Schiller Station

Portsmouth, New Hampshire

Sierra Club Evaluation of Compliance with 1-hour SO_2 NAAQS

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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 results and procedures for an evaluation conducted for the Schiller Station located in Portsmouth, New Hampshire.

The dispersion modeling analysis predicted ambient air concentrations for comparison with the one hour SO_2 NAAQS. The modeling was performed using the most recent version of AERMOD, AERMET, and AERMINUTE, with data provided to the Sierra Club by regulatory air agencies and through other publicly-available sources as documented below. The analysis was conducted in adherence to all available USEPA guidance for evaluating source impacts on attainment of the 1-hour SO_2 NAAQS via aerial dispersion modeling, including the AERMOD Implementation Guide; USEPA's Applicability of Appendix W Modeling Guidance for the 1-hour SO_2 National Ambient Air Quality Standard, August 23, 2010; modeling guidance promulgated by USEPA in Appendix W to 40 CFR Part 51; and, USEPA's March 2011 Modeling Guidance for SO_2 NAAQS Designations, available at http://www.epa.gov/ttn/scram/SO2%20Designations%20Guidance%202011.pdf.

2. Compliance with the One-Hour SO_2 NAAQS

2.1 One-Hour SO2 NAAQS

The one-hour SO_2 NAAQS takes the form of a three-year average of the 99^{th}-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 99^{th}-percentile of the annual distribution of daily maximum one-hour concentrations corresponds to the fourth-highest value at each receptor for a given year.

2.2 Modeling Results

Modeling results for Schiller Station are summarized in Table 1. It was determined that, based on either currently permitted emissions, proposed emission limitations or measured actual emissions, Schiller Station is estimated to create SO_2 concentrations which exceed the 1-hour NAAQS.

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[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. 11103, subroutine Modules. The conversion calculation is $75/0.3823 = 196.2\ \mu g/m^3$.

The currently approved, proposed, and measured actual emission rates used for the modeling analysis are summarized in Table 2. Based on the modeling results using the current allowable emissions, emission reductions from current rates considered necessary to achieve compliance with the 1-hour NAAQS were calculated and presented in Table 3.

Based on either the current allowable or proposed allowable emissions, predicted exceedences of the 1-hour NAAQS for SO_2 extend out to a distance of 50 kilometers throughout the region in the states of New Hampshire and Maine. Figure 1 in the appendix to this report shows the extent of NAAQS violations throughout the entire 50 kilometer modeling domain. The predicted concentrations in this figure do not include any background concentration. The extent of NAAQS violations will vary depending on the applicable background concentration for the area. For New Hampshire, the background concentration is assumed to be 130.8 $\mu g/m^3$ so NAAQS violations occur at 65.4 $\mu g/m^3$. or higher. This is the design value measured during 2008 to 2010 at the monitor located at Pierce Island in Portsmouth, Rockingham County, New Hampshire. A modeling evaluation of this background concentration showed only a 2% contribution by SO_2 emissions from Schiller Station.

For Maine, the background concentration is 10.5 $\mu g/m^3$ so NAAQS violations occur at 185.7 $\mu g/m^3$ or higher. This is the design value measured during 2008 to 2010 at the monitor located in Bar Harbor, Hancock County, Maine.

Figure 2 in the appendix shows NAAQS violations occurring in Kittery, Maine. The predicted concentrations incorporate a background concentration of 10.5 $\mu g/m^3$.

Figures 3 and 4 provide regional and local results based on the proposed allowable emissions.[4]

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:

- Use of 24-hour average allowable emissions to determine compliance with the 1-hour average NAAQS. Emissions during any 1-hour period may be higher than assumed for the modeling analysis.
- 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 off-site sources. These other sources of SO_2 will increase the predicted impacts.

- No consideration of one-minute wind speeds to reduce calm or missing wind speed measurements. AERMOD does not simulate dispersion under calm or missing wind conditions. There is no estimated concentration for these hours even though low wind speeds may result in high air quality impacts.

