Environment

Prepared for:
GenOn Mid-Atlantic, LLC
Morgantown Generating Station

Prepared by:
AECOM
Chelmsford, MA
60318070
October 2016

Morgantown Generating Station
Charles County, Maryland
1-hour SO_2 Modeling Report

Environment

Prepared for:
GenOn Mid-Atlantic, LLC
Morgantown Generating Station

Prepared by:
AECOM
Chelmsford, MA
60318070
October 2016

Morgantown Generating Station
Charles County, Maryland
1-hour SO_2 Modeling Report

Prepared By Kimberly Zuk

Reviewed By Jeffrey Connors

Contents

List of Appendices

List of Tables

List of Figures

1.0 Introduction

1.1 Purpose

In August 2015, the U.S. Environmental Protection Agency (USEPA) issued the SO_2 Data Requirements Rule (DRR), which directs state and tribal air agencies in "an orderly process" to identify maximum ambient air 1-hour SO_2 concentrations in areas with large sources of SO_2 emissions.

This document describes the air quality modeling procedures that are were used in conducting an air dispersion modeling demonstration with respect to the 1-hour National Ambient Air Quality Standard (NAAQS) for sulfur dioxide (SO_2) and the results of this modeling. The modeling was performed to characterize SO_2 concentrations to provide information for establishing the attainment designation for the region surrounding GenOn Mid-Atlantic LLC's Morgantown Generating Station (the Station) located in Newburg, Maryland. GenOn Mid-Atlantic LLC is a subsidiary of NRG Energy, Inc. This modeling report is being prepared and submitted to the Maryland Department of the Environment (MDE) to provide modeling results and a general overview of the modeling procedures used for this analysis.

A dispersion modeling protocol was submitted to MDE on February 19, 2016. MDE provided comments on the modeling protocol on March 7, 2016. Comments were incorporated into a final version of the protocol submitted to MDE on May 11, 2016. In addition, modeling procedures are consistent with applicable guidance, including the August 2016 "SO_2 NAAQS Designations Modeling Technical Assistance Document" (TAD) issued by the USEPA. The modeling approach is also consistent with the final Data Requirements Rule for the 2010 1-hour SO_2 primary NAAQS (80 FR 51052, August 21, 2015).

The current version of the TAD references other USEPA modeling guidance documents, including the following clarification memos (1) the August 23, 2010 "*Applicability of Appendix W Modeling Guidance for the 1-hour SO_2 NAAQS*" and (2) the March 1, 2011 "*Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-hour NO_2 National Ambient Air Quality Standard*" (hereafter referred to as the "clarification memos"). In the March 1, 2011 clarification memo, USEPA declares that the memo applies equally to the 1-hour SO_2 NAAQS even though it was prepared primarily for the 1-hour NO_2 NAAQS.

1.2 Facility Description and Location

The Morgantown Generation Station is located just over 10 miles south of La Plata, Maryland, along the Potomac River in Charles County. The Station has the capability of generating approximately 1,506 megawatts of gross winter generating capacity. The 1,507 megawatts of electrical output are generated from two 640-megawatt supercritical steam coal -fired boilers (Units 1 and 2), two 20-megawatt black start peaking turbines (CTs 1 and 2), and four 65-megawatt oil-fired peaking combustion turbines (CTs 3, 4, 5, and 6). The Station's current air permit also lists four oil-fired auxiliary boilers. Based on the current stack configurations, SO_2 emissions from Units 1 and 2 are controlled by Flue Gas Desulfurization (FGD) systems and exhaust primarily through a dual-flue 400-ft stack. When the FGDs are not available, Units 1 and 2 exhaust through 700-ft Bypass stacks. Units 1 and 2 are the primary sources of SO_2 emissions at the Station.

