	12.5
WV	Hancock	54-029-00008	Ergon, West Virginia Inc.	19.3	8.5
			Hancock Total	***20.34***	
PA	Allegheny	737435	Shenango Coke Plant	275.9	46
PA	Allegheny	737336	Allied Waste Service	17.7	32
PA	Allegheny	737315	Lane McKees Rock Asphalt	7.6	49
PA	Allegheny	737248	Universal Stainless and Alloy	7.4	48
			Allegheny Total	***308.6***	
PA	Lawrence	241793	INMETCO	2.8	47

State	County	Facility ID	Facility Name	2014 SO2 Emissions (TPY)	Distance from W.H. Sammis (km)
			Lawrence Total	***2.8***	
PA	Washington	239832	Langeloth Metallurgical	14.7	27
			Washington Total	***14.7***	
PA	Beaver	242176	Bruce Mansfield Plant	19,784	21
PA	Beaver	244000	Jewel Acquisition/Midland Facility	179.7	18
PA	Beaver	246255	AES Beaver Valley LLC	310.4	27
PA	Beaver	104430	Horsehead Corp/Monaca Smelter	171.7	29
PA	Beaver	238740	IPSCO Koppel Tubulars Corp	155.6	43
PA	Beaver	238606	Anchor Hocking LLC/Monaca Plant	7.1	34
PA	Beaver	495712	First Energy Nuclear/Beaver Valley	1.1	27
			Beaver Total	***20,609.6***	
			Grand Total	***42,346.54***	

Table 2: SO2 sources and 2014 emissions within 50 km of W.H. Sammis.

Ohio's modeling experience with the 1-hour SO_2 and NO_2 standards indicates that sources beyond 25 kilometers are unlikely to interact in a significant manner. For clarity, Ohio EPA is including in Figure 4 a map of those sources within 25 kilometers of the W.H. Sammis facility. These sources are located such that the impact of these sources near those receptors where elevated concentrations were modeled for the W.H. Sammis facility would be reflected by monitored SO_2 concentrations recorded at monitoring site 54-029-0005, from which Ohio EPA determined the representative background concentrations for the W.H. Sammis source area.

Figure 4: Monitor 54-029-0005 location and nearby sources.

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 W.H. Sammis facility.

Receptors

The portion of the source area represented by the current Steubenville, OH-WV nonattainment area was not included in the modeling domain, as Ohio EPA is not making recommendations on designations for this already designated area. Impacts within this nonattainment area, and the potential for impacts from sources outside this nonattainment area on the nonattainment area were previously analyzed by Ohio EPA in prior submittals. As such, Ohio EPA did not place receptors in the Steubenville, OH-WV nonattainment area.

A total of 31,723 receptors were included in the modeling domain for the purposes of designations modeling. 50 meters spacing was used along the fenceline of the W.H. Sammis facility, and a 50 meters spacing to 3 kilometers from the fenceline was used. The dense grid around the facility was informed by screen modeling to ensure that the point of maximum impact would be located within this densely-spaced grid. 100 meters spacing was used within 4 kilometers of the fenceline, 250 meters spacing was used to 7.5 kilometers from the fenceline, and a 500 meters spacing was used to 15 kilometers from the fenceline. Beyond 15 kilometers, a 1,000 meters spacing was used to 25 kilometers distant. Figure 5 shows the location of the facility as well as the receptor grid used. For clarity, receptors beyond 7.5 kilometers are not shown.

