Sierra Club Evaluation of Compliance with 1-hour SO_2 NAAQS

for

Big Sandy Plant - Louisa, Kentucky
Cane Run Generating Station - Louisville, Kentucky
Cooper Power Station - Somerset, Kentucky
Dale Power Station - Ford, Kentucky
Green River Generating Station - Central City, Kentucky
H.L. Spurlock Generating Station - Maysville, Kentucky
Mill Creek Generating Station - Louisville, Kentucky
Robert Reid Power Station - Robards, Kentucky
Tyrone Generating Station - Versailles, Kentucky

February 10, 2012

Conducted by:

Steven Klafka, P.E., BCEE

Wingra Engineering, S.C.

Madison, Wisconsi

1. Introduction

The Sierra Club prepared an air modeling impact analysis to help USEPA, state and local air agencies identify facilities that are likely causing violations of the one-hour sulfur dioxide (SO_2) national ambient air quality standard (NAAQS). This document describes the modeling results and procedures for the following power plants in Kentucky:

- Big Sandy Plant - Louisa, Kentucky
- Cane Run Generating Station - Louisville, Kentucky
- Cooper Power Station - Somerset, Kentucky
- Dale Power Station - Ford, Kentucky
- Green River Generating Station - Central City, Kentucky
- H.L. Spurlock Generating Station - Maysville, Kentucky
- Mill Creek Generating Station - Louisville, Kentucky
- Robert Reid Power Station - Robards, Kentucky
- Tyrone Generating Station - Versailles, Kentucky

The dispersion modeling analysis predicted ambient air concentrations for comparison with the one-hour SO_2 NAAQS. The modeling was performed using data provided to the Sierra Club by regulatory air agencies and through other common sources described below.

2. Compliance with the One-Hour SO_2 NAAQS

2.1 One-Hour SO_2 NAAQS

The one-hour SO_2 NAAQS takes the form of a three-year average of the 99th-percentile of the annual distribution of daily maximum one-hour concentrations, which cannot exceed 75 ppb.[1] Compliance with this standard was verified using USEPA's AERMOD air dispersion model, which produces air concentrations in units of $\mu g/m^3$. The one-hour SO_2 NAAQS of 75 ppb equals 196.2 $\mu g/m^3$, and this is the value used for determining whether modeled impacts exceed the NAAQS.[2] The 99th-percentile of the annual distribution of daily maximum one-hour concentrations corresponds to the fourth-highest value at each receptor for a given year.

---

[1] USEPA, Applicability of Appendix W Modeling Guidance for the 1-hour SO_2 National Ambient Air Quality Standard, August 23, 2010.

[2] The ppb to $\mu g/m^3$ conversion is found in the source code to AERMOD v. 11353, subroutine Modules. The conversion calculation is 75/0.3823 = 196.2 $\mu g/m^3$.

2.2 Modeling Results

Modeling results for each of the power plants are summarized in Table 1. It was determined that based on either currently permitted emissions or measured actual emissions, each of the power plants is estimated to create downwind SO_2 concentrations which exceed the 1-hour NAAQS.

Seven of the nine power plants were predicted to cause NAAQS exceedences out to 50 km, the maximum distance suitable for this type of modeling analysis.

Supporting figures are provided in the following appendices to show the extent of the NAAQS violations:

Appendix A - Big Sandy Plant
Appendix B - Cane Run Generating Station
Appendix C - Cooper Power Station
Appendix D - Dale Power Station
Appendix E - Green River Generating Station
Appendix F - H.L. Spurlock Generating Station
Appendix G - Mill Creek Generating Station
Appendix H - Robert Reid Power Station
Appendix I - Tyrone Generating Station

For each plant, Figure 1 shows the extent of NAAQS violations throughout the entire 50 kilometer modeling domain. Figure 2 provides a close-up local view of NAAQS violations.

Air quality impacts are based on a background concentration of 65.4 $\mu g/m^3$. This is the 2008-10 design value for the ambient monitor located in McCracken County. This is the lowest measured background concentration in the state and so may under-predict compliance with the NAAQS.

The currently permitted emissions and measured actual emissions used for the modeling analysis for each of the power plants are summarized in Tables 2 to 10.

Based on the modeling results, emission reductions from current rates considered necessary to achieve compliance with the 1-hour NAAQS were calculated and presented in Table 11.

2.3 Conservative Modeling Assumptions

A dispersion modeling analysis requires the selection of numerous parameters which affect the predicted concentrations. For the enclosed analysis, several parameters were selected which under-predict facility impacts.

Assumptions used in this modeling analysis which likely under-estimate concentrations include the following:

- Allowable emissions are based a limitation with longer averaging periods than the air quality standard. If the applicable averaging period is greater than a 1-hour average, then emissions during any 1-hour period may be higher than assumed for the modeling analysis. Refer to Tables 2 to 10 for the averaging period for currently approved emission limits.
- No consideration of facility operation at less than 100% load. Stack parameters such as exit flow rate and temperature are typically lower at less than full load, reducing pollutant dispersion and increasing predicted air quality impacts.
- No consideration of building or structure downwash. These downwash effects typically increase predicted concentrations near the facility.
- No consideration of off-site sources. Each of power plants was modeled separately so the combined impacts are not considered. If the power plants were modeled simultaneously or with other sources of SO_2, this will increase the predicted impacts.

Table 1 - SO_2 Modeling Results for the Modeling Analysis

Power Plant	Emission Rates	Averaging Period	99th Percentile 1-hour Daily Maximum (µg/m^3)				Complies with NAAQS?
			Impact	Background	Total	NAAQS	
Big Sandy Plant	Allowable	1-hour	767.1	65.4	832.5	196.2	No
	Maximum	1-hour	264.1	65.4	329.5	196.2	No
Cane Run Generating Station	Allowable	1-hour	5,198.2	65.4	5,263.6	196.2	No
	Maximum	1-hour	5,376.4	65.4	5,441.8	196.2	No
Cooper Power Station	Allowable	1-hour	10,098.9	65.4	10,164.3	196.2	No
	Maximum	1-hour	9,513.4	65.4	9,578.8	196.2	No
Dale Power Station	Allowable	1-hour	8,300.9	65.4	8,366.3	196.2	No
	Maximum	1-hour	8,447.9	65.4	8,513.3	196.2	No
Green River Generating Station	Allowable	1-hour	1,076.3	65.4	1,141.7	196.2	No
	Maximum	1-hour	889.5	65.4	954.9	196.2	No
H.L. Spurlock Generating Station	Allowable	1-hour	1,270.2	65.4	1,335.6	196.2	No
	Maximum	1-hour	407.7	65.4	473.1	196.2	No
Mill Creek Generating Station	Allowable	1-hour	829.6	65.4	895.0	196.2	No
	Maximum	1-hour	1,168.3	65.4	1,233.7	196.2	No
Robert Reid Power Station	Allowable	1-hour	533.4	65.4	598.8	196.2	No
	Maximum	1-hour	387.3	65.4	452.7	196.2	No
Tyrone Generating Station	Allowable	1-hour	16,568.8	65.4	16,634.2	196.2	No
	Maximum	1-hour	12,790.6	65.4	12,856.0	196.2	No

Table 2 - Modeled SO_2 Emissions for the Big Sandy Plant

Boiler	Allowable Emissions[3] 24-hour Average (lbs/hr)	Maximum Emissions[4] 1-hour Average (lbs/hr)
Unit 1	15,072	7,094
Unit 2	47,484	14,464
Total	62,556	21,558

Table 3 - Modeled SO_2 Emissions for the Cane Run Generating Station

Boiler	Allowable Emissions[5] 3-hour Average (lbs/hr)	Maximum Emissions[4] 1-hour Average (lbs/hr)
Unit 4	1,967	1,827
Unit 5	2,228	2,513
Unit 6	2,944	3,085
Total	7,139	7,425

Table 4 - Modeled SO_2 Emissions for the Cooper Power Station

Boiler	Allowable Emissions[6] 24-hour Average (lbs/hr)	Maximum Emissions[4] 1-hour Average (lbs/hr)
Unit 1	3,564	3,244
Unit 2	6,894	6,696
Total	10,458	9,940

[3] Allowable emissions are based on the 6.0 lbs/mmbtu limitation in Air Quality Permit V-06-053 issued by the Kentucky Department of Environmental Protection on July 2, 2007.

[4] Maximum emissions are based on measured hourly rates reported during 2010 taken from USEPA, Clean Air Markets - Data and Maps.

[5] Allowable emissions are based on the 1.2 lbs/mmbtu limitation in Title V Operation Permit 175-00-TV (R1)issued by the Air Pollution Control District of Jefferson County, Kentucky on October 30, 2002.

[6] Allowable emissions are based on the 3.3 lbs/mmbtu limitation in Air Quality Permit V-05-082 R2 issued by the Kentucky Department of Environmental Protection on September 29, 2010.

Table 5 - Modeled SO_2 Emissions for the Dale Power Station

Boiler	Allowable Emissions[7] 24-hour Average (lbs/hr)	Maximum Emissions[4] 1-hour Average (lbs/hr)
Unit 1	461	440
Unit 2	461	583
Unit 3	1,433	1,369
Unit 4	1,361	1,405
Total	3,715.4	3,796.5

Table 6 - Modeled SO_2 Emissions for the Green River Power Station

Boiler	Allowable Emissions[8] 24-hour Average (lbs/hr)	Maximum Emissions[4] 1-hour Average (lbs/hr)
Unit 3	4,460	3,764
Unit 4	5,758	4,644
Total	10,219	8,407

Table 7 - Modeled SO_2 Emissions for the H.L. Spurlock Generating Station

Boiler	Allowable Emissions[9] 24-hour Average (lbs/hr)	Maximum Emissions[4] 1-hour Average (lbs/hr)
Unit 1	10,500	3,913
Unit 2	16,800	3,045
Unit 3	7,500	4,096
Unit 4	8,400	2,099
Total	43,200	13,152

[7] Allowable emissions are based on the 1.8 lbs/mmbtu limitation in Air Quality Permit V-08-009 issued by the Kentucky Department of Environmental Protection on September 26, 2008.

[8] Allowable emissions are based on the 4.57 lbs/mmbtu limitation in Air Quality Permit V-06-014 R1 issued by the Kentucky Department of Environmental Protection on August 6, 2007.

[9] Allowable emissions are based on the 3.0 lbs/mmbtu limitation in Air Quality Permit V-06-007R3 issued by the Kentucky Department of Environmental Protection on April 27, 2010.

Table 8 - Modeled SO_2 Emissions for the Mill Creek Generating Station

Boiler	Allowable Emissions[10] 3-hour Average (lbs/hr)	Maximum Emissions[4] 1-hour Average (lbs/hr)
Unit 1	3,702	3,225
Unit 2	3,702	4,603
Unit 3	5,045	12,947
Unit 4	6,030	5,313
Total	18,479	26,087

Table 9 - Modeled SO_2 Emissions for the Robert Reid Power Station

Boiler	Allowable Emissions[11] 24-hour Average (lbs/hr)	Maximum Emissions[4] 1-hour Average (lbs/hr)
Unit 1	4,337	3,149

Table 10 - Modeled SO_2 Emissions for the Tyrone Generating Station

Boiler	Allowable Emissions[12] 24-hour Average (lbs/hr)	Maximum Emissions[4] 1-hour Average (lbs/hr)
Unit 1	1,756.8	1,356.2

[10] Allowable emissions are based on the 1.2 lbs/mmbtu limitation in Title V Operating Permit 145-97-TV issued by the Air Pollution Control District of Louisville - Jefferson County Metro Government, Kentucky on June 1, 2003.

[11] Allowable emissions are based on the 5.4 lbs/mmbtu limitation in Air Quality Permit V-11-003 issued by the Kentucky Department of Environmental Protection on September 28, 2011.

[12] Allowable emissions are based on the 1.8 lbs/mmbtu limitation in Air Quality Permit V-05-018 issued by the Kentucky Department of Environmental Protection on July 2, 2007.

Table 11 - Required Emission Reductions for Compliance with 1-hour SO_2 NAAQS

Power Plant	Acceptable Impact (NAAQS - Background) 99th Percentile 1-hour Daily Max ($\mu g/m^3$)	Required Total Facility Emission Reduction (%)	Required Total Facility Emission Rate (lbs/hr)
Big Sandy Plant	130.8	82.9%	10,666.6
Cane Run Generating Station		97.5%	179.6
Cooper Power Station		98.7%	135.5
Dale Power Station		98.4%	58.5
Green River Generating Station		87.8%	1,241.9
H.L. Spurlock Generating Station		89.7%	4,448.6
Mill Creek Generating Station		84.2%	2,913.5
Robert Reid Power Station		75.5%	1,063.5
Tyrone Generating Station		99.2%	13.9

3. Modeling Methodology

3.1 Air Dispersion Model

The modeling analysis used USEPA's AERMOD program, version 11353. AERMOD, as available from the Support Center for Regulatory Atmospheric Modeling (SCRAM) website, was used in conjunction with a third-party modeling software program, *AERMOD View*, sold by Lakes Environmental Software.

3.2 Control Options

The AERMOD model was run with the following control options:

- One-hour average air concentrations
- Regulatory defaults
- Flagpole receptors

To reflect a representative inhalation level, a flagpole height of 1.5 meters was used for all modeled receptors. This parameter was added to the receptor file when running AERMAP, as described in Section 4.4.

An evaluation was conducted to determine if the modeled facility was located in a rural or urban setting using USEPA's methodology outlined in Section 7.2.3 of the Guideline on Air Quality

Models.[13] For urban sources, the URBANOPT option is used in conjunction with the urban population from an appropriate nearby city and a default surface roughness of 1.0 meter. Methods described in Section 4.1 to determine whether rural or urban dispersion coefficients were used.

3.3 Output Options

The AERMOD analysis was based on five years of recent meteorological data. The modeling analyses used one run with five years of sequential meteorological data from 2006-2010. Consistent with USEPA's Modeling Guidance for SO_2 NAAQS Designations, AERMOD provided the fourth-high one-hour SO_2 impacts.[14]

Please refer to Table 1 for the modeling results. Please see the supporting figures in the appendices for a presentation of concentration isopleths.