Table 1 - SO_2 Modeling Results for Schiller Station Modeling Analysis

Location	Emission Rates	Averaging Period	99th Percentile 1-hour Daily Maximum ($\mu g/m^3$)				Complies with NAAQS?
			Impact	Background	Total	NAAQS	
New Hampshire	Allowable[3]	1-hour	459.5	130.8	590.3	196.2	No
	Allowable[4]	1-hour	361.5	130.8	492.3	196.2	No
	Maximum	1-hour	316.9	130.8	447.7	196.2	No
Maine	Allowable[3]	1-hour	652.5	10.5	663.0	196.2	No
	Allowable[4]	1-hour	542.5	10.5	553.0	196.2	No
	Maximum	1-hour	444.8	10.5	455.3	196.2	No
Massachu-setts	Allowable[3]	1-hour	63.2	26.2	89.4	196.2	Yes
	Allowable[4]	1-hour	52.5	26.2	78.7	196.2	Yes
	Maximum	1-hour	43.2	26.2	69.4	196.2	Yes

Table 2 - Modeled SO_2 Emissions from Schiller Station

Stack ID	Unit ID	Allowable Emissions[3] 24-hour Average (lbs/hr)	Allowable Emissions[4] 24-hour Average (lbs/hr)	Maximum Emissions[5] 1-hour Average (lbs/hr)
S01	Unit 4	1,664.6	1,377.6	971.2
S02	Unit 5	76.2	76.2	66.1
S03	Unit 6	1,664.6	1,377.6	1,286.9
Total		3,405.4	2,831.4	2,324.2

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3 Allowable emissions are based on 24-hour average limitations in Title V Operating Permit TV-OP-053 issued March 9, 2007 by NHDES. Unit 4 and 6 allowable emissions are 2.9 lbs per mmbtu.

4 Allowable emissions are based on 24-hour average limitations in Draft Temporary Operating Permit TP-0106 issued July 24, 2012 by NHDES. Unit 4 and 6 allowable emissions are 2.4 lbs per mmbtu.

5 Maximum emission rate is based on measured hourly rates reported for 2010 in USEPA, Clean Air Markets - Data and Maps.

Table 3 - Required Emission Reductions for Compliance with 1-hour SO_2NAAQS

Location	Acceptable Impact (NAAQS - Background) 99th Percentile 1-hour Daily Max ($\mu g/m^3$)	Required Total Facility Maximum Emission Reduction (%)	Required Total Facility Maximum Emission Rate (lbs/hr)	Required Total Facility Maximum Emission Rate (lbs/mmbtu)
New Hampshire	66.4	86%	492.1	0.41
Maine	185.7	72%	969.2	0.81

Note: Required emission reductions are derived from modeling results based on the current allowable emissions.[3]

3. Modeling Methodology

3.1 Air Dispersion Model

The modeling analysis used USEPA's AERMOD program, version 11103. 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.[6] 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.

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[6] 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.

3.3 Output Options

The AERMOD analysis was based on five years of recent meteorological data. The surface measurements were obtained from the Portsmouth International Airport at Pease located 2 miles from Schiller Station and were supplemented with upper air measurements from the station at Gray, Maine. 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, the MXDYBYYR and MAXDCONT output options were used to create a table of fourth-high one-hour SO_2 impacts.[7] This provided a file of one-hour SO_2 concentrations consistent with the form of the one-hour SO_2 NAAQS. It is from these files that the maximum one-hour SO_2 value was determined and reported. Please see Table 1 for the modeling results. This file also provided the data necessary for preparing air concentration isopleths. Please see Figure 1 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 New Hampshire Department of Environmental Services. 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. The site was not obviously rural or urban, so 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% of the area within 3 kilometers has urban land uses. Otherwise, rural dispersion coefficients are appropriate.[8]

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[7] USEPA, Area Designations for the 2010 Revised Primary Sulfur Dioxide National Ambient Air Quality Standards, Attachment 3, March 24, 2011, pp. 24-26.
[8] 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.

