Modeling Analysis for the State of Connecticut 1-Hour Sulfur Dioxide (SO_2) Section 51.1203 of 40 CFR Part 51, Subpart BB Submittal

Purpose: The purpose of this modeling report is to characterize air quality in the vicinity of the Bridgeport Harbor Station in Bridgeport, Connecticut. This analysis was performed to satisfy provisions in 40 CFR Part 51, Subpart BB.

1.0 Introduction

On August 21, 2015, the U.S. Environmental Protection Agency (EPA) published the SO_2 data requirements rule in the federal register 40 CFR Part 51, by adding Subpart BB Data Requirements for Characterizing Air Quality for the Primary SO_2 NAAQS. The purpose of this rule is to require air agencies to develop and submit air quality data characterizing maximum 1-hour ambient SO_2 concentrations in their jurisdiction. This requirement applies to any air agency having one or more applicable sources with annual actual SO_2 emissions of 2,000 tons or more, or having one or more sources that the air agency determines requires further air quality characterization.

The Connecticut Department of Energy and Environmental Protection (DEEP) submitted a letter to EPA on January 8, 2016 notifying EPA that Connecticut does not have any applicable SO_2 sources but identified Bridgeport Harbor Station (BHS) Emission Unit Number 3 (EU-3), in Bridgeport Connecticut as a source requiring further air quality characterization. In a March 17, 2016 letter from Curtis Spalding, EPA Region I to Anne Gobin (DEEP), EPA concurred that the BHS EU-3 was the only source in Connecticut that needed further air quality characterization.

On May 16, 2016, DEEP submitted a protocol to EPA outlining the modeling procedures that will be used to support a designation of attainment with the 1-hour SO_2 NAAQS. EPA Region I approved the modeling protocol in the summer of 2016, and expected the DEEP to submit the final modeling analyses, characterizing SO_2 air quality across the lower Fairfield and New Haven Counties, supporting documentation, modeling input/output and plot files to Region I by January 13, 2017. The modeling analysis was conducted following the procedures and recommendations in EPA's SO_2 NAAQS Designations Modeling Technical Assistance Document (TAD) (EPA Draft 2016) for designation purposes only. The TAD recommends modeling procedures and methods based on the most recent three (3) years of actual emissions with actual stack heights from any nearby sources identified that required further air quality characterization, and the proper use of modeling inputs such as emissions, building downwash if required, receptor elevations data, meteorological data and ambient background concentrations.

The remainder of this report describes the ambient air quality modeling approach, analysis and final results that were used to assess 1-hour SO_2 air quality impacts in the vicinity of the Bridgeport Harbor Station. The modeling results show compliance with the 1-hour SO_2 NAAQS across southwestern Connecticut. The report also shows that monitored 1-hour SO_2 design values are less than half the 1-hour SO_2 NAAQS that confirms attainment statewide and that

DEEP is not required to annually assess air quality impacts from BHS EU-3 and its' surrounding area of concern. The following elements are discussed in detail below:

- modeling approach, models used;
- sources modeled;
- receptor modeling domain and structure;
- urban/rural analysis;
- emissions data;
- stack height;
- meteorological data used;
- an accounting of existing ambient SO_2 background levels,
- modeled results; and
- DEEP's recommendation of "attainment" designation statewide for the 1-hour SO_2 NAAQS supported by modeling & monitoring analyses.

2.0 Dispersion Models Used

The EPA Guideline on Air Quality Models codified in 40 CFR 51 Appendix W recommends air quality modeling techniques that should be applied to State Implementation Plan (SIP) revisions for existing sources and for new source reviews (NSR) including Prevention of Significant Deterioration (PSD). For this analysis, DEEP utilized the Appendix W recommended AERMOD modeling system which includes the dispersion model AERMOD (version 15181) and its pre-processor modules AERMINUTE (version 15272), AERMET (version 15181), AERSURFACE (version 13016), AERMAP (version11103), and the building processor program BPIPRIME (version 04274). The AERMOD modeling system is recommended for the modeling of point, area and volume sources, for near surfaces and elevated releases, in either rural or urban settings, and with either simple or complex terrain. The BHS located on the coastal plain of Connecticut, currently has two operational fossil fuel burning units with effluents emitted from two separate stacks. However, EU-3 was the only source modeled because EU-4 operates less than 500 hours per year and is therefore considered an intermittent source as displayed in Table 1. AERMOD is the most appropriate model to accurately predict the 1-hour SO_2 design concentration for this source type.