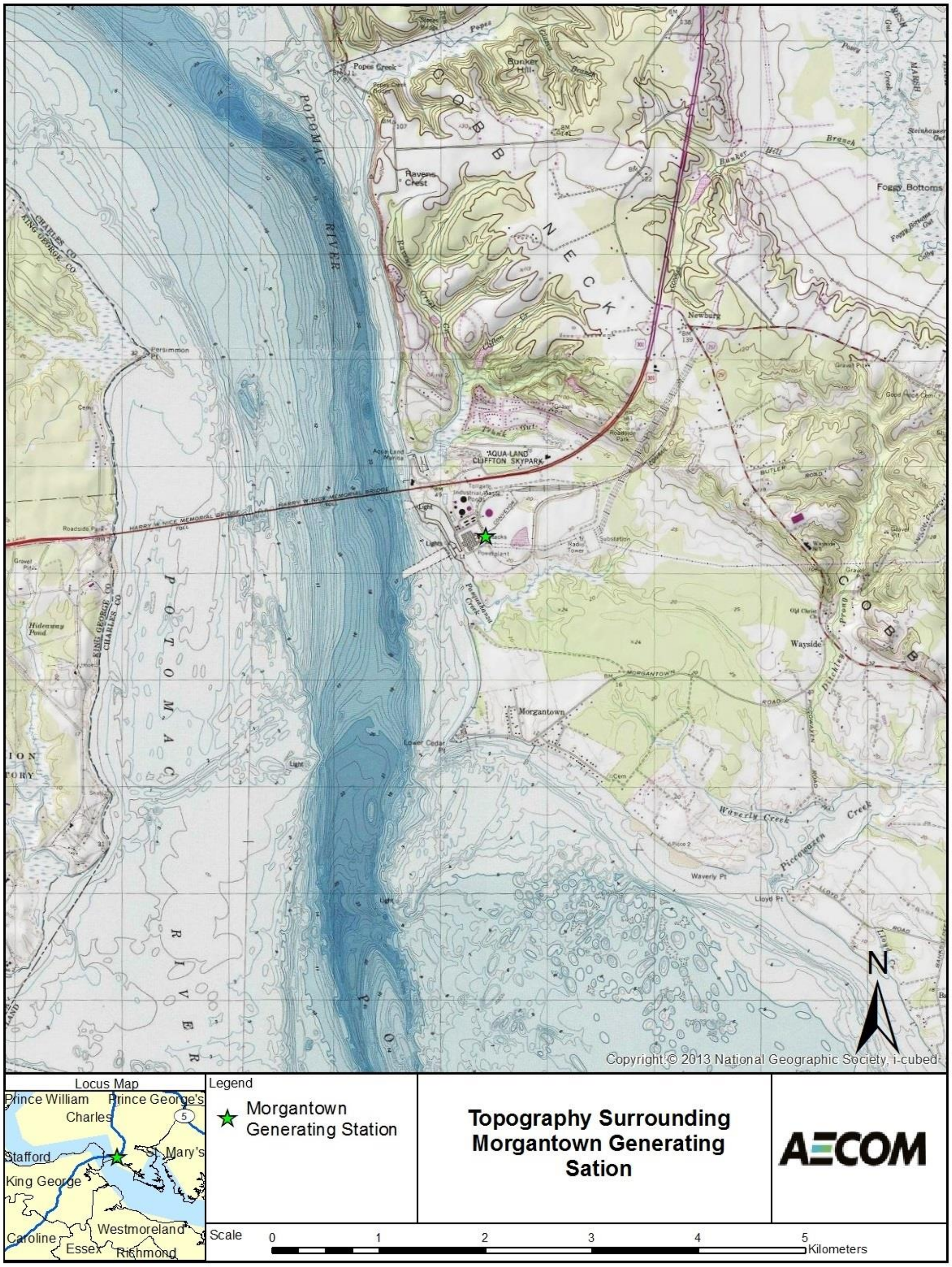
The areas surrounding the Station can be characterized as predominantly rural, flat terrain with gently rolling hills, along with some sparsely populated residences, agricultural areas, and waterways. The location of the Station is shown in **Figure 1-1**. A topographic map of the area surrounding the plant is provided in **Figure 1-2**. Additional discussion on whether the site is classified as rural or urban can be found in **Section 3.2**. As shown in **Figures 1-1** and **1-2**, the area in the immediate vicinity (i.e. within 3 km) of the Station can be characterized as having a rural land use type.

1.3 Contents of the Modeling Report

This protocol document consists of six sections. **Section 1** provides an introductory presentation. **Section 2** contains a description of the model selection. **Section 3** discusses the model configuration, including model domain, nearby sources, receptors, and meteorological data. **Section 4** includes a discussion of the emission rates used in the modeling. **Section 5** presents the ambient background data for inclusion in the modeling. **Section 6** presents the results of the modeling analysis.

Figure 1-1 Location of the Morgantown Generating Station

Figure 1-2 Topography in the Vicinity of Morgantown Generating Station



2.0 Model Selection

AERMOD (USEPA 2004a) (Version 15181) was used for this modeling study. AERMOD is the USEPA guideline model for short-range transport and has the ability to account for the source types and dispersion environment located at, and surrounding, the Morgantown Generating Station. AERMOD is appropriate for use in many different types of dispersion environments including: sources subject to building downwash and sources located in flat or elevated terrain.

As described in Section 1.2, the area surrounding the Morgantown Generating Station is characterized by predominantly flat terrain with some small rolling hills.

Based on USEPA guidance provided in the TAD, all stacks were modeled with their actual physical stack height. In addition, the USEPA's Building Profile Input Program (BPIP-Version 04274) version that is appropriate for use with PRIME algorithms in AERMOD was used to incorporate downwash effects in the model for all modeled point sources. The building dimensions of each structure were input in BPIPPRM program to determine direction-specific building data. PRIME addresses the entire structure of the wake, from the cavity immediately downwind of the building to the far wake.

3.0 Modeling Configuration

3.1 Modeling Domain

The area surrounding Morgantown Generating Station does not contain any other industrial facilities that emit large amounts of SO_2. As discussed below, a 20 km area surrounding the station was evaluated for the possible inclusion of nearby background sources, however no sources were identified.