USEPA's AERSURACE model Version 08009 was used to develop the meteorological data for the modeling analysis. This model evaluates surrounding land use and provides a summary of land use types within 3 kilometers. Based on the output from the AERSURFACE, approximately 14% of surrounding land use around the facility is considered urban. Since this is less than 50%, rural dispersion coefficients were used for modeling the facility. 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: 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 are summarized in Table 4.

Table 4 – Schiller Station Stack Parameters and Emissions

Description	Unit 4	Unit 5	Unit 6
X Coord. [m]	354822	354845	354841
Y Coord. [m]	4773170	4773124	4773144
Base Elevation [m]	7.95	7.31	6.6
Release Height [m]	68.89	69.19	68.89
Gas Exit Temperature [°K]	450	431.483	450
Gas Exit Velocity [m/s]	21.555	25.24	21.555
Inside Diameter [m]	2.44	2.44	2.44
Current Allowable Emission Rate [g/s]	209.7	9.6	209.7
Proposed Allowable Emission Rate [g/s]	173.5	9.6	173.5
Maximum Emission Rate [g/s]	122.4	8.3	162.1

The above stack parameters and emissions were obtained from regulatory agency permit files and files from prior modeling analyses.[9] [10] 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. When possible, stack parameters such as emission rates,

[9] NHDES, Title V Operation Permit TV-OP-053, March 9, 2007.

[10] AERMOD modeling files provided by NHDES for the 2006 NWPP analysis for the PSNH Schiller Wood Fired Boiler.

diameters, and exit flow rates were checked for accuracy.

4.3 Building Dimensions and GEP

Modeling files were provided by the regulatory agency and included results from a prior downwash analysis. These results were incorporated into the AERMOD analysis presented in this report.

4.4 Receptors

For Schiller Station, three receptors grids were employed:

1. A 100-meter Cartesian receptor grid centered on Schiller Station and extending 5 kilometers.
2. A 500-meter Cartesian receptor grid centered on Schiller Station and extending 10 kilometers.
3. A 1000-meter Cartesian receptor grid centered on Schiller Station and extending 50 kilometers.

A flagpole height of 1.5 meters was used for all these receptors in the 5, 10 and 50 kilometer grids.

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

The applicable state air regulatory agency was contacted to determine the availability of existing AERMOD-ready meteorological data files. NHDES originally provided files from the 1990 to 1994 period for the Portsmouth International Airport at Pease. This is located approximately 2 miles west of Schiller Station.

To improve the accuracy of the modeling analysis, new meteorological data from the most recently available measurements at the airport, 2006 to 2010, were used. One-minute ASOS data were not available for this airport so USEPA methods were not used to reduce calm and missing hours.[11] AERMOD does not simulate dispersion under calm or missing wind conditions. There is no estimated concentration for these hours even though low wind speeds may result in high air quality impacts.

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

The meteorological data was 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. 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

We used 2006 through 2010 Integrated Surface Hourly (ISH) data obtained from the National Climatic Data Center (NCDC). From the ISH dataset, data from the airport site were extracted.

The ISH surface data was processed through AERMET Stage 1, which performs data extraction and quality control checks.

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.

For Schiller Station, the concurrent 2006 through 2010 upper air data from twice-daily radiosonde measurements obtained at the closest and most representative location were used. This location was the Gray, Maine measurement station. These data are in Forecast Systems Laboratory (FSL) format and were downloaded in ASCII text format from NOAA's FSL website.[12] All reporting levels were downloaded and processed with AERMET.

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.

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

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 monthly periods using 30-degree sectors. Seasonal moisture conditions were considered average with 3 months of snow cover.

4.5.4 Data Review

Missing meteorological data were not filled as the data file met USEPA's 90% data completeness requirement.[13] The AERMOD output file shows there was 7.9% missing data.

The representativeness of airport meteorological data is a potential concern in modeling industrial source sites.[14] The surface characteristics of the airport data collection site and the modeled source location were compared. Since Portsmouth International Airport at Pease is extremely close to Schiller Station (i.e. 2 miles), this meteorological data set was considered appropriate for this modeling analysis.