3.0 Modeling Domain and Receptor Spacing

DEEP has employed the EPA sponsored terrain pre-processor AERMAP (v. 11103) in the development of receptor networks for the modeling domain. AERMAP processes Digital Elevation Model (DEM) data and creates an elevation and height scale (the terrain height and location that has the greatest influence on dispersion) for each receptor in the domain. AERMAP automatically selects the closest node elevation in each quadrant with respect to the receptor or source and then weights that elevation with respect to the distance from the receptor or source. The closer the node elevation, the more weight it is given. Conversely, further distances are weighted less. AERMAP is also capable of processing National Elevation Dataset (NED) data in GEO-TIFF format, which is accessible through the U.S. Geological Survey (USGS) Seamless Data Server http://www.mrlc.gov/viewerjs/. The program also has the ability to process Digital

Elevation Model (DEM) data in the USGS DEM format. AERMAP does not have the capability of processing both formats within a single application. The USGS NED (1/3-arc second) GEO-TIFF formatted data was used to develop receptors for the modeling domain that makes up this modeling exercise.

DEEP developed a Cartesian Grid centered on the BHS EU-3 Stack with 250 meter spacing out to a distance in all directions to 5 kilometers (km), 500 meter spacing from 5 km to 10 km, and 1km spacing, from 10 km to 20 km. Additional fence line receptors were placed along the BHS property boundary in 50 meter increments.

4.0 Urban/Rural Determination In The Vicinity Of Bridgeport Harbor Station

There are two methods of the urban/rural classification outlined in Section 7.2.3 of Appendix W. The first method is land use in which the user analyzes the land within a 3 km radius of the source modeled. The second method uses a population density as described in Section 7.2.3d of Appendix W. If the population density within 3 km of the source is greater than or equal to 750 people/km^2 then the source is considered urban. EPA cautions users on either classification method that is discussed in Section of 5.1 of AERMOD Implementation Guide (AIG) (EPA 2015f). When using the land use method, a source may be in an urban area but located close enough to a body of water or other non-urban land use areas to result in an erroneous rural classification scheme. If using the population density method; caution is also advised because of large industrial complexes with major highways but with less population density that could classify a source as rural in an urban setting. The AIG recommends considering for urban heat island effect across a full modeling domain. Both examples can be argued that BHS EU-3 stack is located in an area that could be classified as either urban or rural. The DEEP characterized the Bridgeport area as urban, even though the land-use centered on EU-3 out to 3 km showed 48% urban and 52% rural because of close proximity to Long Island Sound, an industrialized zone, and a major interstate highway system. DEEP followed Section 5.2 of the AIG by adding the population of several urban centers across the modeling domain for a total of 308,000 people.

5.0 Meteorological Data

The AERMOD-ready five year meteorological data set has been developed and can be accessed through the following web link: **http://www.ct.gov/deep/cwp/view.asp?a=2684&q=450396&deepNav_GID=1619.** DEEP developed these data sets from National Weather Service (NWS) Automated Surface Observing System (ASOS) stations in Connecticut and upper air sounding data at either Albany, NY or Brookhaven, NY. Connecticut used integrated Surface Hourly Data (ISHD), pre-processed through the EPA developed program AERMINUTE (v. 15272). This program uses the archived one minute wind data to develop hourly average wind speed and wind direction. This approach reduced the number of calm hours produced from the technique outlined in Section 6 of the Meteorological Monitoring Guideline (EPA 2000) to calculate average wind speed and direction. Connecticut used Forecast Systems Laboratory (FSL) formatted upper air data and processed

with the AERMINUTE produced surface data by the meteorological preprocessor AERMET (version 15181) to generate the AERMOD ready data sets.

The three-year set of meteorological data encompassing the years 2013-2015 from the NWS ASOS station at Sikorsky Airport Stratford, CT and concurrent upper air data from Brookhaven, NY, the closest source of upper air data, was processed and used in the modeling. Meteorological data capture rates were all above 90%. The Sikorsky airport site is very representative of the coastal region of Connecticut and is located five (5) kilometers to the east-northeast of the BHS.