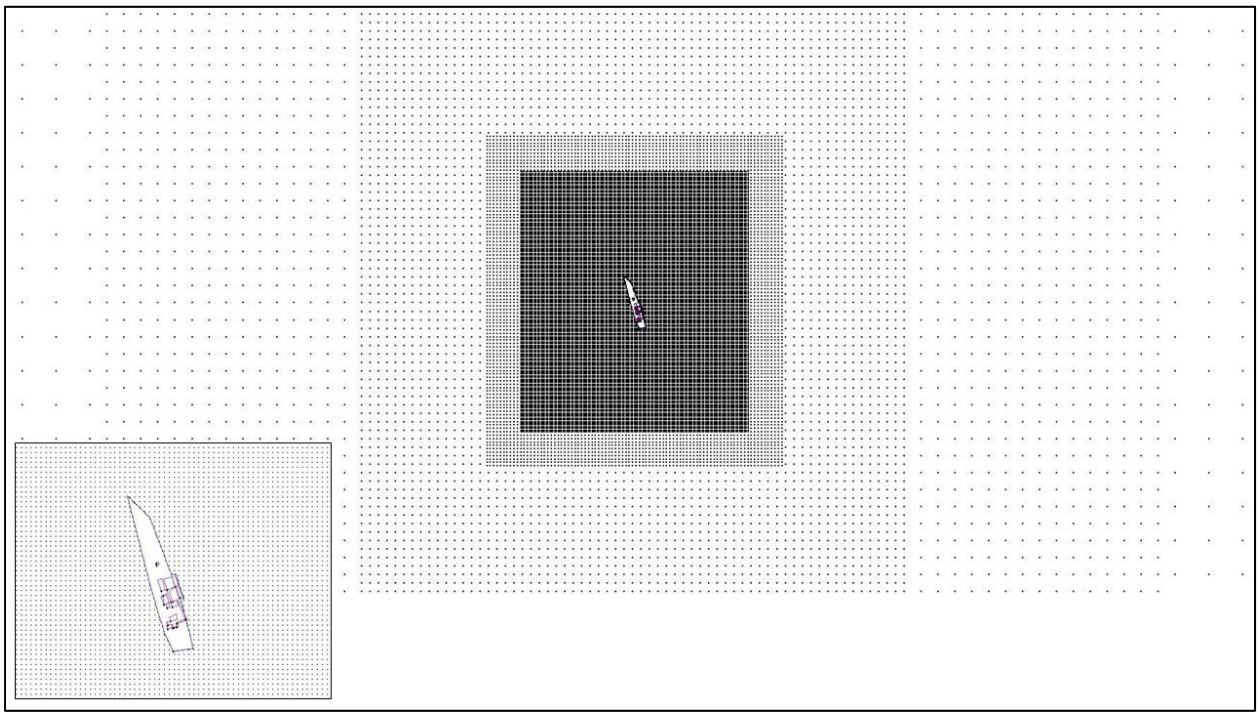

Figure 5: W.H. Sammis facility and receptor grid. Dense grid and fenceline grid, inset.

Results

The dispersion modeling analysis evaluated the impact of the W.H. Sammis facility as a design value when modeled using hourly variable SO_2 emissions. Any maximum impact

exceeding 196.2 μg/m^3 would represent a modeled exceedance, as seasonal and hourly varying backgrounds were included as a source in the modeling domain. For this analysis, the maximum modeled 3-year design value, years 2012-2014, was 84.50621 μg/m^3, or 32.3 ppb. Thus, no exceedance of the standard was modeled. The results of this analysis are shown in Figure 6. Note that for clarity, only design values of 80 μg/m^3 or greater are displayed. These impacts extend approximately 5 kilometers from the egress point. Beyond 5 kilometers, modeled design values are highly uniform, as they are dominated by the peak background concentration of 25 ppb (65.4 μg/m^3) rather than emissions from the W.H. Sammis facility.