5. Background SO_2 Concentrations

Background concentrations were determined consistent with USEPA's Modeling Guidance for SO_2 NAAQS Designations.[15] 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.[16]

Background concentrations were based on the 2008-10 design value measured by the ambient monitors located in New Hampshire, Maine and Massachusetts.[17]

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[13] 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.
[14] USEPA, AERMOD Implementation Guide, March 19, 2009, pp. 3-4.
[15] USEPA, Area Designations for the 2010 Revised Primary Sulfur Dioxide National Ambient Air Quality Standards, Attachment 3, March 24, 2011, pp. 20-23.
[16] USEPA, Applicability of Appendix W Modeling Guidance for the 1-hour SO_2 National Ambient Air Quality Standard, August 23, 2010, p. 3.
[17] http://www.epa.gov/airtrends/values.html

The background concentration for New Hampshire is the design value measured during 2008 to 2010 at the monitor located at Pierce Island in Portsmouth, Rockingham County, New Hampshire. This monitor is located approximately 4 kilometers southeast of Schiller Station, so a modeling evaluation was conducted to determine if SO2 emissions from Schiller Station contributed to this design value. It was estimated that only 2% of the design value was contributed by Schiller Station.

The background concentration for Maine is the design value measured during 2008 to 2010 at the monitor located in Bar Harbor, Hancock County, Maine.

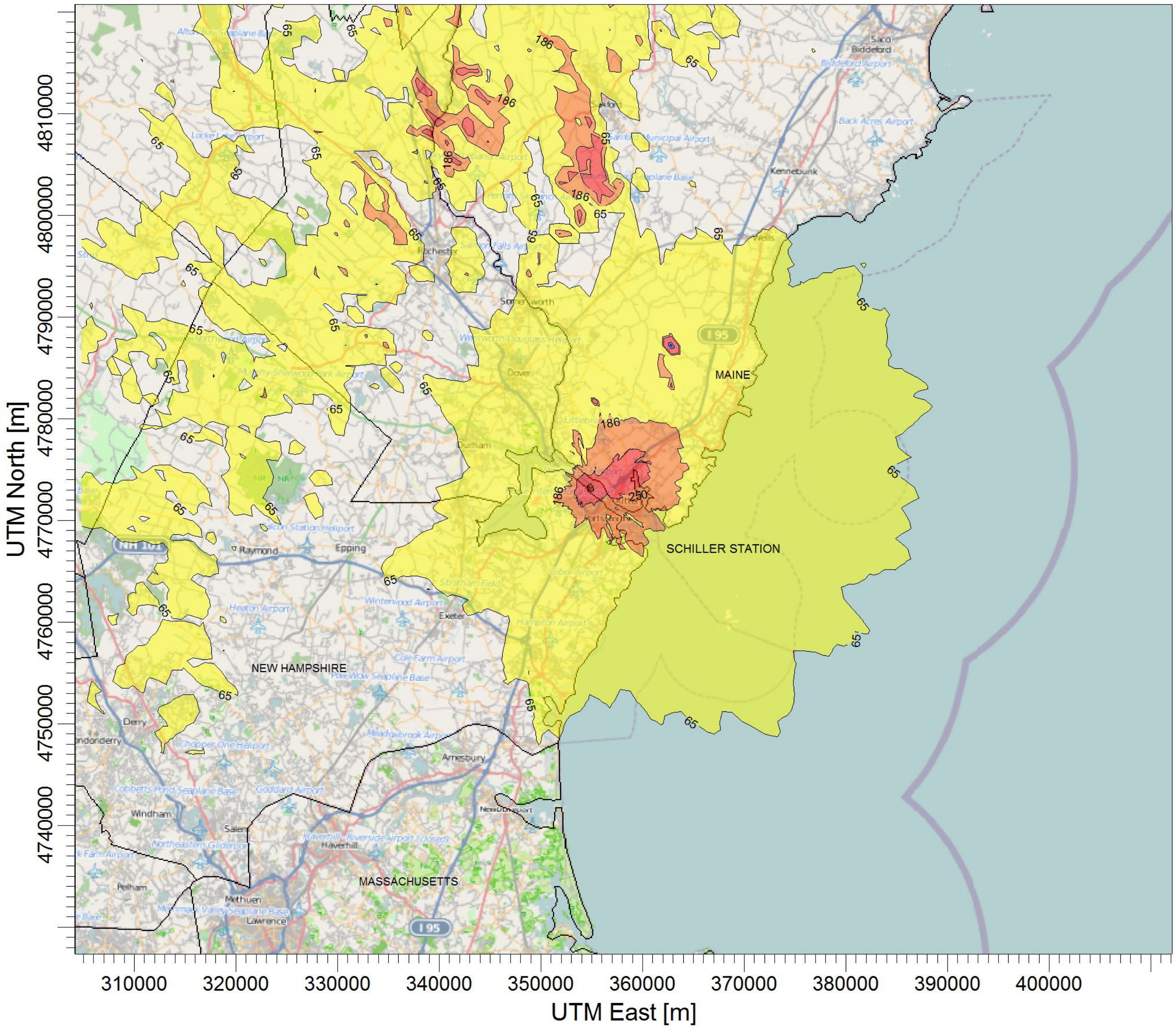
The background concentrations for Massachusetts is the design value measured during 2008-10 at the monitor located in Hampshire County.