6.0 Modeled Emissions

Table 1 below lists the type and general description of the fuel burning equipment currently operational at BHS. Figure 1 below lists the most recent three years of actual annual SO_2 emissions in tons per year (tpy) from BHS EU-3, indicating that BHS EU-3 is slightly less than half the 2000tpy SO_2 emission threshold. However, peak hourly emissions occur during very cold stable conditions with light wind-speeds when BHS EU-3 is fully operational that could potentially cause high impacts of SO_2. DEEP obtained the hourly Continuous Emissions Monitoring (CEM) SO_2 data from the three most recent years (2013-2015) processed the emissions in AERMOD ready format that was used in the modeling for EU-3. Variable stack exhaust flow data, extracted from the Clean Air Markets Data base (CAMD) was matched with the CEM data and concurrent meteorological data discussed in Section 4 above for the purpose of calculating 99th percentile 1-hour SO_2 design impacts. Hourly CEM and stack flow data files from EU-3 will be submitted with the AERMOD input and output files, plot files and meteorological files to EPA.

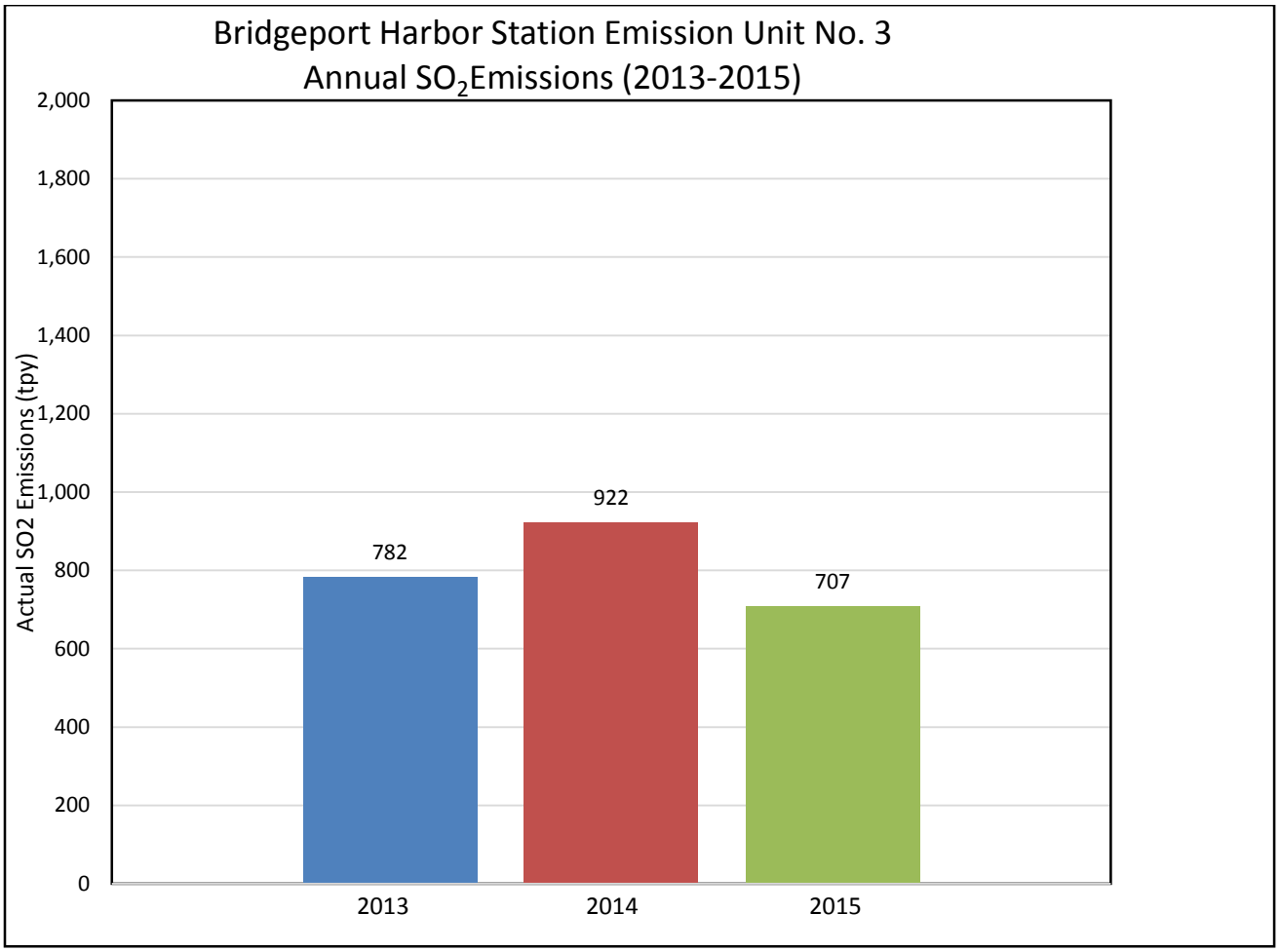
EU-4 is limited to the burning of Jet A fuel and actual emission from this 22Mw turbine have been very limited over the past several years as discussed in Table 1. Due to its extreme limited use, EU-4 was not included in the modeling demonstration since DEEP considers this source an "intermittent source" of less than 500hrs/yr. of operation.