4. Model Inputs

4.1 Geographical Inputs

The "ground floor" of all air dispersion modeling analyses is establishing a coordinate system for identifying the geographical location of emission sources and receptors. These geographical locations are used to determine local characteristics (such as land use and elevation), and also to ascertain source to receptor distances and relationships.

The Universal Transverse Mercator (UTM) NAD83 coordinate system was used for identifying the easting (x) and northing (y) coordinates of the modeled sources and receptors. Stack locations were obtained from facility permits and prior modeling files provided by the regulatory agencies for the facilities – Kentucky Department of Environmental Protection and Air Pollution Control District of Louisville - Jefferson County Metro Government . The stack locations were then verified using aerial photographs.

The facility was evaluated to determine if it should be modeled using the rural or urban dispersion coefficient option in AERMOD. A GIS was used to determine whether rural or urban dispersion coefficients apply to a site. Land use within a three-kilometer radius circle surrounding the facility was considered. USEPA guidance states that urban dispersion coefficients are used if more than 50%

---

[13] USEPA, Revision to the Guideline on Air Quality Models: Adoption of a Preferred General Purpose (Flat and Complex Terrain) Dispersion Model and Other Revisions, Appendix W to 40 CFR Part 51, November 9, 2005.
[14] USEPA, Area Designations for the 2010 Revised Primary Sulfur Dioxide National Ambient Air Quality Standards, Attachment 3, March 24, 2011, pp. 24-26.

of the area within 3 kilometers has urban land uses. Otherwise, rural dispersion coefficients are appropriate.[15]

USEPA's AERSURACE model Version 08009 was used to develop the meteorological data for the modeling analysis. This model was also used to evaluate surrounding land use within 3 kilometers of either the facility or the airport which provided the meteorological data. Based on the output from the AERSURFACE, the surrounding land use consisting of urban land use types (i.e. 21 – Low Intensity Residential, 22 – High Intensity Residential, and 23 – Commercial / Industrial / Transportation) was determined.

For each of the plants, the urban land use types were less than the 50% value considered appropriate for the use of urban dispersion coefficients. Based on the AERSURFACE analysis, it was concluded that the rural option would be used for the modeling summarized in this report. Please refer to Section 4.5.3 for a discussion of the AERSURFACE analysis.

4.2 Emission Rates and Source Parameters

The modeling analyses only considered SO_2 emissions from the facility. Off-site sources were not considered. Concentrations were predicted for two scenarios shown in Table 2:

1) approved or allowable emissions based on permits issued by the regulatory agency, and

2) measured actual hourly SO_2 emissions obtained from USEPA's Clean Air Markets Database.

Stack parameters and emissions used for the modeling analysis for each plant are summarized in Tables 12 through 20. These were obtained from regulatory agency permit files including operation permits and emission inventory reports. The analysis was conducted based on 100% operating load using maximum exhaust flow rates and emission rates. Operation at less than full capacity loads was not considered. This assumption tends to under-predict impacts since stack parameters such as exit flow rate and temperature are typically lower at less than full load, reducing pollutant dispersion and increasing predicted air quality impacts. Stack location, height and diameter were verified using aerial photographs, and flue gas flow rate and temperature were verified using combustion calculations.

---

[15] USEPA, Revision to the Guideline on Air Quality Models: Adoption of a Preferred General Purpose (Flat and Complex Terrain) Dispersion Model and Other Revisions, Appendix W to 40 CFR Part 51, November 9, 2005, Section 7.2.3.

Table 12 – Stack Parameters and Emissions for the Big Sandy Plant

Description	Unit 1 and Unit 2
X Coord. [m]	358232
Y Coord. [m]	4226042
Base Elevation [m]	172.3
Release Height [m]	250.9
Gas Exit Temperature [°K]	430.9
Gas Exit Velocity [m/s]	29.9
Inside Diameter [m]	8.6
Allowable Emission Rate [g/s]	7882.0
Maximum Emission Rate [g/s]	2716.0

Table 13 – Stack Parameters and Emissions for the Cane Run Generating Station

Description	Unit 4	Unit 5	Unit 6
X Coord. [m]	597277	597298	597323
Y Coord. [m]	4226689	4226718	4226740
Base Elevation [m]	138.4	138.1	137.3
Release Height [m]	72.9	72.9	152.4
Gas Exit Temperature [°K]	322.0	322.0	322.0
Gas Exit Velocity [m/s]	21.9	24.5	24.2
Inside Diameter [m]	4.7	4.7	5.8
Allowable Emission Rate [g/s]	247.8	280.7	370.9
Maximum Emission Rate [g/s]	230.2	316.6	388.7

Table 14 – Stack Parameters and Emissions for the Cooper Power Station

Description	Unit 1	Unit 2
X Coord. [m]	714252	714252
Y Coord. [m]	4097342	4097342
Base Elevation [m]	243.5	243.5
Release Height [m]	79.3	79.3
Gas Exit Temperature [°K]	433.2	433.2
Gas Exit Velocity [m/s]	8.4	16.3
Inside Diameter [m]	5.4	5.4
Allowable Emission Rate [g/s]	449.1	868.6
Maximum Emission Rate [g/s]	408.7	843.7

Table 15 – Stack Parameters and Emissions for the Dale Power Station

Description	Units 1 and 2	Units 3 and 4
X Coord. [m]	740814	740837
Y Coord. [m]	4196137	4196100
Base Elevation [m]	186.2	187.8
Release Height [m]	45.1	45.1
Gas Exit Temperature [°K]	433.0	433.0
Gas Exit Velocity [m/s]	4.0	10.5
Inside Diameter [m]	5.2	5.2
Allowable Emission Rate [g/s]	128.8	349.5
Maximum Emission Rate [g/s]	116.1	352.1

Table 16 – Stack Parameters and Emissions for the Green River Power Station

Description	Unit 4	Unit 3
X Coord. [m]	489195	489234
Y Coord. [m]	4135196	4135192
Base Elevation [m]	124.8	124.5
Release Height [m]	75.3	60.1
Gas Exit Temperature [°K]	422.0	422.0
Gas Exit Velocity [m/s]	28.4	18.9
Inside Diameter [m]	3.0	3.4
Allowable Emission Rate [g/s]	725.5	562.0
Maximum Emission Rate [g/s]	585.1	474.3

Table 17 – Stack Parameters and Emissions for the H.L. Spurlock Generating Station

Description	Unit 1	Unit 2	Unit 3	Unit 4
X Coord. [m]	255091	254991	254949	254898
Y Coord. [m]	4287293	4287270	4287224	4287191
Base Elevation [m]	164.0	164.0	164.0	164.0
Release Height [m]	245.4	245.4	198.1	219.5
Gas Exit Temperature [°K]	424.3	424.3	333.2	333.2
Gas Exit Velocity [m/s]	32.7	32.7	18.2	16.0
Inside Diameter [m]	4.6	4.6	4.6	4.9
Allowable Emission Rate [g/s]	1323.0	2117.0	945.0	1058.0
Maximum Emission Rate [g/s]	493.0	383.7	516.1	264.5

Table 18 – Stack Parameters and Emissions for the Mill Creek Generating Station

Description	Unit 1	Unit 2	Unit 3	Unit 4
X Coord. [m]	595631	595631	595640	595636
Y Coord. [m]	4212281	4212281	4212189	4212125
Base Elevation [m]	141.8	141.8	142.1	142.0
Release Height [m]	182.9	182.9	182.9	182.9
Gas Exit Temperature [°K]	325.4	327.0	327.0	324.8
Gas Exit Velocity [m/s]	19.5	21.1	20.0	22.5
Inside Diameter [m]	4.7	4.7	5.5	5.9
Allowable Emission Rate [g/s]	466.4	466.4	635.7	759.8
Maximum Emission Rate [g/s]	406.3	580.0	1631.0	669.4

Table 19 – Stack Parameters and Emissions for the Robert Reid Power Station

Description	Unit 1
X Coord. [m]	455631
Y Coord. [m]	4166795
Base Elevation [m]	130.8
Release Height [m]	76.2
Gas Exit Temperature [°K]	433.2
Gas Exit Velocity [m/s]	9.0
Inside Diameter [m]	3.7
Allowable Emission Rate [g/s]	546.5
Maximum Emission Rate [g/s]	396.8

Table 20 – Stack Parameters and Emissions for the Tyrone Generating Station

Description	Unit 3
X Coord. [m]	688804
Y Coord. [m]	4213358
Base Elevation [m]	156.58
Release Height [m]	54.86
Gas Exit Temperature [°K]	435.928
Gas Exit Velocity [m/s]	5.414
Inside Diameter [m]	3.444
Allowable Emission Rate [g/s]	221.4
Maximum Emission Rate [g/s]	170.9

4.3 Building Dimensions and GEP

This modeling analysis did not address the effects of building or structure downwash which may increase predicted concentrations.

4.4 Receptors

For each of the power plants, three receptor grids were employed:

1. A 100-meter Cartesian receptor grid centered on the station and extending out 5 kilometers.
2. A 500-meter Cartesian receptor grid centered on the station and extending out 10 kilometers.
3. A 1,000-meter Cartesian receptor grid centered on the station and extending out 50 kilometers. 50 kilometers is the maximum distance accepted by USEPA for the use of the AERMOD dispersion model.[16]

A flagpole height of 1.5 meters was used for all these receptors.

Elevations from stacks and receptors were obtained from National Elevation Dataset (NED) GeoTiff data. GeoTiff is a binary file that includes data descriptors and geo-referencing information necessary for extracting terrain elevations. These elevations were extracted from 1 arc-second (30 meter) resolution NED files using USEPA's AERMAP program, v. 11103.

4.5 Meteorological Data

To improve the accuracy of the modeling analysis, recent meteorological data for the 2006 to 2010 period were prepared using the USEPA's program AERMET which creates the model-ready surface and profile data files required by AERMOD. Required data inputs to AERMET included surface meteorological measurements, twice-daily soundings of upper air measurements, and the micrometeorological parameters surface roughness, albedo, and Bowen ratio. When available, one-minute ASOS data were used to reduce calm and missing hours.[17]

This section discusses how the meteorological data was prepared for use in the one-hour SO_2 NAAQS modeling analyses. AERMET v. 11059 was used for these tasks.

4.5.1 Surface Meteorology

Integrated Surface Hourly (ISH) data for the 2006 to 2010 period were obtained from the National

---

[16] USEPA, Revision to the Guideline on Air Quality Models: Adoption of a Preferred General Purpose (Flat and Complex Terrain) Dispersion Model and Other Revisions, Appendix W to 40 CFR Part 51, Section A.1.(1), November 9, 2005.

[17] USEPA, Area Designations for the 2010 Revised Primary Sulfur Dioxide National Ambient Air Quality Standards, Attachment 3, March 24, 2011, p. 19.

Climatic Data Center (NCDC). The ISH surface data was processed through AERMET Stage 1, which performs data extraction and quality control checks. Table 21 presents the weather station used to obtain surface meteorology for each power plant. The distance and direction from the plant to the weather station is provided along with the availability of one-minute wind data from a ASOS type station.

Table 21 – Surface Data Weather Stations

Power Plant	Surface Station	Distance	ASOS
Big Sandy Plant	Huntington Tri-State Airport	18 miles north	Yes
Cane Run Generating Station	Louisville International Airport	10 miles east	Yes
Cooper Power Station	Lexington Bluegrass Airport	85 miles north	Yes
Dale Power Station	Lexington Bluegrass Airport	20 miles northwest	Yes
Green River Generating Station	Bowling Green-Warren County Regional Airport	63 miles southeast	Yes
H.L. Spurlock Generating Station	Covington Municipal Airport	60 miles west	Yes
Mill Creek Generating Station	Louisville International Airport	16 miles northeast	Yes
Robert Reid Power Station	Henderson City-County Airport	19 miles northwest	No
Tyrone Generating Station	Capitol City Airport	9 miles north	Yes

4.5.2 Upper Air Data

Upper-air data are collected by a "weather balloon" that is released twice per day at selected locations. As the balloon is released, it rises through the atmosphere, and radios the data back to the surface. The measuring and transmitting device is known as either a radiosonde, or rawindsonde. Data collected and radioed back include: air pressure, height, temperature, dew point, wind speed, and wind direction. The upper air data were processed through AERMET Stage 1, which performs data extraction and quality control checks.

The concurrent 2006 through 2010 upper air data from twice-daily radiosonde measurements were obtained from the most representative location for each power plant. Table 22 summaries the upper air station which was used for each plant. These upper air data are in Forecast Systems Laboratory (FSL) format and were downloaded in ASCII text format from NOAA's FSL website.[18] All reporting levels were downloaded and processed with AERMET.

[18] Available at: http://esrl.noaa.gov/raobs/

Table 22 – Upper Air Data Weather Stations

Power Plant	Upper Air Station
Big Sandy Plant	Wilmington, Ohio
Cane Run Generating Station	Wilmington, Ohio
Cooper Power Station	Nashville, Tennessee
Dale Power Station	Wilmington, Ohio
Green River Generating Station	Nashville, Tennessee
H.L. Spurlock Generating Station	Wilmington, Ohio
Mill Creek Generating Station	Wilmington, Ohio
Robert Reid Power Station	Nashville, Tennessee
Tyrone Generating Station	Wilmington, Ohio

4.5.3 AERSURFACE

AERSURFACE is a non-guideline program that extracts surface roughness, albedo, and daytime Bowen ratio for an area surrounding a given location. AERSURFACE uses land use and land cover (LULC) data in the U.S. Geological Survey's 1992 National Land Cover Dataset to extract the necessary micrometeorological data. LULC data was used for processing meteorological data sets used as input to AERMOD.

AERSURFACE v. 08009 was used to develop surface roughness, albedo, and daytime Bowen ratio values in a region surrounding the meteorological data collection site. AERSURFACE was used to develop surface roughness in a one kilometer radius surrounding the data collection site. Bowen ratio and albedo was developed for a 10 kilometer by 10 kilometer area centered on the meteorological data collection site. These micrometeorological data were processed for seasonal periods using 30-degree sectors. Seasonal moisture conditions were considered average with no months with continuous snow cover.