Each of the background concentrations was the lowest design value for each state so may under-predict NAAQS exceedences.

6. Reporting

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

Figure 1 - Regional View
1-hour SO2 NAAQS Compliance Analysis for Schiller Station, NH

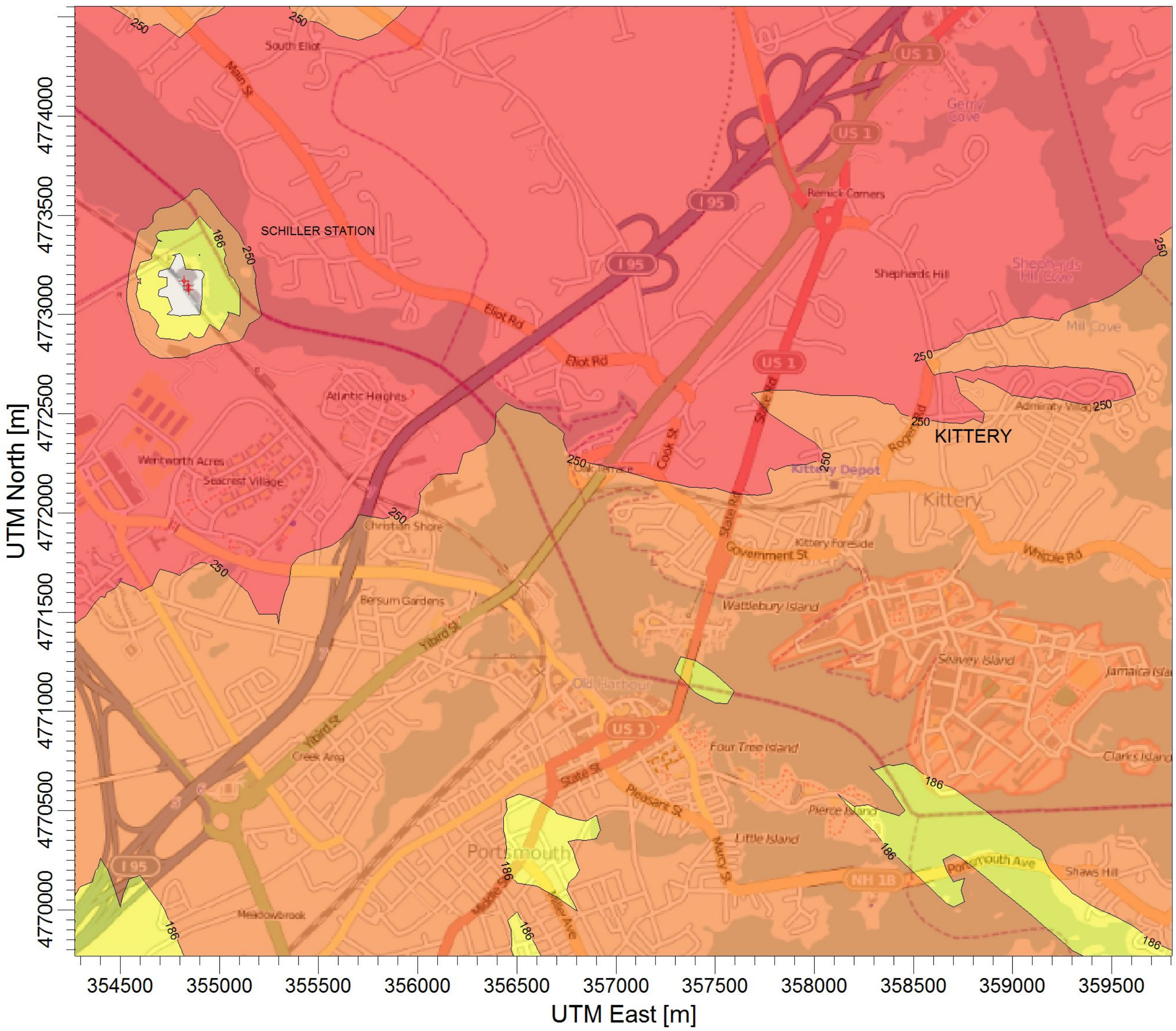


1 HOUR AVERAGE SO2 CONCENTRATIONS (UG PER CUBIC METER)

65 ug/m3 exceeds NAAQS with New Hampshire background. 186 ug/m3 exceeds NAAQS with Maine background. This is figure is based on the current allowable emissions for Units 4 and 6 of 2.9 lbs per mmbtu.	Total Sources **9**	**Conducted on behalf of the Sierra Club**	
	Total Receptors **22083**	**by Wingra Engineering, S.C.**	
	Output Type **Concentration**	SCALE: 1:678,817 0 — 20 km	
	Maximum **652.47407 ug/m^3**	DATE: **08/29/12**	

AERMOD View - Lakes Environmental Software

Figure 2 - Kittery View
1-hour SO2 NAAQS Compliance Analysis for Schiller Station, NH