EU-5 and EU-6 are also considered intermittent emission units under the EPA March 1, 2011 memorandum entitled "Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-hour NO_2 National Ambient Air Quality Standard". As discussed in Table 1 below, the units are limited to emergency and testing use only; and, therefore are considered intermittent emission units and were excluded from the modeling demonstration.

Table 1

Emissions Unit	Emissions Unit Description	Monitoring Unit Description	Permit, Order, Registration, or Regulation Number
EU-3	Combustion Engineering Steam Generator, BHS EU-3 with in-line heater, and Dense Pack Turbine (410 MW). EU-3 operates primarily on very low sulfur sub-bituminous coal and higher sulfur bituminous coal and uses No. 2 fuel oil on startup. It is equipped with an in-line heater (No. 2 fuel oil fired) that removes excess moisture from coal prior to combustion. An electrostatic precipitator and fabric filter bag house control particulate emissions. A low NO_x burner controls NO_x emissions. Activated carbon and dry sorbent injection systems, both upstream of the fabric filter bag house, control Hg and HCl emissions, respectively, during coal burning.	Teledyne Monitor Labs, Inc. Model 560 Opacity Monitor TECO CEM Model 42i for NO_X 43i for SO_X TECO CEM for CO_2	P 015-0089 TAO No. 8336 P 015-001-TIV CGS §22a-99 RCSA 22a-174-22c 40 CFR Part 75 40 CFR Part 63 Subpart UUUUU
EU-4	Pratt & Whitney Aircraft FT 4A-8LI Turbo- Jet Gas Turbine Generator, BHS EU-4 (22 MW). EU-4 burns only aviation fuel, Jet Fuel A. The unit is used to generate electric power only when electric energy supply and demand is required. The unit actual emissions over the last three years (2012-2014) have been 0.04tpy, 0.03tpy and 0.46tpy respectively. Total annual hours of operation amounted to 46 hours, 12 hours and 48 hours respectively. This data was taken from the sources Title V reporting.	None	R 015-0166 TAO No. 8330
EU-5	Cummins Diesel Fired Pump Engine Model # JN-130-1P SBM86790 (0.69 MMBtu/hr). EU-5 is a 98 hp diesel fired emergency pump engine located at Tank Farm Foam House. Unit operates under emergency engine status and as such is limited to emergency and periodic testing operation only.	None	40 CFR Part 63 Subpart ZZZZ
EU-6	Cummins Diesel Fired Pump Engine Model # H6-1P SBM99305 (0.71 MMBtu/hr). EU-6 is a 101 hp diesel fired emergency pump engine located near EU-4. Unit operates under emergency engine status and as such is limited to emergency and periodic testing operation only.	None	40 CFR Part 63 Subpart ZZZZ