4.5.4 Data Review

Missing meteorological data were not filled as the data file met USEPA's 90% data completeness requirement.[19] The AERMOD output files show there were less than 5% missing data for each of the modeling power plants.

[19] USEPA, Meteorological Monitoring Guidance for Regulatory Modeling Applications, EPA-454/R-99-05, February 2000, Section 5.3.2, pp. 5-4 to 5-5.

The representativeness of airport meteorological data is a potential concern in modeling industrial source sites.[20] The surface characteristics of the airport data collection site and the modeled source location were compared. The selected meteorological data set for each plant was considered appropriate for its modeling analysis.

5. Background SO_2 Concentrations

Background concentrations were determined consistent with USEPA's Modeling Guidance for SO_2 NAAQS Designations.[21] To preserve the form of the one-hour SO_2 standard, based on the 99th percentile of the annual distribution of daily maximum one-hour concentrations averaged across the number of years modeled, the background fourth-highest daily maximum one-hour SO_2 concentration was added to the modeled fourth-highest daily maximum one-hour SO_2 concentration.[22]

Background concentrations were based on the 2008-10 design value measured by the ambient monitors located in each state where concentrations were predicted.[23]

Air quality impacts are based on a background concentration of 65.4 $\mu g/m^3$. This is the 2008-10 design value for the ambient monitor located in McCracken County. This is the lowest measured background concentration in the state and so may under-predict compliance with the NAAQS.

6. Reporting

All files from the programs used for this modeling analysis are available to regulatory agencies. These include analyses prepared with AERSURFACE, AERMET, AERMAP, and AERMOD.

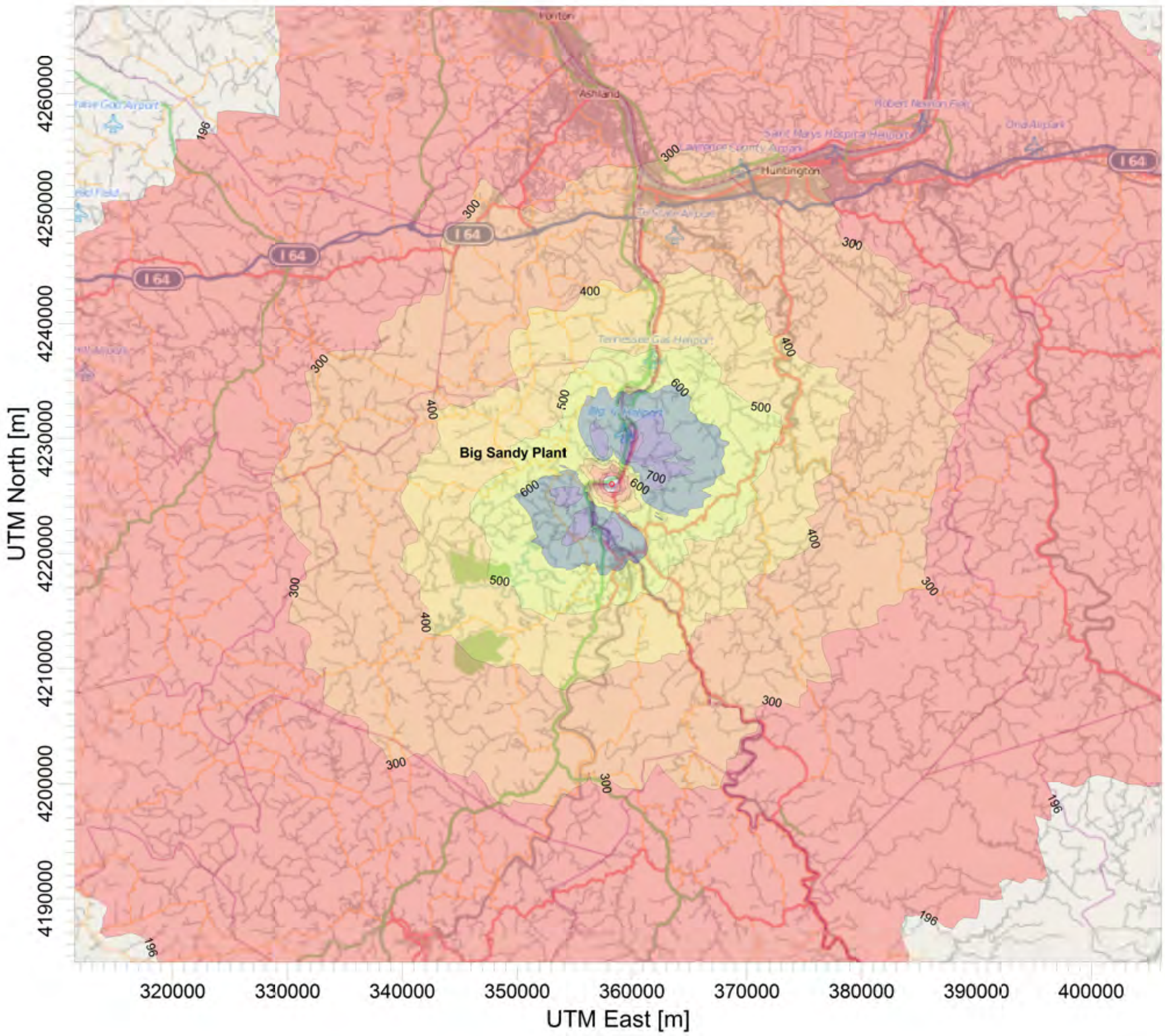
[20] USEPA, AERMOD Implementation Guide, March 19, 2009, pp. 3-4.
[21] USEPA, Area Designations for the 2010 Revised Primary Sulfur Dioxide National Ambient Air Quality Standards, Attachment 3, March 24, 2011, pp. 20-23.
[22] USEPA, Applicability of Appendix W Modeling Guidance for the 1-hour SO_2 National Ambient Air Quality Standard, August 23, 2010, p. 3.
[23] http://www.epa.gov/airtrends/values.html

Appendix A

Big Sandy Plant

Supporting Figures

Figure 1 - Regional View - Big Sandy Plant - Louisa, Kentucky
Evaluation of Compliance with the 1-hour NAAQS for SO2



1-hour Average SO2 Concentrations (ug per cubic meter) - All colored areas exceed the NAAQS.

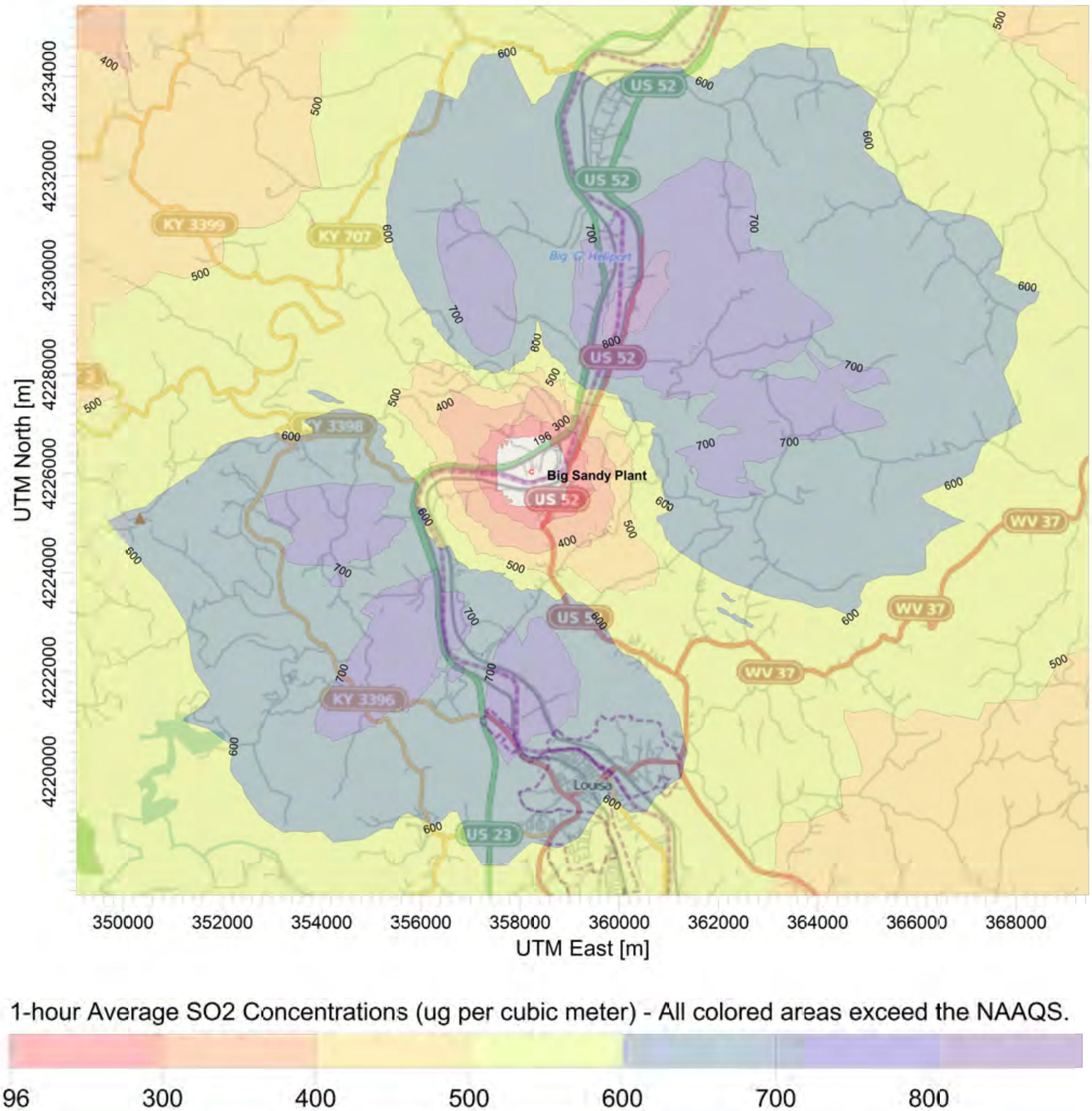
196 300 400 500 600 700 800

All concentrations include a background of 65.4 ug/m3.

Total Sources **2**	**Conducted on behalf of the Sierra Club**
Total Receptors **22083**	**by Wingra Engineering, S.C.**
Output Type **Concentration**	SCALE: 1:594,941 0 ——— 20 km
Maximum **832.53055 ug/m^3**	DATE: **12/01/11**

AERMOD View - Lakes Environmental Software

Figure 2 - Local View - Big Sandy Plant - Louisa, Kentucky
Evaluation of Compliance with the 1-hour NAAQS for SO2



All concentrations include a background of 65.4 ug/m3.

Total Sources **2**	**Conducted on behalf of the Sierra Club**	
Total Receptors **22083**	**by Wingra Engineering, S.C.**	
Output Type **Concentration**	SCALE: 0 ___ 5 km	1:128,244
Maximum **832.53055 ug/m^3**	DATE: **12/01/11**	

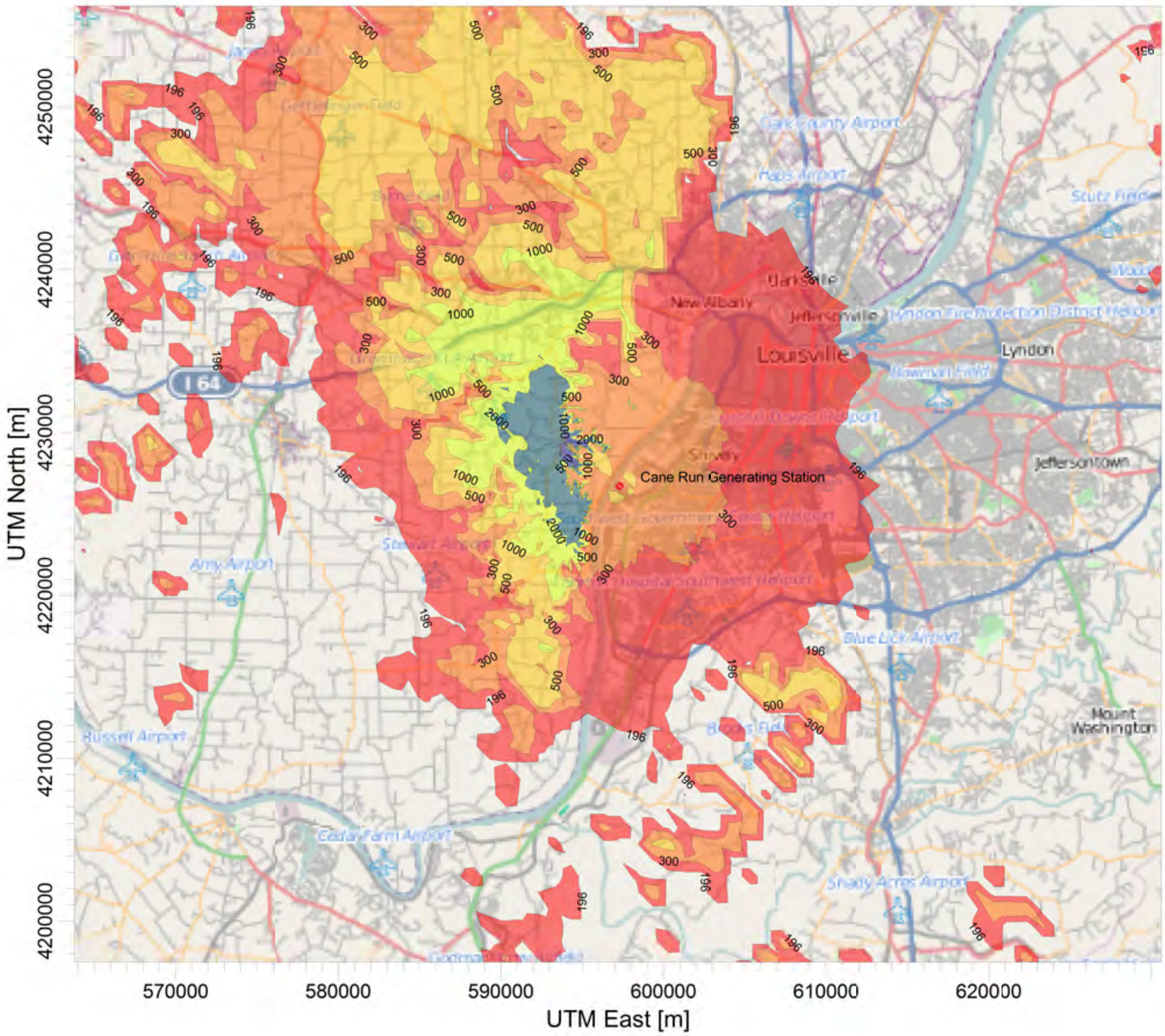
AERMOD View - Lakes Environmental Software

Appendix B

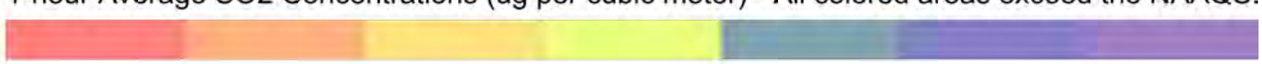
Cane Run Generating Station

Supporting Figures

Figure 1 - Regional View - Cane Run Generating Station - Louisville, Kentucky
Evaluation of Compliance with the 1-hour NAAQS for SO2



1-hour Average SO2 Concentrations (ug per cubic meter) - All colored areas exceed the NAAQS.