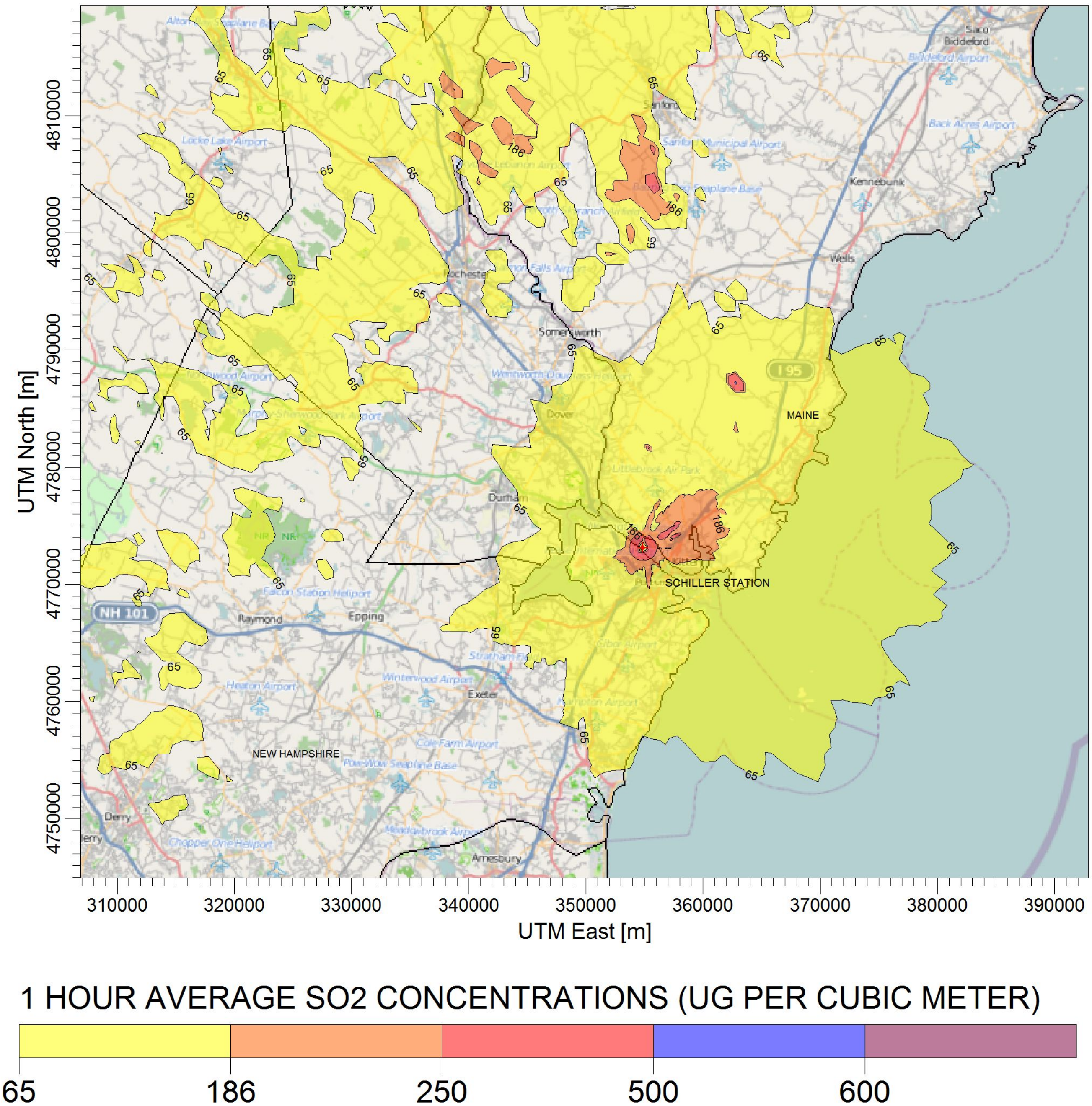
1 HOUR AVERAGE SO2 CONCENTRATIONS (UG PER CUBIC METER)

65 | 186 | 250 | 500 | 600

65 ug/m3 exceeds NAAQS with New Hampshire background. 186 ug/m3 exceeds NAAQS with Maine background. This is figure is based on the current allowable emissions for Units 4 and 6 of 2.9 lbs per mmbtu.	Total Sources **9**	**Conducted on behalf of the Sierra Club**	
	Total Receptors **22083**	**by Wingra Engineering, S.C.**	
	Output Type **Concentration**	SCALE: 1:34,793 0 1 km	
	Maximum **652.47407 ug/m^3**	DATE: **08/29/12**	