Figure 1



7.0 Stack Height

The SO_2 TAD requires that when modeling using actual hourly emissions, actual stack heights should also be modeled with building downwash to ensure excessive SO_2 concentrations do not violate the 1-hour NAAQS. BHS EU-3 was modeled using the actual stack height of 498 feet above mean sea level (msl) and actual SO_2 hourly emissions (2013-2015) from CEMS to determine the predicted 1-hour SO_2 design concentrations. EPA provides guidance for determining the Good Engineering Practice (GEP) stack height and for determining whether excessive air pollutant concentrations, due to building downwash, will occur in the Guideline for Determination of Good Engineering Practice Stack Height (Technical Support Document for the Stack Height Regulations)(Revised June 1985) (EPA-450/4-80-023R). GEP is defined as "the height necessary to ensure that emissions from the stack do not result in excessive concentrations of any air pollutant in the immediate vicinity of the source as a result of atmospheric downwash, eddies, and wakes that may be created by the source itself, nearby structures, or nearby terrain obstacles." In the case of BHS EU-3 stack, the start-up source date was August 1968 {(DEEP (formerly DEP) Registration No. 015--164)} and therefore is exempt from building downwash

consideration in accordance with Table 3-1(C) of EPA's GEP Stack Height Regulation (TAD), "for sources and stacks in existence prior to December 31, 1970; use the actual stack height to set emission limits".

8.0 Connecticut's SO_2 Ambient Monitoring Data

DEEP's current SO_2 monitoring network consists of Thermo Environmental Instruments, Inc. Model 43i-TLE continuous trace monitors operated at five sites: Bridgeport (Edison School), Cornwall (Mohawk Mountain), East Hartford (McAuliffe Park), New Haven (Criscuolo Park), and Westport (Sherwood Island). These instruments comply with federal equivalent method EQSA-0486-060**.**

Figure 2 depicts historical 1-hour SO_2 monitored design value trends since 1982 at Connecticut's five SO_2 ambient air monitoring sites. A significant decline in measured values over the period of record has occurred. Design values at all air quality monitors have not exceeded the new 1-hour NAAQS of 75 ppb since 2000 or earlier. Monitoring data indicates design values continue to trend downward and attainment with the 1-Hour SO_2 NAAQS is maintained in Connecticut. This is critical because the Edison School Monitor in SW Connecticut near BHS show 1-hour design concentration less than half the 1-hour SO_2 NAAQS of 196µg/m^3.