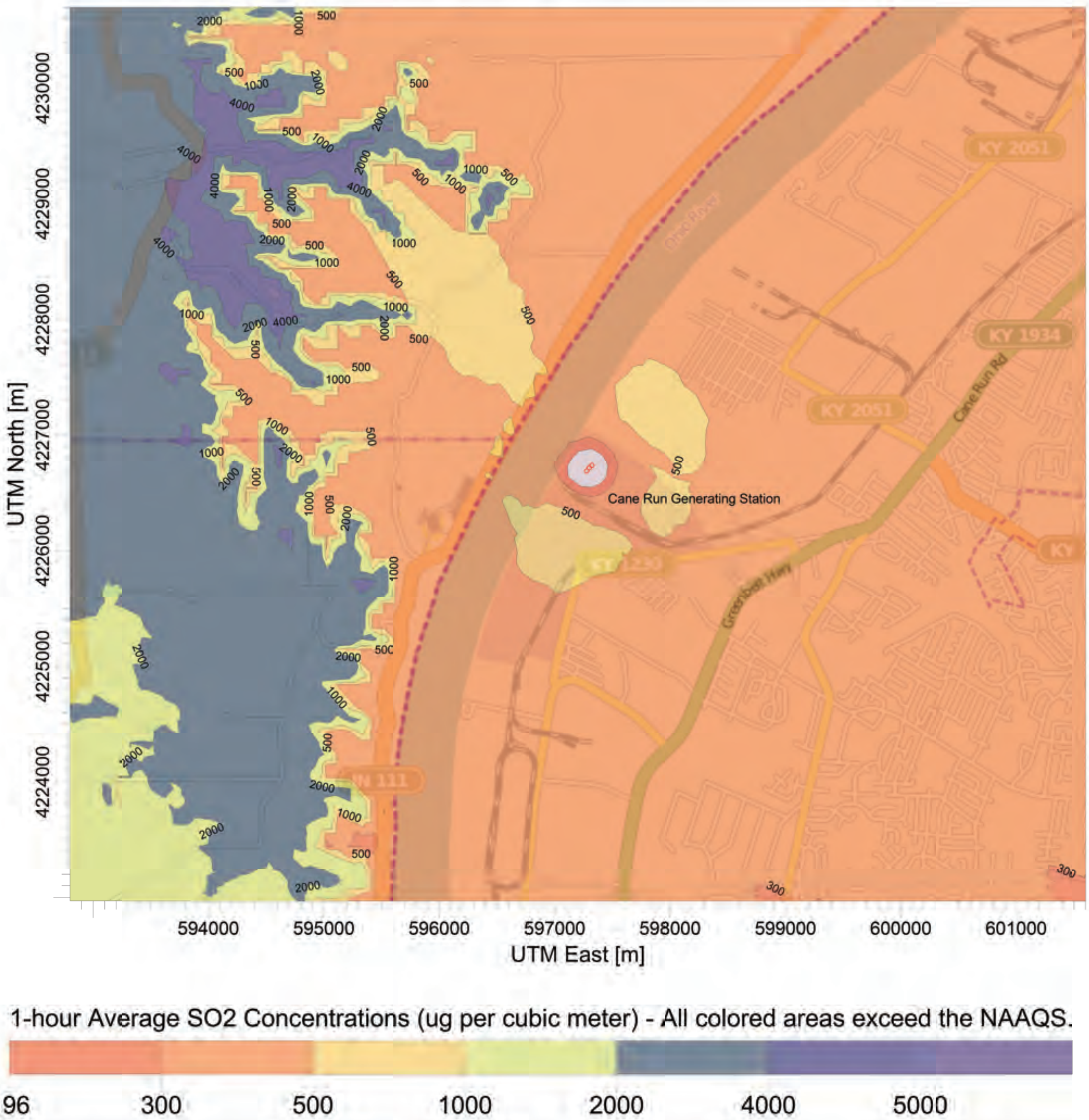
196 300 500 1000 2000 4000 5000

All concentrations include a background of 65.4 ug/m3.

Total Sources **6**	**Conducted on behalf of the Sierra Club**
Total Receptors **22083**	**Wingra Engineering, S.C.**
Output Type **Concentration**	SCALE: 1:420,106 0 — 10 km
Maximum **5263.57552 ug/m^3**	DATE: **12/07/11**

AERMOD View - Lakes Environmental Software

Figure 2 - Local View - Cane Run Generating Station - Louisville, Kentucky
Evaluation of Compliance with the 1-hour NAAQS for SO2



All concentrations include a background of 65.4 ug/m3.	Total Sources **6**	**Conducted on behalf of the Sierra Club**
	Total Receptors **22083**	**Wingra Engineering, S.C.**
	Output Type **Concentration**	SCALE: 1:55,322 0 2 km
	Maximum **5263.57552 ug/m^3**	DATE: **12/07/11**

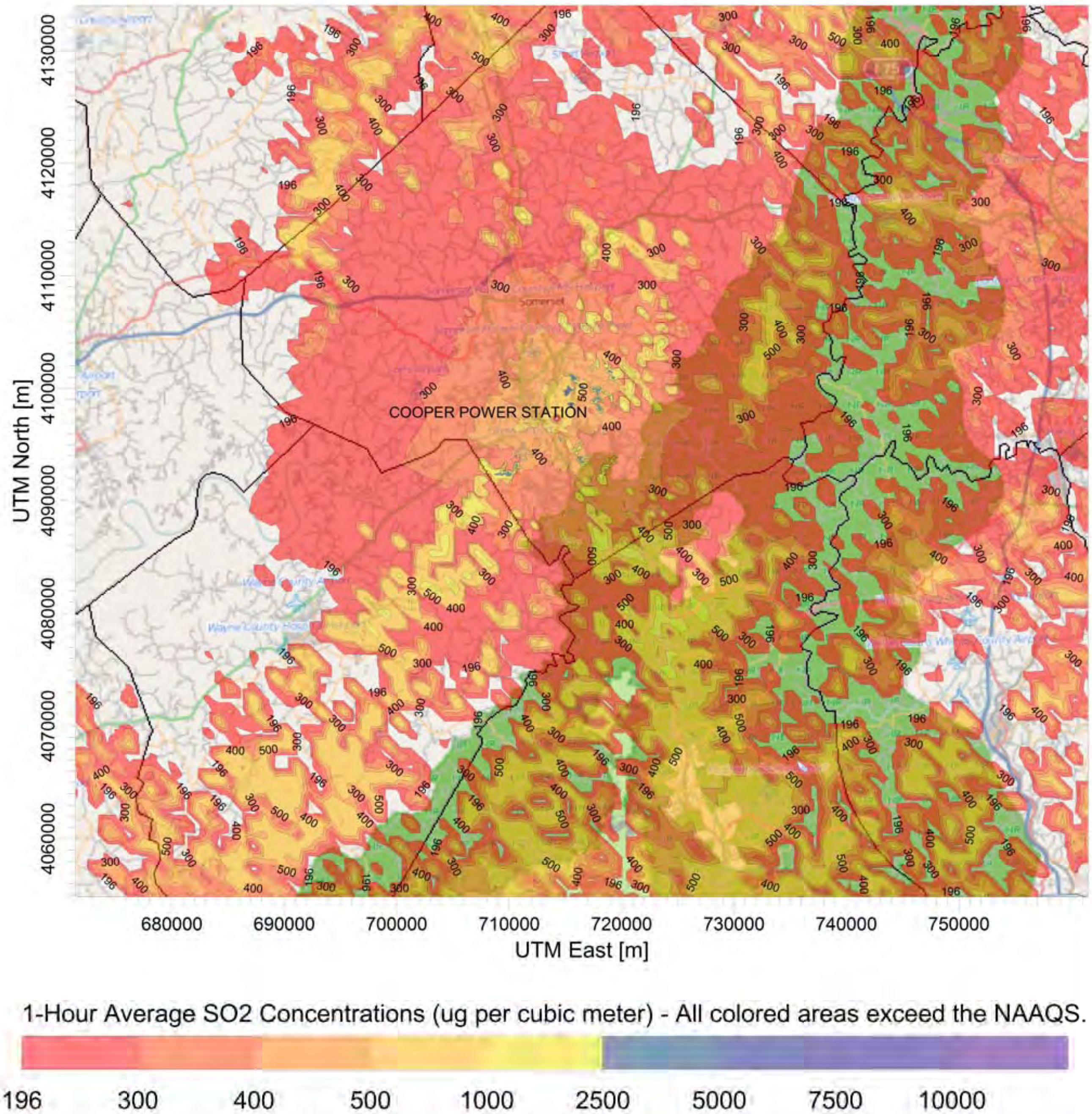
AERMOD View - Lakes Environmental Software

Appendix C

Cooper Power Station

Supporting Figures

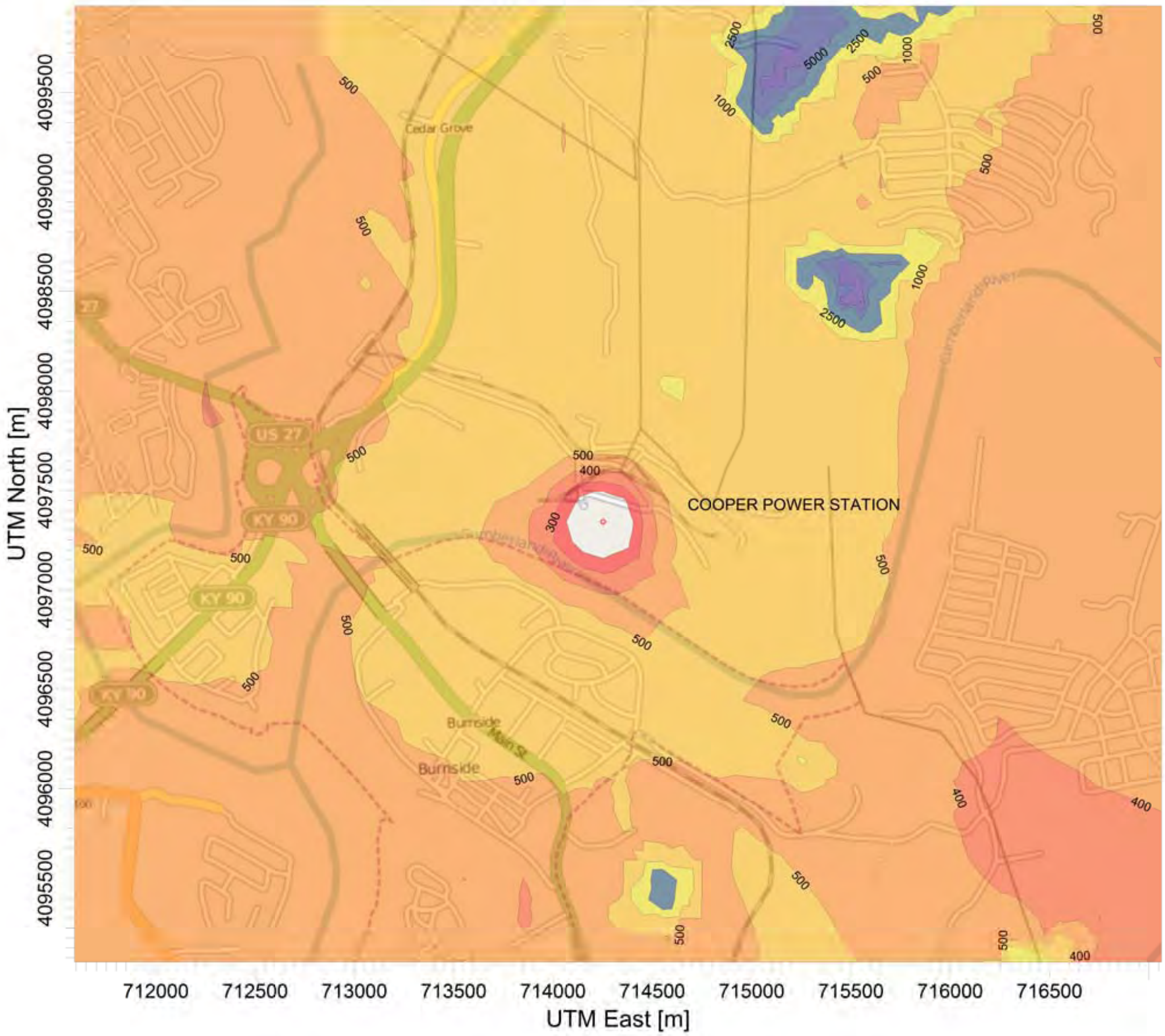
Figure 1 - Regional View - Cooper Power Station - Somerset, Kentucky
Evaluation of Compliance with the 1-hour NAAQS for SO2



All concentrations include a background of 65.4 ug/m3.	Total Sources **4**	**Conducted on behalf of the Sierra Club**	
	Total Receptors **22083**	**by Wingra Engineering, S.C.**	
	Output Type **Concentration**	SCALE: 1:566,311 0 — 20 km	
	Maximum **10164.32384 ug/m^3**	DATE: **11/22/11**	

AERMOD View - Lakes Environmental Software

Figure 2 - Local View - Cooper Power Station - Somerset, Kentucky
Evaluation of Compliance with the 1-hour NAAQS for SO2



1-Hour Average SO2 Concentrations (ug per cubic meter) - All colored areas exceed the NAAQS.