AERMOD View - Lakes Environmental Software

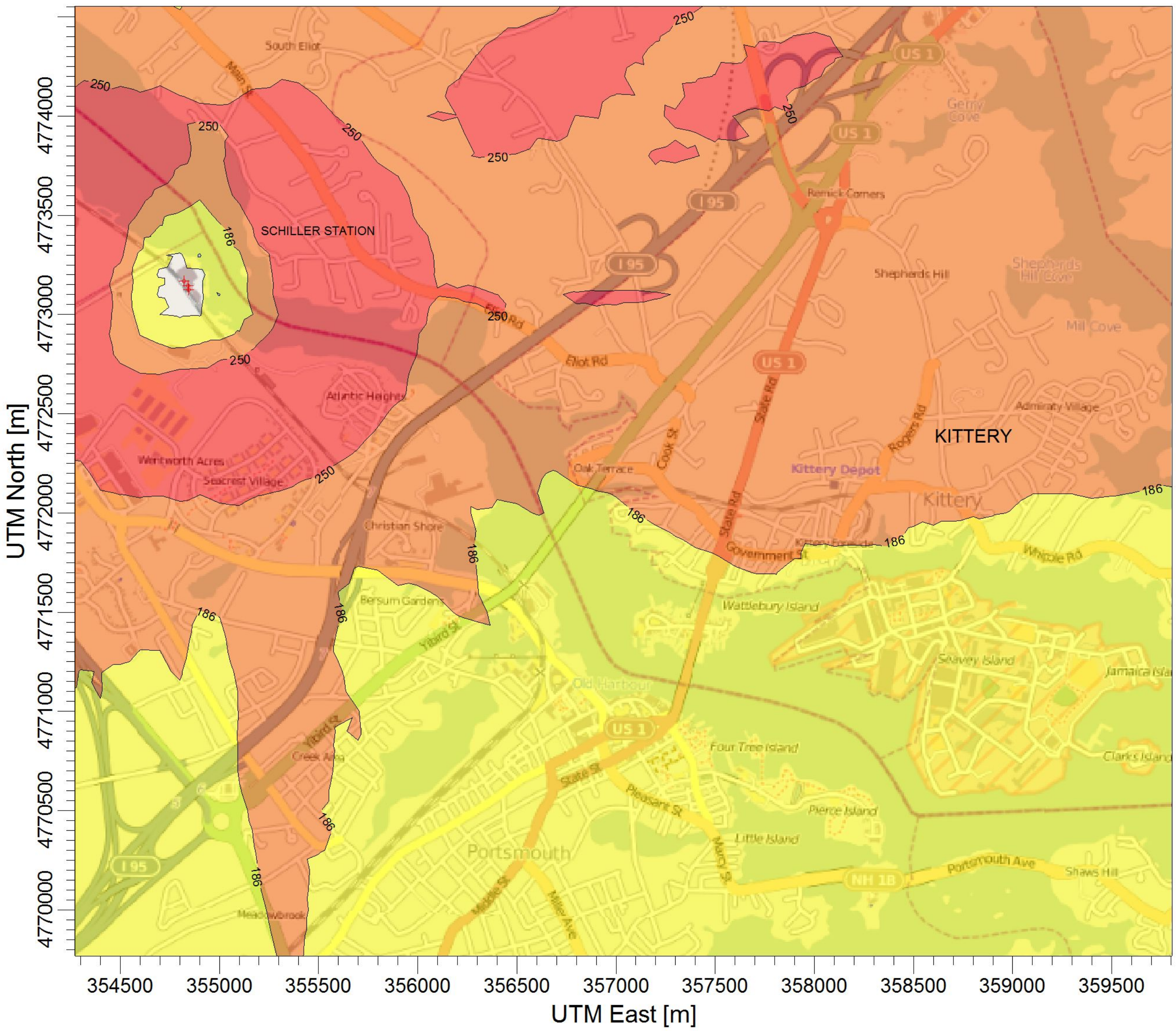
Figure 3 - Regional View
1-hour SO2 NAAQS Compliance Analysis for Schiller Station, NH



65 ug/m3 exceeds NAAQS with New Hampshire background. 186 ug/m3 exceeds NAAQS with Maine background. This is figure is based on the proposed allowable emissions for Units 4 and 6 of 2.4 lbs per mmbtu.	Total Sources **9**	**Conducted on behalf of the Sierra Club**
	Total Receptors **22083**	**by Wingra Engineering, S.C.**
	Output Type **Concentration**	SCALE: 1:540,943 0 — 20 km
	Maximum **542.47562 ug/m^3**	DATE: **08/29/12**

AERMOD View - Lakes Environmental Software

Figure 4 - Kittery View
1-hour SO2 NAAQS Compliance Analysis for Schiller Station, NH



1 HOUR AVERAGE SO2 CONCENTRATIONS (UG PER CUBIC METER)

65 186 250 500 600

65 ug/m3 exceeds NAAQS with New Hampshire background. 186 ug/m3 exceeds NAAQS with Maine background. This is figure is based on the proposed allowable emissions for Units 4 and 6 of 2.4 lbs per mmbtu.	Total Sources **9**	**Conducted on behalf of the Sierra Club**	
	Total Receptors **22083**	**by Wingra Engineering, S.C.**	
	Output Type **Concentration**	SCALE: 1:34,793 0 — 1 km	
	Maximum **542.47562 ug/m^3**	DATE: **08/29/12**	

AERMOD View - Lakes Environmental Software