Figure 2

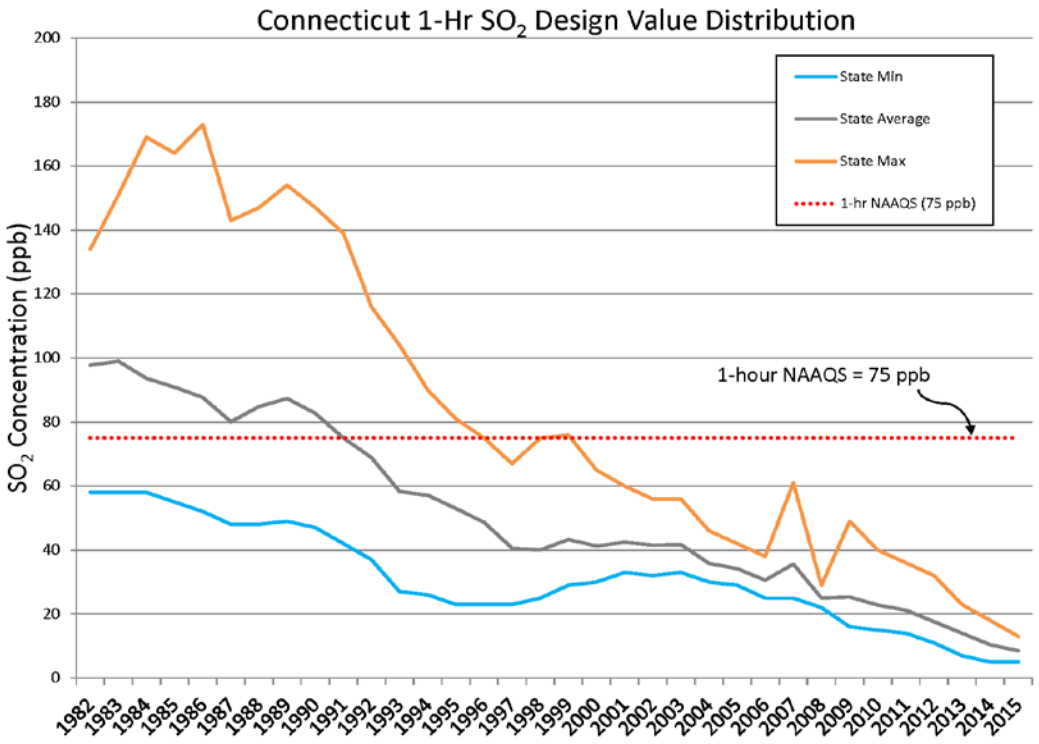
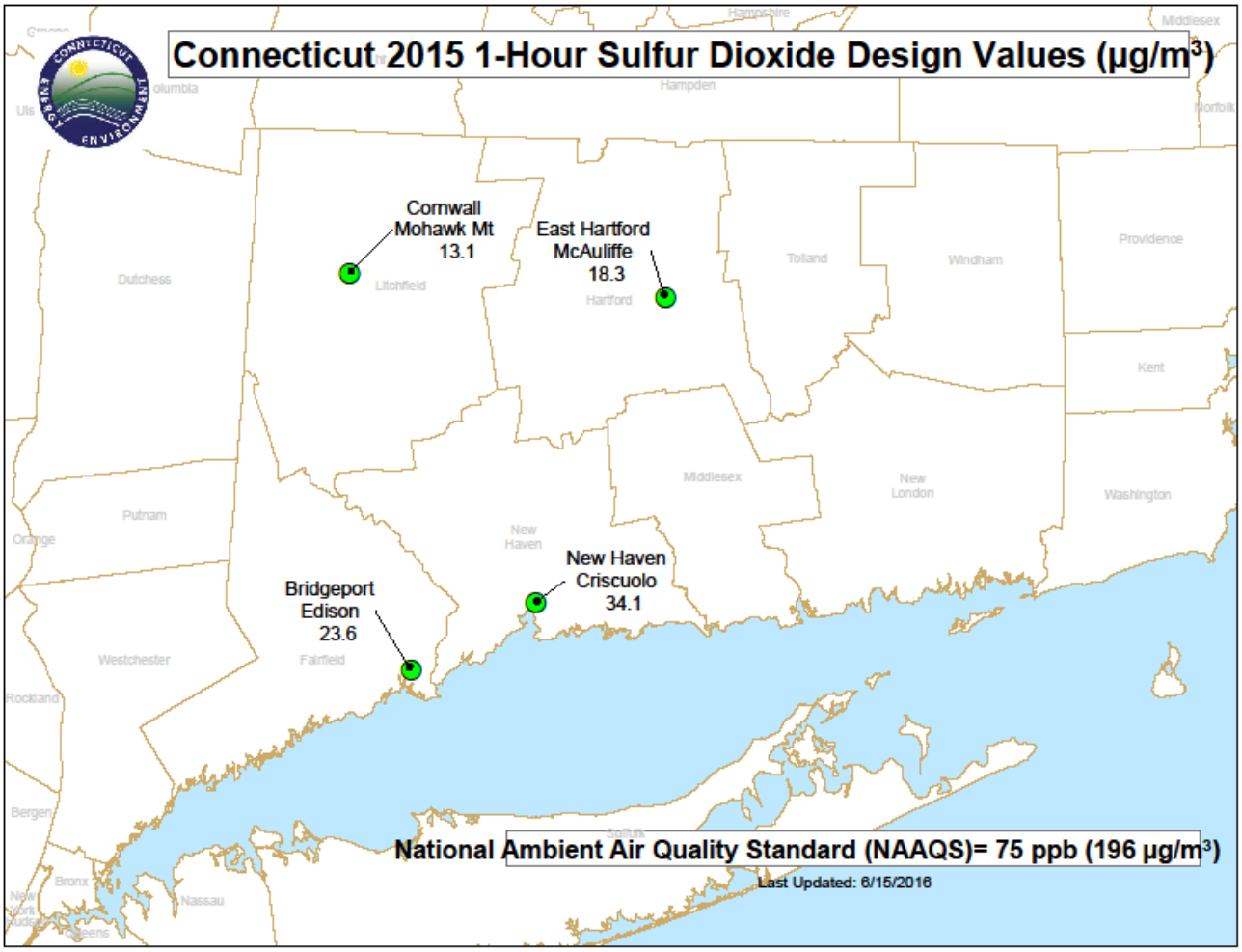