196 300 400 500 1000 2500 5000 7500 10000

All concentrations include a background of 65.4 ug/m3.	Total Sources **4**	**Conducted on behalf of the Sierra Club**	
	Total Receptors **22083**	**by Wingra Engineering, S.C.**	
	Output Type **Concentration**	SCALE: 1:34,399 0 ___ 1 km	
	Maximum **10164.32384 ug/m^3**	DATE: **11/22/11**	

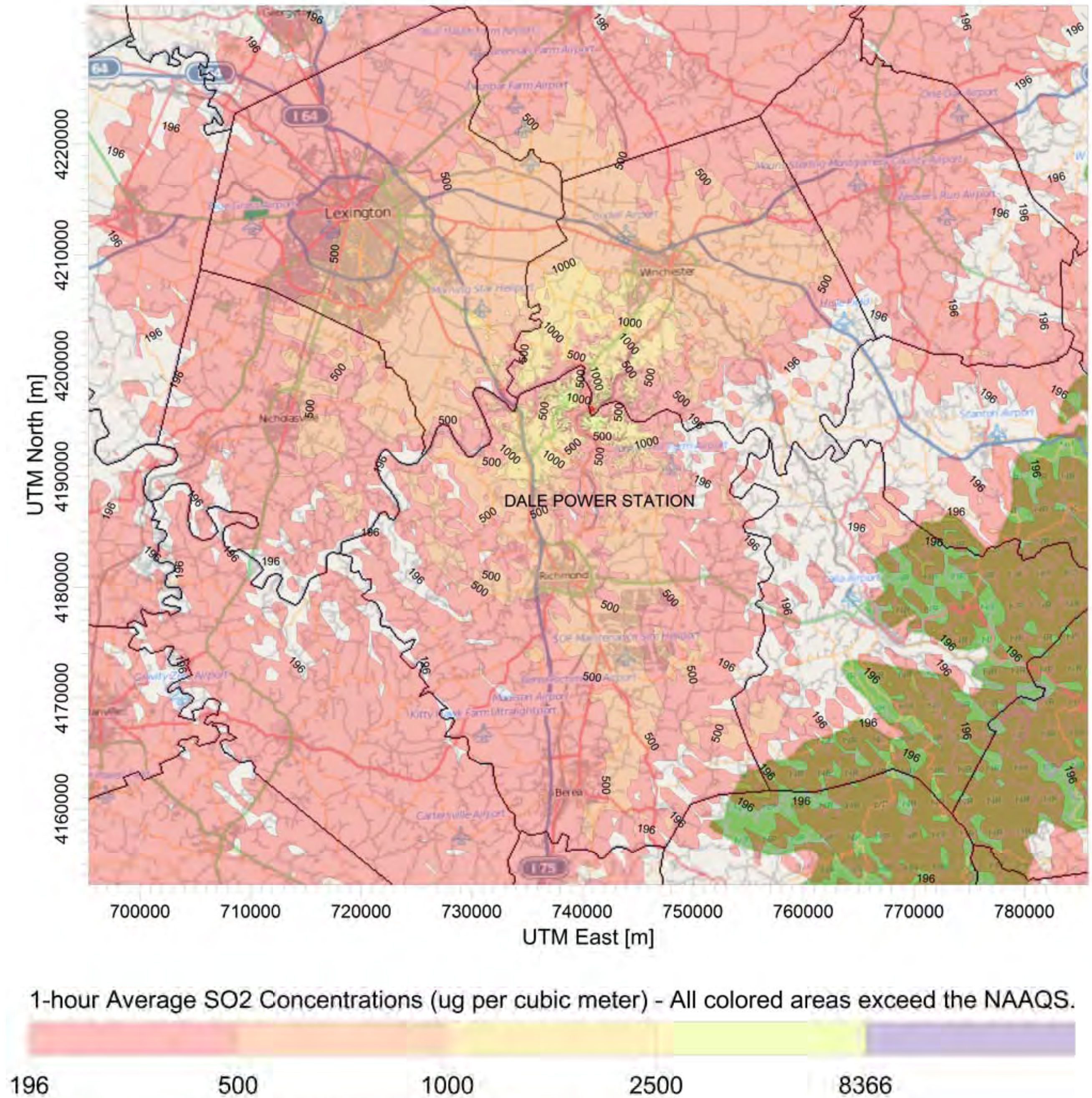
AERMOD View - Lakes Environmental Software

Appendix D

Dale Power Station

Supporting Figures

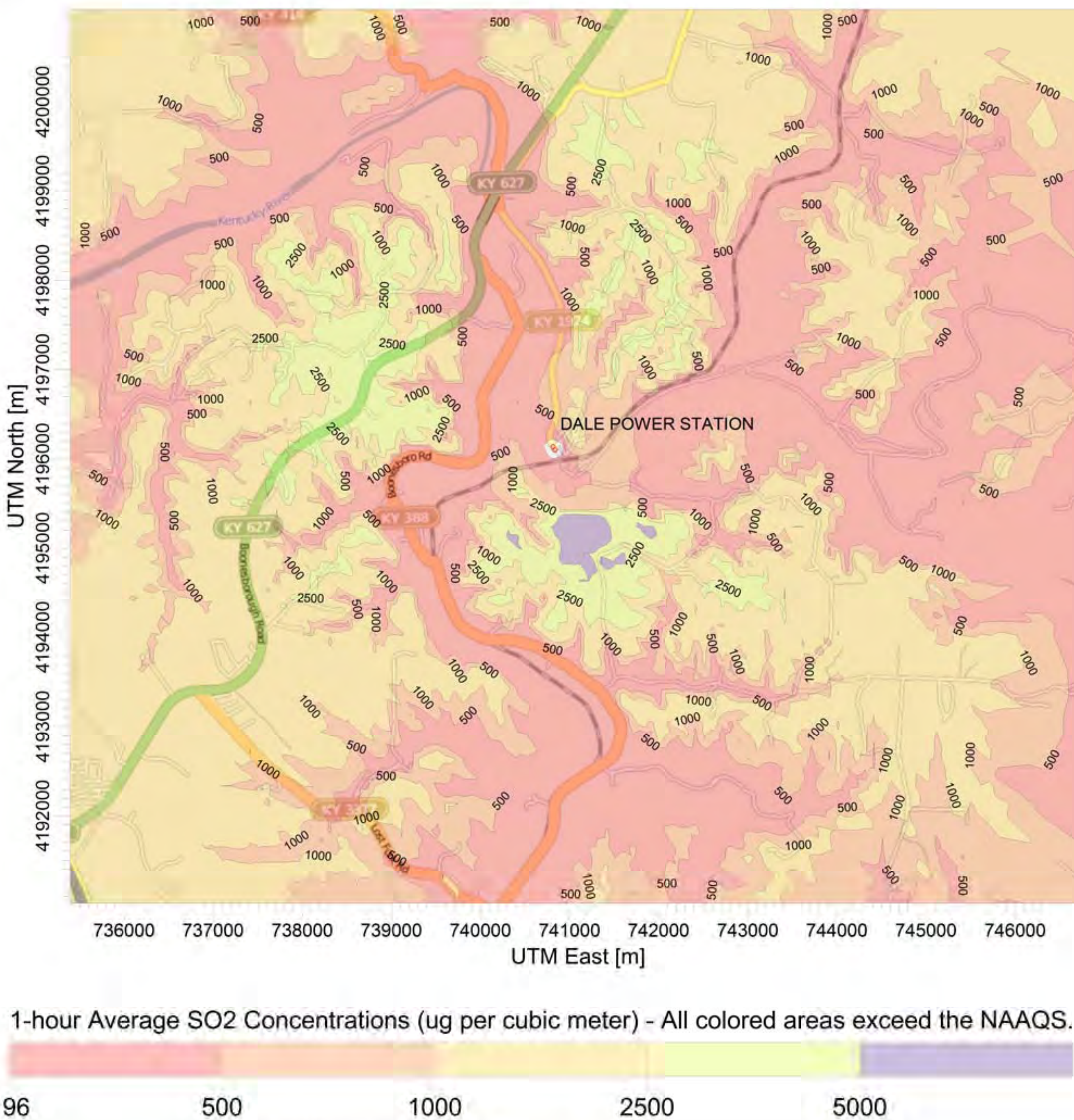
Figure 1 - Region View - Dale Power Station, Ford, Kentucky
Evaluation of Compliance with the 1-hour NAAQS for SO2



All concentrations include a background of 65.4 ug/m3.	Total Sources **4**	**Conducted on behalf of the Sierra Club**	
	Total Receptors **22083**	**by Wingra Engineering, S.C.**	
	Output Type **Concentration**	SCALE: 1:568,216 0 ▬▬ 20 km	
	Maximum **8366.27904 ug/m^3**	DATE: **10/25/2011**	

AERMOD View - Lakes Environmental Software

Figure 2 - Local View - Dale Power Station, Ford, Kentucky
Evaluation of Compliance with the 1-hour NAAQS for SO2



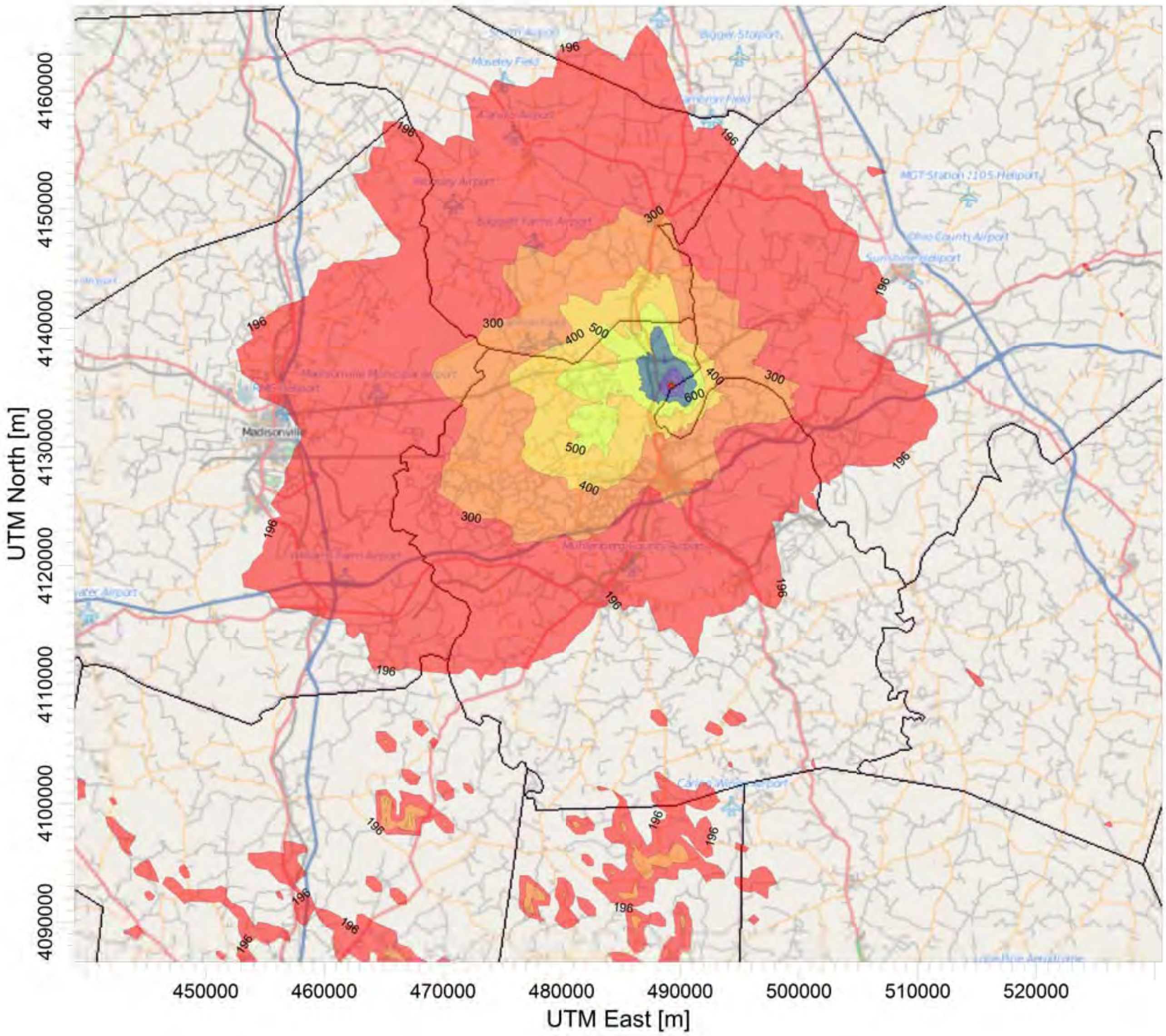
All concentrations include a background of 65.4 ug/m3.	Total Sources **4**	**Conducted on behalf of the Sierra Club**	
	Total Receptors **22083**	**by Wingra Engineering, S.C.**	
	Output Type **Concentration**	SCALE: 1:71,662 0 ___ 2 km	
	Maximum **8366.27904 ug/m^3**	DATE: **10/25/2011**	