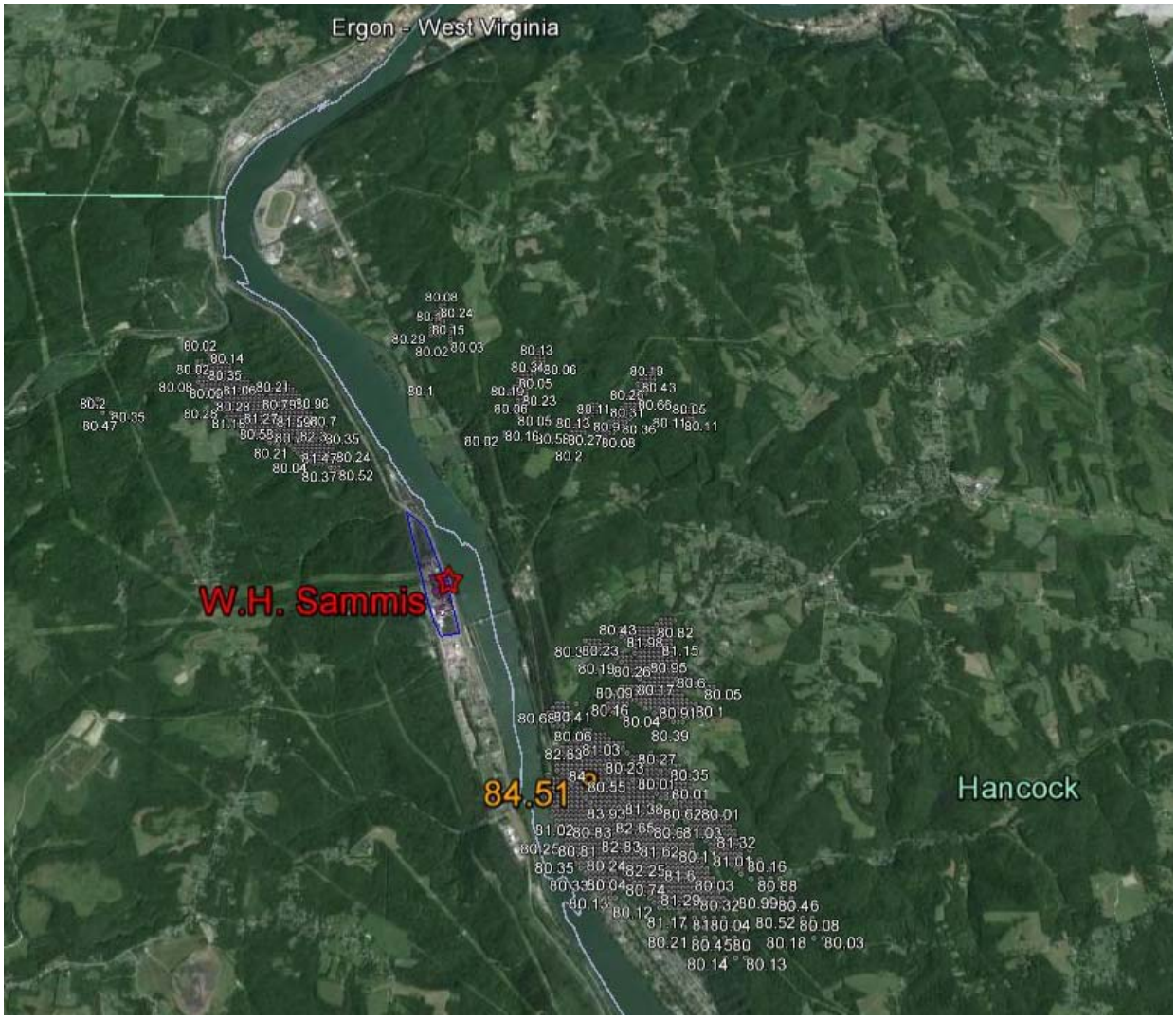

Figure 6: Maximum SO_2 impacts, W.H. Sammis facility, 2012-2014, including background. Concentrations in μg/m^3.

The maximum modeled concentration, 84.50621 μg/m^3, or 32.3 ppb including background, was modeled approximately 2.6 kilometers to the southeast of the egress point at the W.H. Sammis plant.

The dispersion modeling analysis for the designation of the area surrounding the W.H. Sammis facility, including a seasonally and hourly 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.