Figure 3 shows the most recent 1-hour SO_2 design values (2013-2015) for each of the sites. Design values range from a low of 13.1 µg/m^3 at the Cornwall site to a high of 34.1µg/m^3 at the New Haven site. These values are well below half the new 1-hour SO_2 NAAQS of 196 µg/m^3. Compliance with the new 1-hour SO_2 NAAQS is achieved at a monitor when the 3-year average of the 99th percentile of the annual distribution of daily maximum 1-hour average concentrations (i.e., the design value) does not exceed 75 ppb (196µg/m^3). The most representative background data also indicate a 1-hour SO_2 design value of 23.6µg/m^3 measured at the Bridgeport (Edison) site (88% below the NAAQS), supporting the modeling analysis that demonstrates compliance with the 1-hour SO_2 NAAQS in the Bridgeport area.

Figure 3



8.1 Background Ambient 1-Hour SO_2 Design Concentrations

EPA's March 1, 2011 memorandum, "Additional Clarification Regarding Application of Appendix W…", notes that ambient air quality data should generally be used to account for background concentrations. A two tier hierarchy approach to calculate background

concentrations were added to the AERMOD modeled predicted concentrations to determined attainment with the 1-hour SO_2 NAAQS:

Tier I – 1-hour design value for the latest 3-year period

Tier II – multi-year average of 99th percentile (2nd high measured 1-hour concentrations) for each season and hour-of-day combination, or the 4th high measured 1-hour concentration for hour-of-day only.

DEEP used the Tier II approach to develop background concentrations. A three year average of 2nd high measured 1-hour concentrations for each season and hour-of-day combination from the years 2013-2015 account for background SO_2 concentrations from out of state transport, and local in state point, area and mobile source emissions. The 96 season by hour of day values was inserted directly into the AERMOD input run stream. DEEP developed the 96 season by hour of day background values from hourly SO_2 levels measured by Federal Reference Method (FRM) equivalent monitor located at the Edison School in Bridgeport, CT.

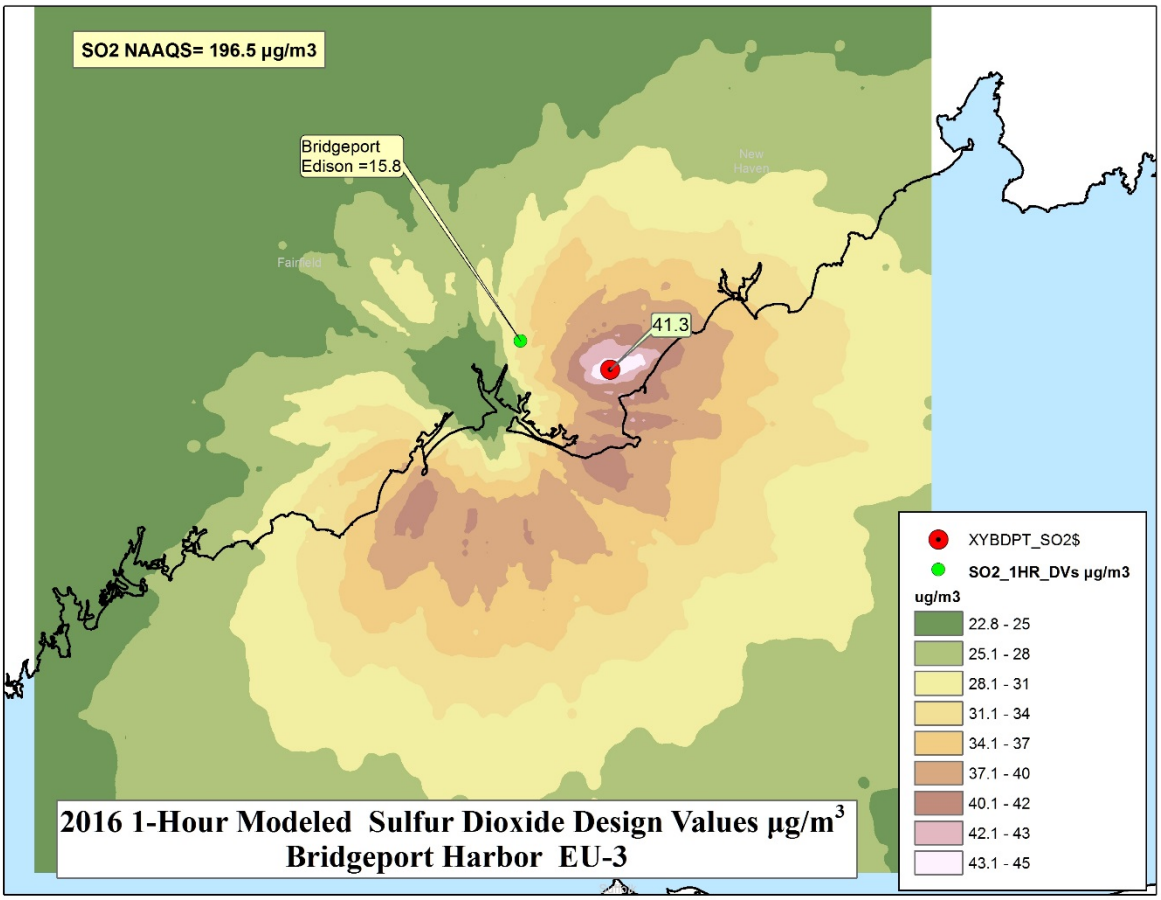
9.0 Modeled Results Supporting 1-Hour SO_2 NAAQS Attainment