Appendix E

Green River Generating Station

Supporting Figures

Figure 1 - Regional View - Green River Generating Station
Evaluation of Compliance with the 1-hour NAAQS for SO2



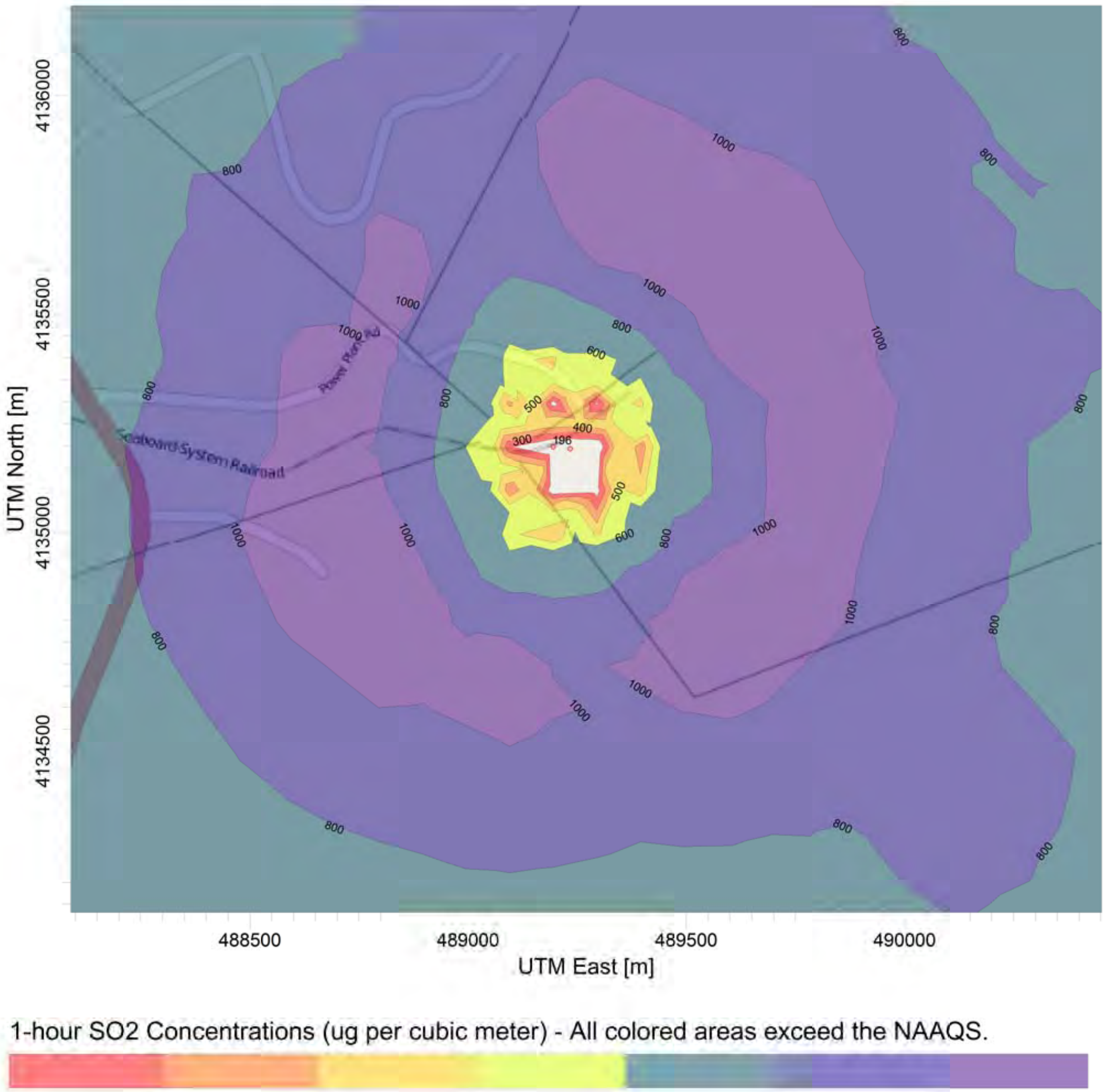
1-hour SO2 Concentrations (ug per cubic meter) - All colored areas exceed the NAAQS.

196 300 400 500 600 800 1000

All concentrations include a background of 65.4 ug/m3.	Total Sources **4**	**Conducted on behalf of the Sierra Club**	
	Total Receptors **22083**	**by Wingra Engineering, S.C.**	
	Output Type **Concentration**	SCALE: 1:576,161 0 20 km	
	Maximum **1141.73702 ug/m^3**	DATE: **11/13/2011**	

AERMOD View - Lakes Environmental Software

Figure 2 - Local View - Green River Generating Station
Evaluation of Compliance with the 1-hour NAAQS for SO2



All concentrations include a background of 65.4 ug/m3.	Total Sources **4**	**Conducted on behalf of the Sierra Club**	
	Total Receptors **22083**	**by Wingra Engineering, S.C.**	
	Output Type **Concentration**	SCALE: 1:14,847 0 ▬ 0.5 km	
	Maximum **1141.73702 ug/m^3**	DATE: **11/13/2011**	

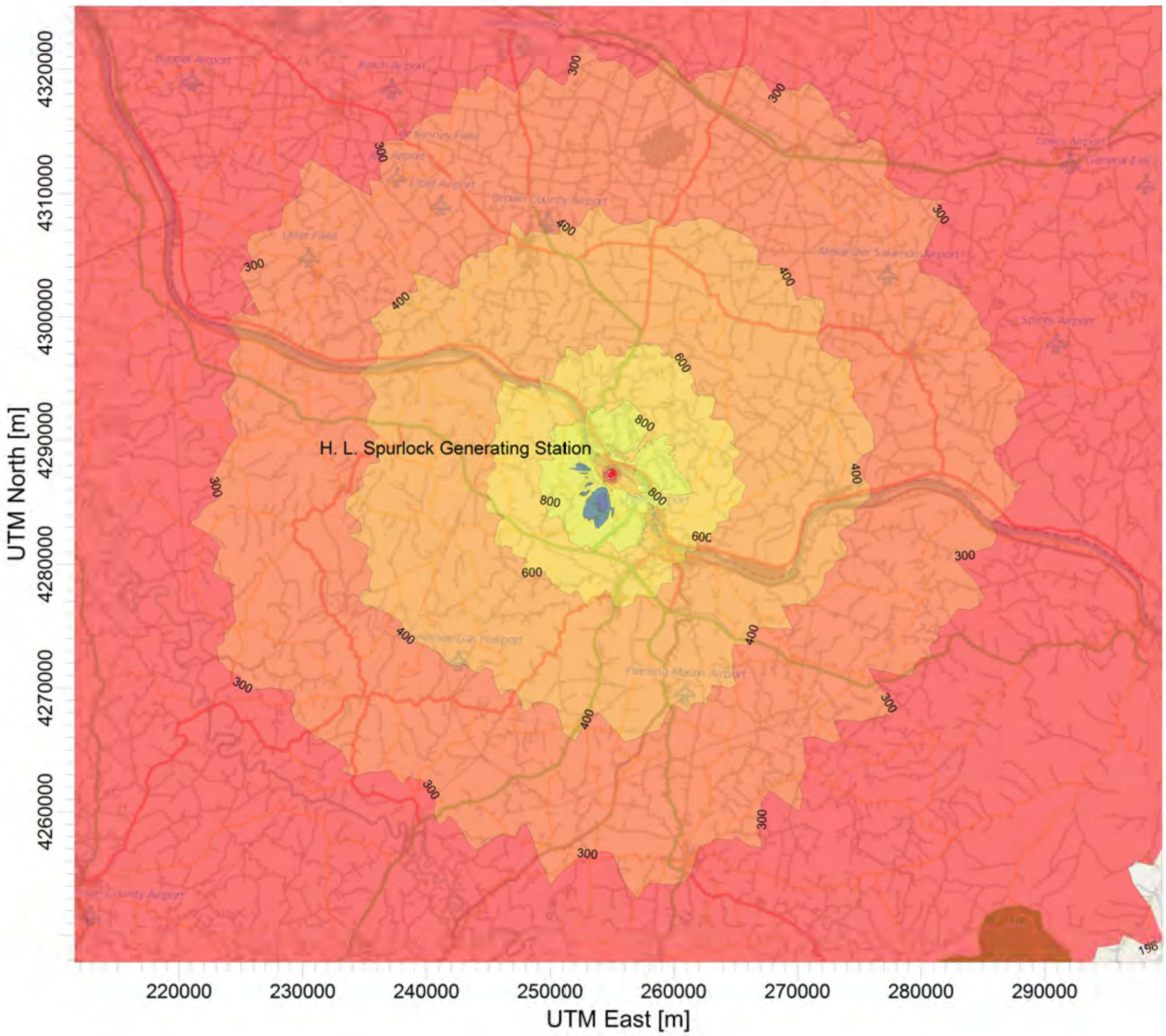
AERMOD View - Lakes Environmental Software

Appendix F

H.L. Spurlock Generating Station

Supporting Figures

Figure 1 - Regional View - H. L. Spurlock Generating Station - Maysville, Kentucky
Evaluation of Compliance with the 1-hour NAAQS for SO2



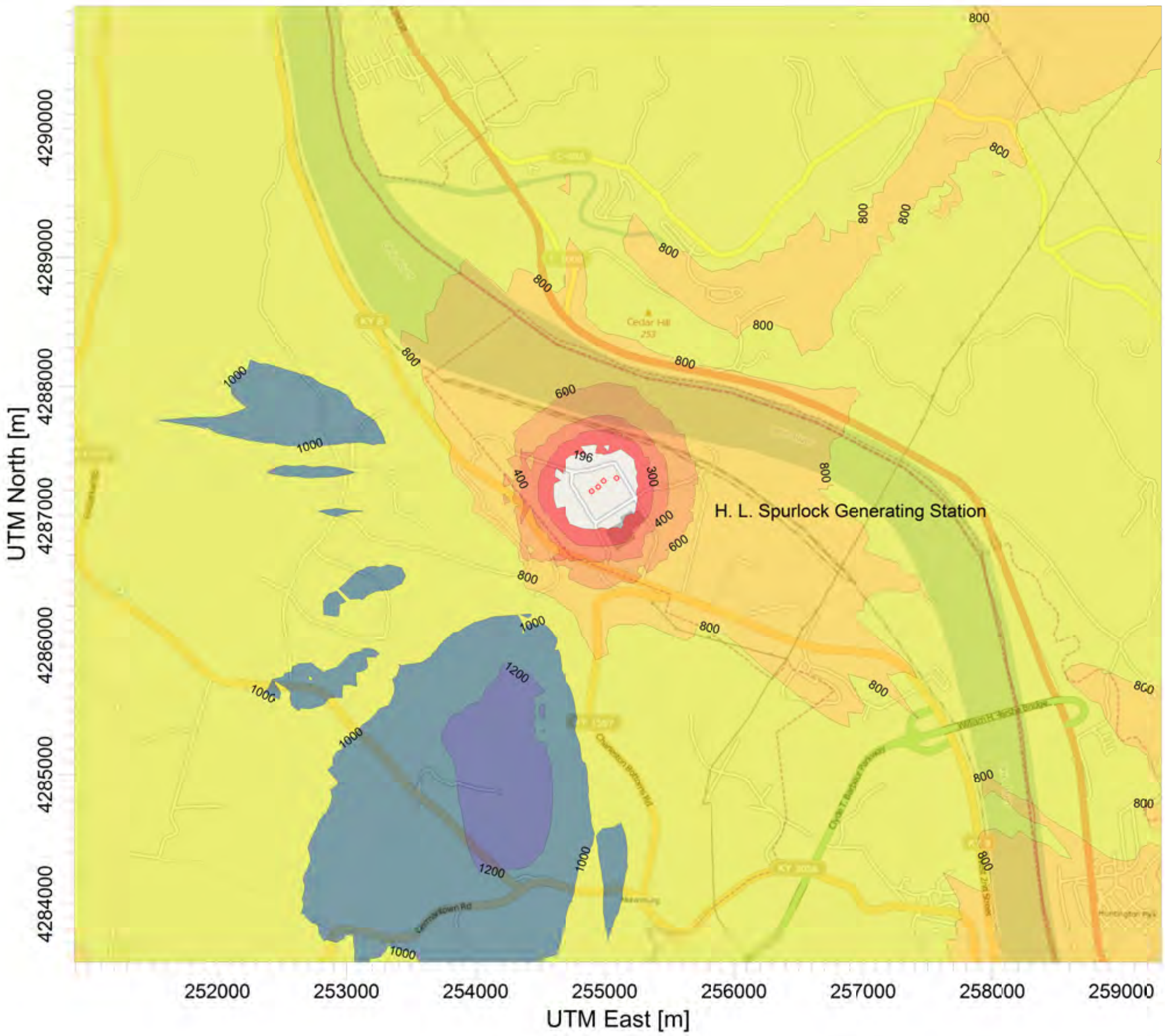
1-hour Average SO2 Concentrations (ug per cubic meter) - All colored areas exceed the NAAQS.

196 300 400 600 800 1000 1200

All concentrations include a background of 65.4 ug/m3.	Total Sources **8**	**Conducted on behalf of the Sierra Club**	
	Total Receptors **22083**	**by Wingra Engineering, S.C.**	
	Output Type **Concentration**	SCALE: 0 20 km	1:552,732
	Maximum **1335.6213 ug/m^3**	DATE: **12/16/2011**	

AERMOD View - Lakes Environmental Software

Figure 2 - Local View - H. L. Spurlock Generating Station - Maysville, Kentucky
Evaluation of Compliance with the 1-hour NAAQS for SO2



1-hour Average SO2 Concentrations (ug per cubic meter) - All colored areas exceed the NAAQS.