Table 3 displays the 2013-2015 1-hour SO_2 AERMOD predicted design concentrations from BHS EU-3, background concentrations and total predicted concentrations. The Table also shows the 2013-2015 AERMOD predicted 1-hour SO_2 concentration located at the Edison Monitor compared to the 2013-2015 monitored 1-hour SO_2 design concentration. Figure 4 show the isopleths and location of the maximum 1-hour SO_2 impacts in the vicinity of Bridgeport Connecticut. The results in Table 3 and Figure 4 clearly show compliance with the 1-Hour SO_2 NAAQS and therefore confirm Connecticut's designation request of attainment with the 1-hour SO_2 NAAQS from DEEP to EPA Region I in a letter dated on February 19, 2013.

Table 3

Source Description	**Location Coordinates UTM-X (meters)**	**UTM-Y (meters)**	**Elevation (Z)**	**1-Hour SO_2 Design Conc. ($\mu g/m^3$)**	**1-Hour SO_2 NAAQS ($\mu g/m^3$)**
BHS EU-3 Stack	658,000	4,560,750	1.22	22.5	196
Background				18.7	
Total: EU-3 Plus Background	658,000	4,560,750	1.22	41.3	196
Bridgeport Edison Monitor					
Source Description	**Location Coordinates UTM-X (meters)**	**UTM-Y (meters)**	**Elevation (Z)**	**Modeled 1-Hour SO_2 Design Conc. ($\mu g/m^3$)**	**Monitored 1-Hour SO_2 Design Conc. ($\mu g/m^3$)**
BHS EU-3 Stack	654,049	4,562,049	34	15.7	23.6

Figure 4



10.0 On-Going Data Requirements for the 1-Hour SO_2 NAAQS Attainment Designation

The modeling analysis and results show a demonstration of attainment with the 1-hour SO_2 NAAQS across the modeling domain as discussed in section 9.0 and displayed in Table 3 and Figure 4. The maximum 1-hour design SO_2 concentration of 41.3µg/m^3 is only 21% of the 1-hour SO_2 NAAQS of 196µg/m^3. Therefore in accordance with section 51.1205 paragraph (b) (2) of the DRR, Connecticut is no longer subject to any further modeling requirements in the Bridgeport modeled area.

11.0 Conclusion: Connecticut Statewide Attainment Designation for the 1-Hour SO_2 NAAQS

DEEP has completed the SO_2 characterization in the vicinity of Bridgeport Harbor Station in Bridgeport, Connecticut for 1-hour SO_2 designation modeling in support of Part 51 Subpart BB-Data Requirements for Characterizing Air Quality for the Primary SO_2 NAAQS. The modeling results shown in Table 3 and Figure 4 demonstrate compliance with the 1-hour SO_2 NAAQS of 75 ppb (196µg/m^3) in southwest Connecticut where Bridgeport Harbor Station is located. The modeling analysis provided herein, supported by the latest monitored 1-hour SO_2 design concentrations displayed in Figure 3, show attainment state-wide across Connecticut, confirming DEEP's initial designation request of attainment statewide in a February 19, 2013 letter to EPA Region I.