196 300 400 600 800 1000 1200

All concentrations include a background of 65.4 ug/m3.	Total Sources **8**	**Conducted on behalf of the Sierra Club**
	Total Receptors **22083**	**by Wingra Engineering, S.C.**
	Output Type **Concentration**	SCALE: 1:52,896 0 2 km
	Maximum **1335.6213 ug/m^3**	DATE: **12/16/2011**

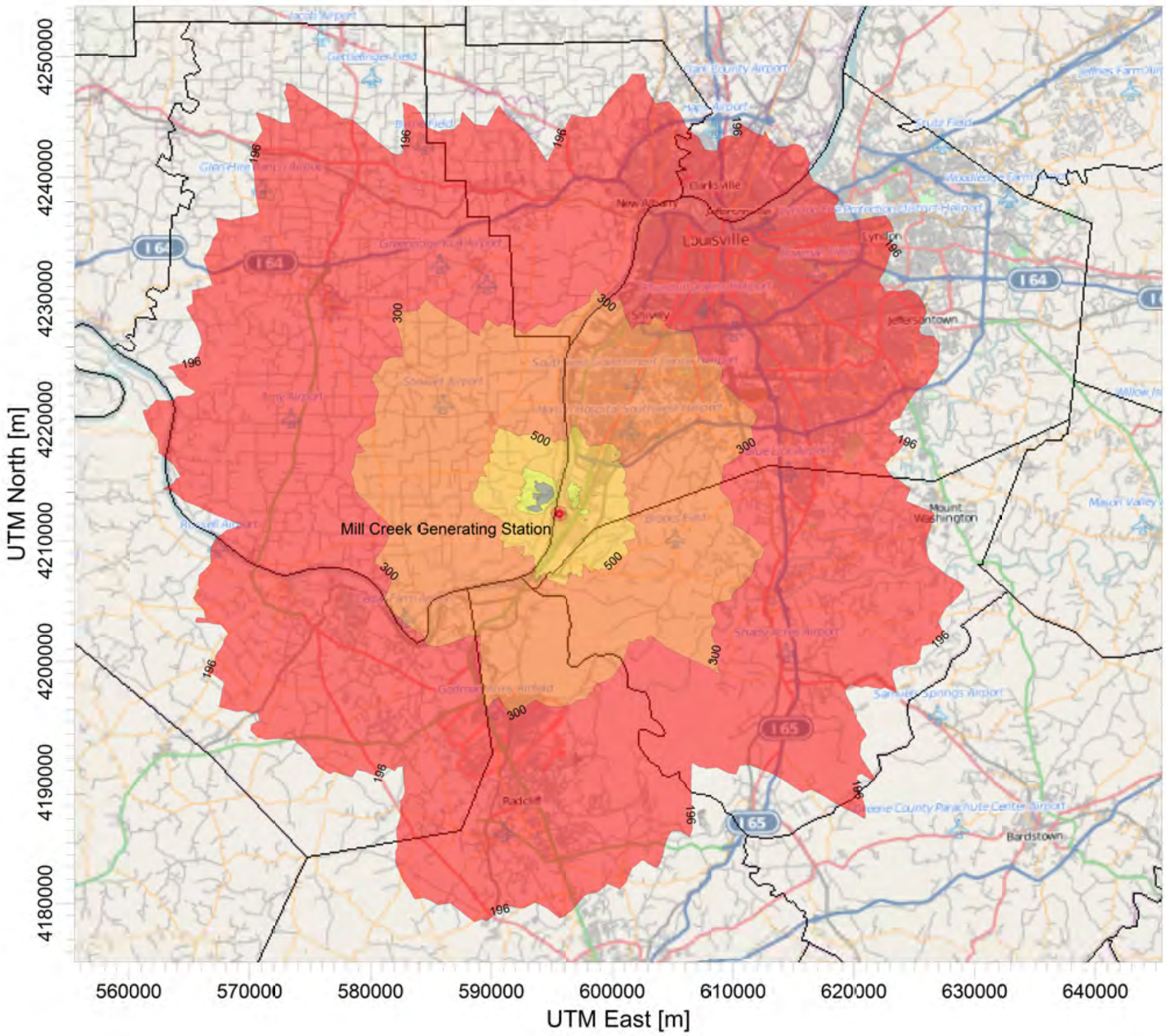
AERMOD View - Lakes Environmental Software

Appendix G

Mill Creek Generating Station

Supporting Figures

Figure 1 - Regional View - Mill Creek Generating Station - Louisville, Kentucky
Evaluation of Compliance with the 1-hour NAAQS for SO2



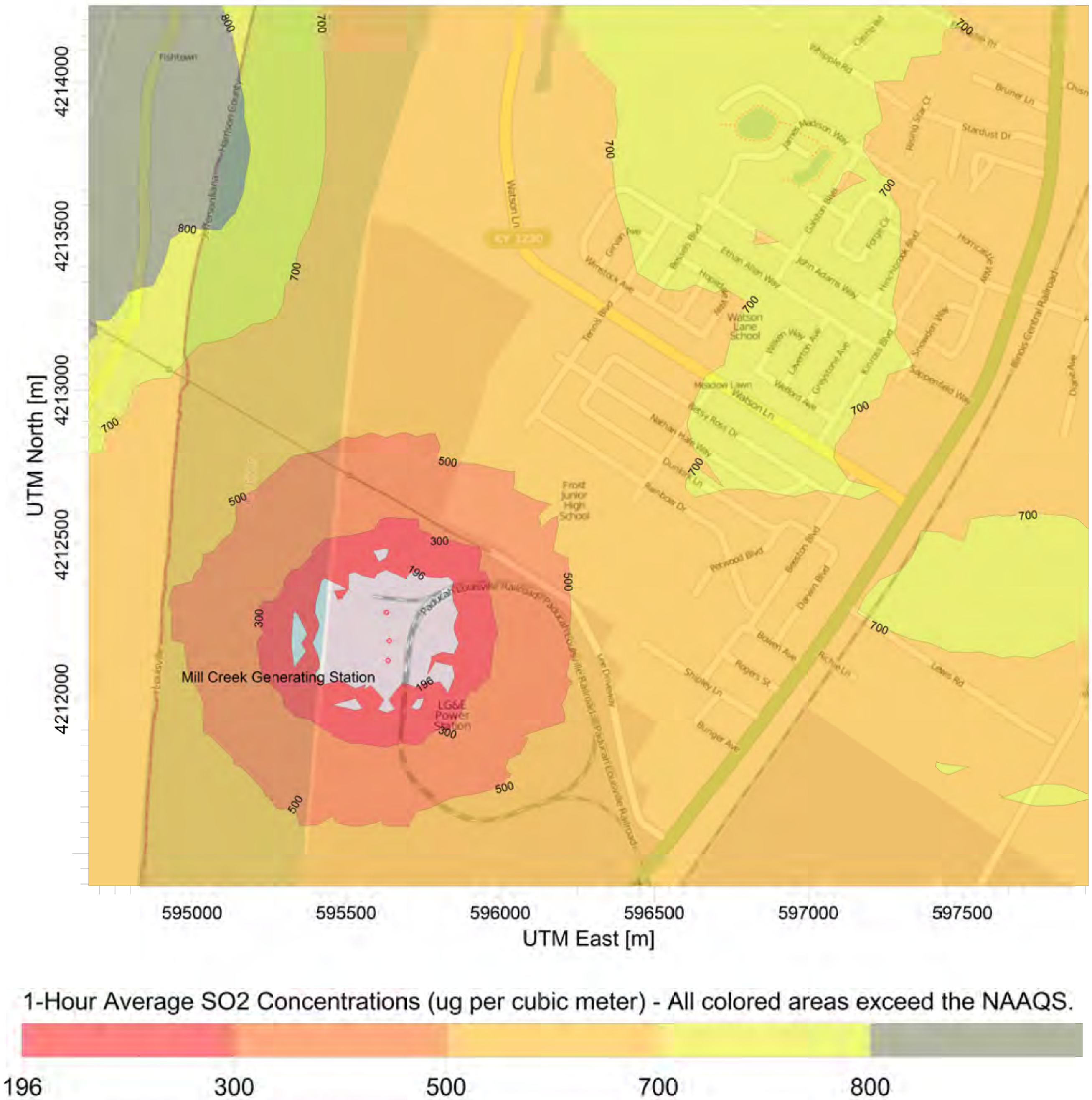
1-Hour Average SO2 Concentrations (ug per cubic meter) - All colored areas exceed the NAAQS.

196 300 500 700 800

All concentrations include a background of 65.4 ug/m3.	Total Sources **8**	**Conducted on behalf of the Sierra Club**
	Total Receptors **22083**	**by Wingra Engineering, S.C.**
	Output Type **Concentration**	SCALE: 1:565,709 0 20 km
	Maximum **895.01694 ug/m^3**	DATE: **12/9/2011**

AERMOD View - Lakes Environmental Software

Figure 2 - Local View - Mill Creek Generating Station - Louisville, Kentucky
Evaluation of Compliance with the 1-hour NAAQS for SO2



All concentrations include a background of 65.4 ug/m3.	Total Sources **8**	**Conducted on behalf of the Sierra Club**
	Total Receptors **22083**	**by Wingra Engineering, S.C.**
	Output Type **Concentration**	SCALE: 1:20,403 0 — 0.5 km
	Maximum **895.01694 ug/m^3**	DATE: **12/9/2011**

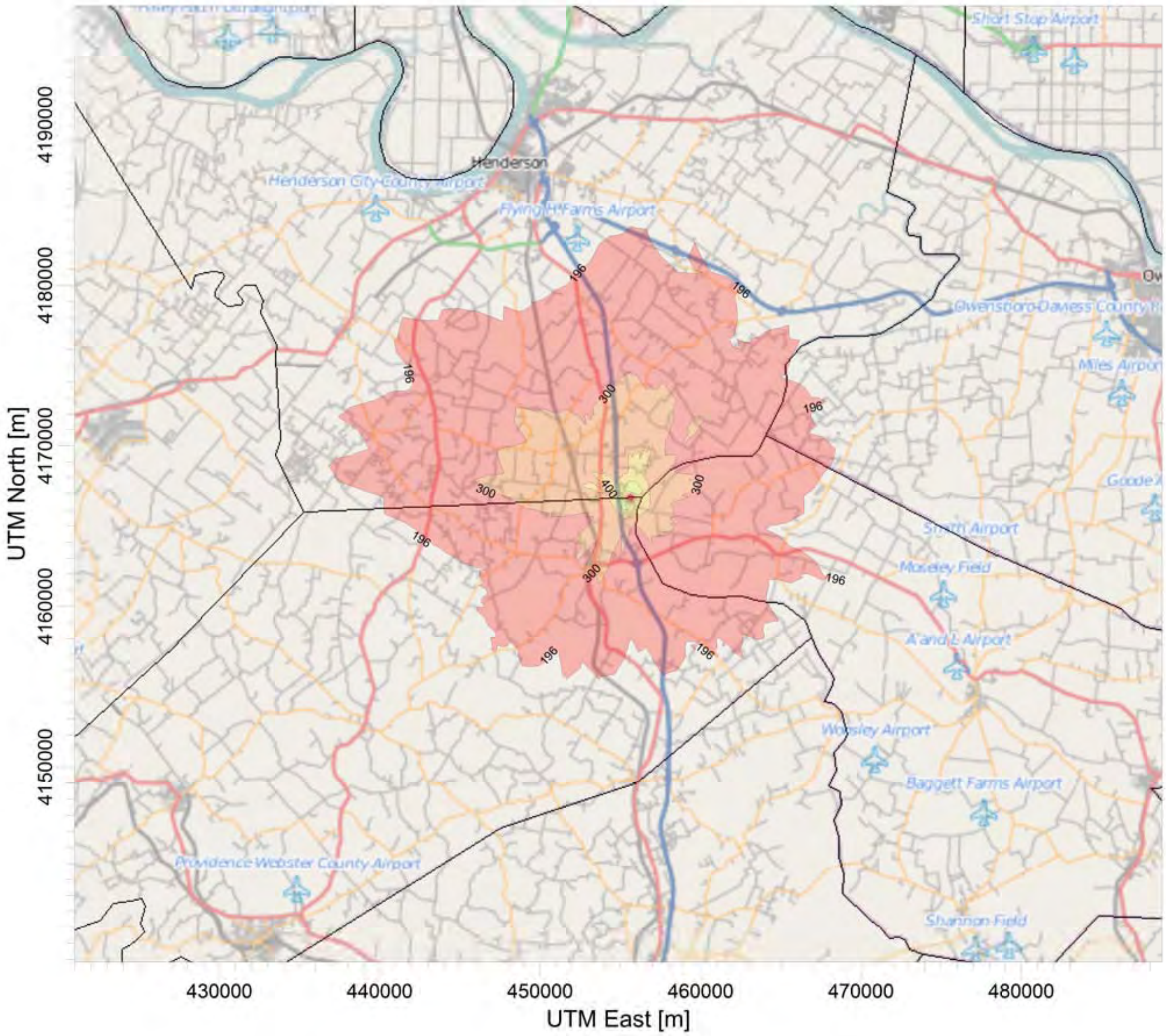
AERMOD View - Lakes Environmental Software

Appendix H

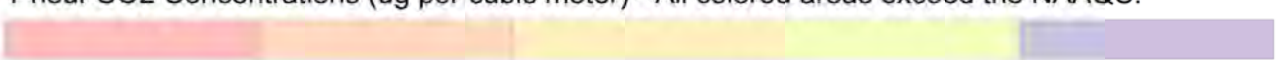
Robert Reid Power Station

Supporting Figures

Figure 1 - Regional View - Robert Reid Power Station - Robards, Kentucky
Evaluation of Compliance with the 1-hour NAAQS for SO2



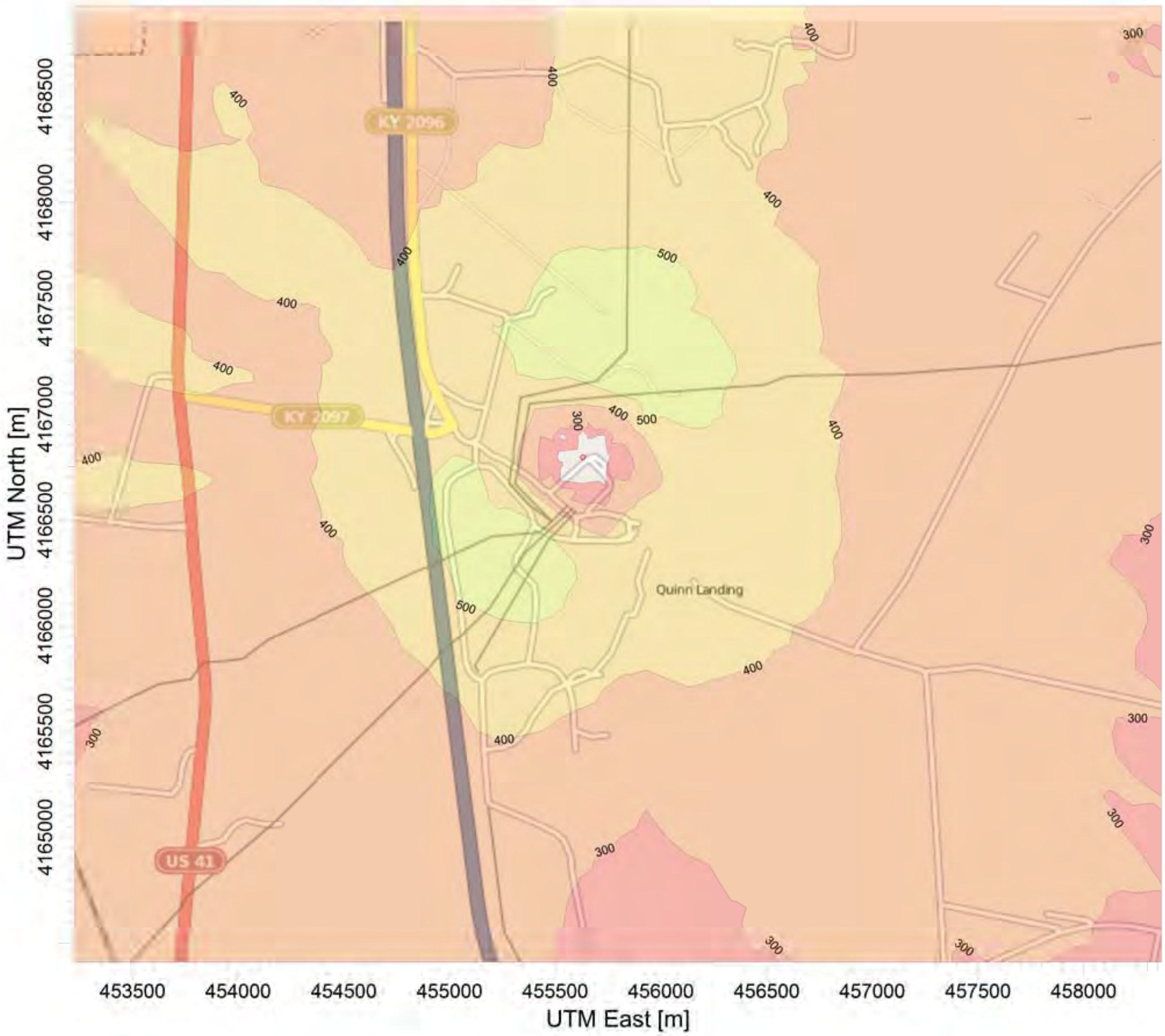
1-hour SO2 Concentrations (ug per cubic meter) - All colored areas exceed the NAAQS.



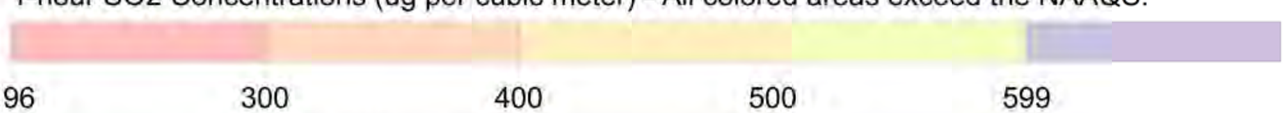
196 300 400 500 599

All concentrations include a background of 65.4 ug/m3.	Total Sources **2**	**Conducted on behalf of the Sierra Club**	
	Total Receptors **22083**	**by Wingra Engineering, S.C.**	
	Output Type **Concentration**	SCALE: 1:426,167 0 ▬ 10 km	
	Maximum **598.77398 ug/m^3**	DATE: **11/6/2011**	

Figure 2 - Local View - Robert Reid Power Station - Robards, Kentucky
Evaluation of Compliance with the 1-hour NAAQS for SO2



1-hour SO2 Concentrations (ug per cubic meter) - All colored areas exceed the NAAQS.



All concentrations include a background of 65.4 ug/m3.	Total Sources **2**	**Conducted on behalf of the Sierra Club**	
	Total Receptors **22083**	**by Wingra Engineering, S.C.**	
	Output Type **Concentration**	SCALE: 1:32,323 0 ___ 1 km	
	Maximum **598.77398 ug/m^3**	DATE: **11/6/2011**	

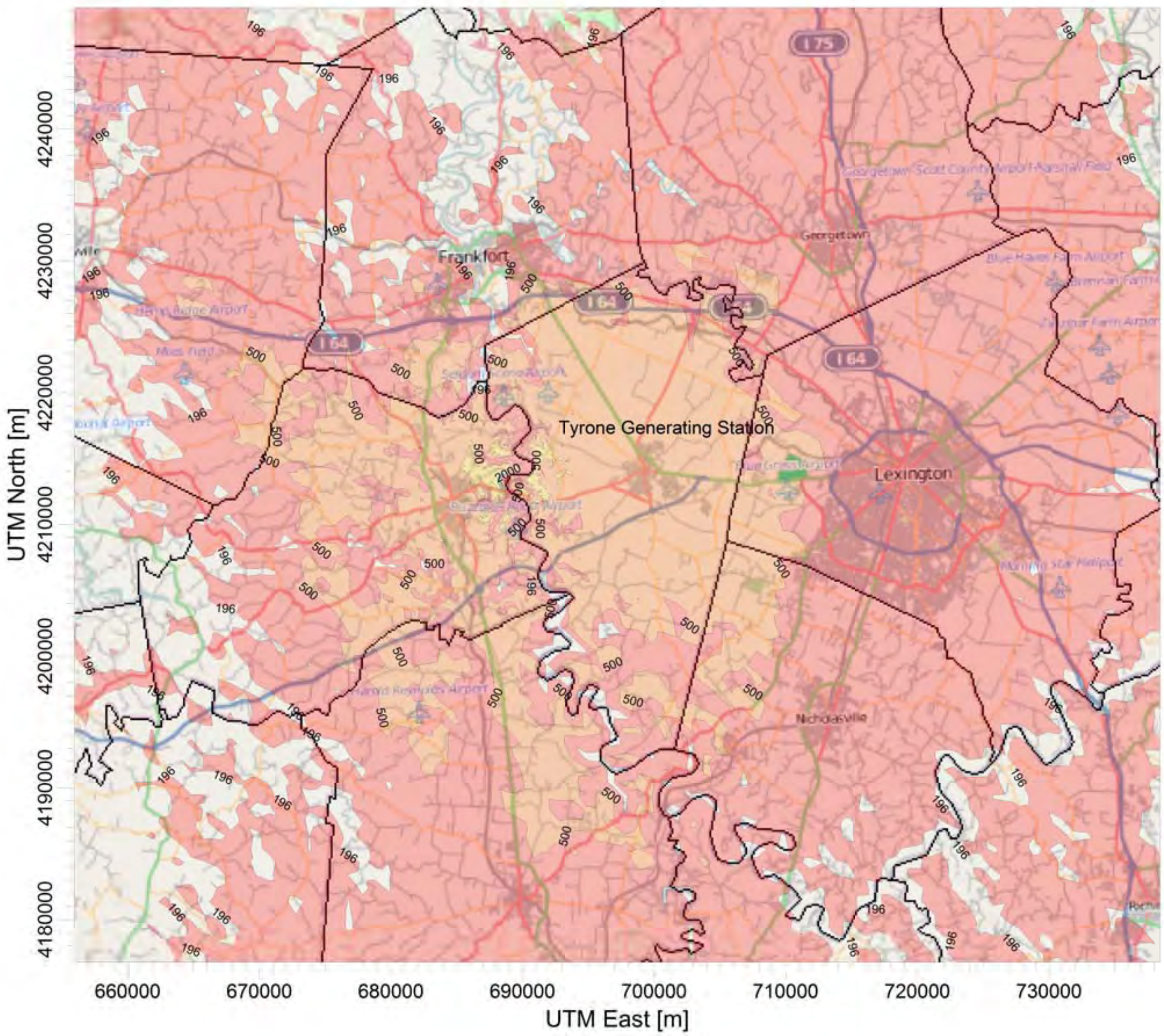
AERMOD View - Lakes Environmental Software

Appendix I

Tyrone Generating Station

Supporting Figures

Figure 1 - Regional View - Tyrone Generating Station - Lawrenceburg, Kentucky
Evaluation of Compliance with the 1-hour NAAQS for SO2



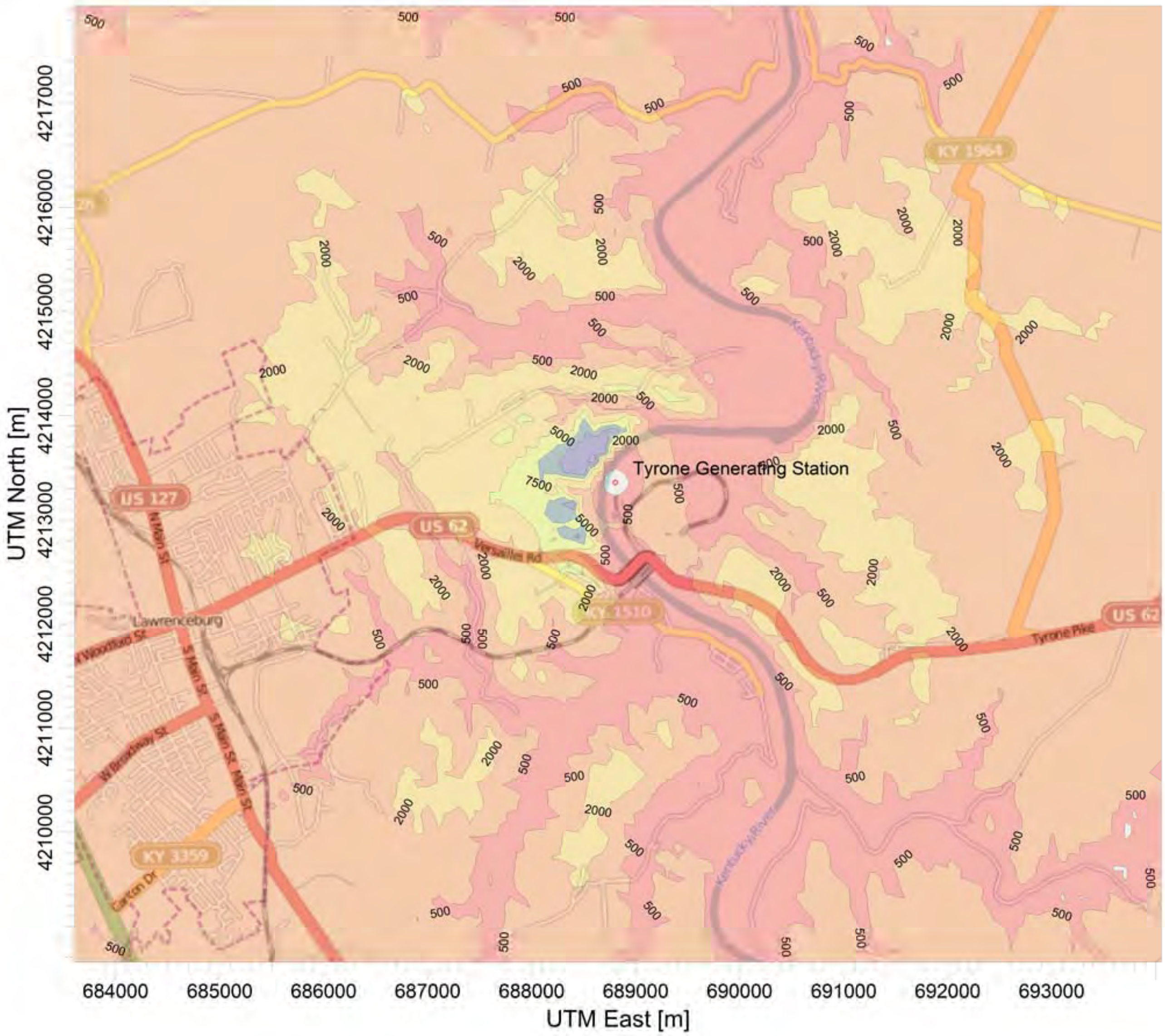
1-hour SO2 Concentrations (ug per cubic meter) - All colored areas exceed the NAAQS.

196 500 2000 5000 7500 10000 15000

All concentrations include a background of 65.4 ug/m3.	Total Sources **2**	**Conducted on behalf of the Sierra Club**	
	Total Receptors **22083**	**by Wingra Engineering, S.C.**	
	Output Type **Concentration**	SCALE: 1:518,527 0 ___ 10 km	
	Maximum **16634.19764 ug/m^3**	DATE: **10/26/2011**	

AERMOD View - Lakes Environmental Software

Figure 2 - Local View - Tyrone Generating Station - Lawrenceburg, Kentucky
Evaluation of Compliance with the 1-hour NAAQS for SO2



1-hour SO2 Concentrations (ug per cubic meter) - All colored areas exceed the NAAQS.

196 | 500 | 2000 | 5000 | 7500 | 10000 | 15000

All concentrations include a background of 65.4 ug/m3.	Total Sources **2**	**Conducted on behalf of the Sierra Club**	
	Total Receptors **22083**	**by Wingra Engineering, S.C.**	
	Output Type **Concentration**	SCALE: 1:65,692 0 ___ 2 km	
	Maximum **16634.19764 ug/m^3**	DATE: **10/26/2011**	

AERMOD View - Lakes Environmental Software

Last Page