Primary Source

The modeling domain for the Charles County, MD SO_2 attainment area designation modeling analysis focused primarily on the Morgantown Generating Station. The DRR characterizes primary sources as those sources which have over 2,000 tons per year (TPY) of SO_2 emissions based on the most recent year of emissions data. The Morgantown Generating Station was identified by MDE as having actual SO_2 emissions for the most recent calendar year in excess of 2,000 TPY. Therefore, an evaluation of the attainment status of the surrounding area with respect to the 1-hour NAAQS for SO_2 must be made.

Nearby Sources

Current modeling guidance in the TAD states that professional judgment should be used in the process of determining which nearby sources to include in the attainment area designation modeling analysis. Guidance on Page 7 in the TAD and in the referenced clarification memos state that the "*number of sources to explicitly model should generally be small*."

Applicable guidance in the TAD and clarification memos also mention that any nearby sources that are expected to cause a significant concentration gradient in the vicinity of the primary sources should be included in the area designation modeling. Additionally, guidance says the impacts of any other sources should be incorporated via a consideration of background air quality concentrations.

The initial screening area for sources that could have potentially been included in the 1-hour SO_2 modeling was set to be a 20 kilometer radius in all directions from the Morgantown Generating Station. Available guidance for this distance is 10 km from the March 1, 2011 Clarification Memo and "10-20 km" from the proposed Appendix W updates (80 FR 45373). Sources beyond 20 kilometers are very unlikely to cause or contribute to a violation of the 1-hour SO_2 NAAQS in the vicinity of the primary sources or cause a significant concentration gradient in the vicinity of the primary sources. Based on a review of the 2011 National Emissions Inventory (NEI), there were no sources within 20 km of the Morgantown Generating Station with more than 50 tons/year of actual SO_2 emissions.

The closest large SO_2 emission source is the Chalk Point Generating Station which is located over 30-km to the northeast of Morgantown. USEPA's own guidance supports this conclusion based on the recommendation of 10 km distance from the March 1, 2011 Clarification Memo and "10-20 km" from the proposed Appendix W updates (80 FR 45373). In addition, as will be shown in Section 6, the modeled design concentrations from Morgantown drops below the level of the ambient background at a distance of around 4 kilometers from the plant. This suggests beyond 4-km there is not a significant concentration gradient that could overlap with impacts from Chalk Point.

3.2 Dispersion Environment

The application of AERMOD requires characterization of the local (within 3 kilometers) dispersion environment as either urban or rural, based on a USEPA-recommended procedure (commonly referred to as the Auer Method) that characterizes an area by prevalent land use. This land use approach classifies an area according to 12 land use types. In this scheme, areas of industrial, commercial, and compact residential land use are designated urban. According to USEPA modeling guidelines, if more than 50% of an area within a 3-km radius of the facility is classified as rural, then rural dispersion coefficients are to be used in the dispersion modeling analysis. Conversely, if more than 50% of the area is urban, then the area will be classified as urban.

Visual inspection of the 3-km area surrounding the Morgantown Generating Station (see **Figure 3-1**) clearly shows the area is rural. Therefore, the urban model option in AERMOD was not employed.

3.3 Receptor Grid

The modeling analysis was conducted using the following Cartesian receptor grid design. The receptor grid consisted of receptors spaced 25 meters apart along the fence line of the Morgantown Generating Station. A spacing of 100 meters was used for the receptors extending out 3 kilometers from the grid center. Between 3 and 5 kilometers, a spacing of 250 meters was used. Between 5 and 10 kilometers, a spacing of 500 meters was used. Beyond 10 km (out to 20 km), a spacing of 1000 meters was used. The receptor grid used in the modeling analysis was based on Universal Transverse Mercator (UTM) coordinates referenced to NAD 83 datum and in zone 18. The receptor grid was centered at the following UTM coordinate: Easting = 327,510 meters and Northing = 4,247,550 meters.

The extent of this grid was sufficient to capture the maximum modeled impacts. Furthermore, the maximum modeled design concentration was within 100-meter-spaced receptors, ensuring the maximum impacts are resolved to a refined receptor grid spacing.

Figures 3-2 and **3-3** show a graphical depiction of the near-field receptors and entire receptor grid used for modeling.

AERMAP (version 11103) (USEPA 2004c), the AERMOD terrain preprocessor program, was used to calculate terrain elevations and critical hill heights for the modeled receptors (NAD83 datum and zone 18) using National Elevation Data (NED). The dataset was downloaded from the USGS website (http://viewer.nationalmap.gov/viewer/) and consisted of 1/3 arc second (~10 m resolution) NED. As per the AERMAP User's Guide (USEPA, 2004), the domain was sufficient to ensure all significant nodes were included such that all terrain features exceeding a 10% elevation slope from any given receptor was considered.

Additionally, Section 4.2 of the TAD states that receptors do not need to be located in areas where it is not feasible to place a monitor (water bodies, etc.). To be conservative, the grid used in this modeling analysis does not exclude any receptors that may be in such areas.

Figure 3-1 Land Use Surrounding the Morgantown Generating Station

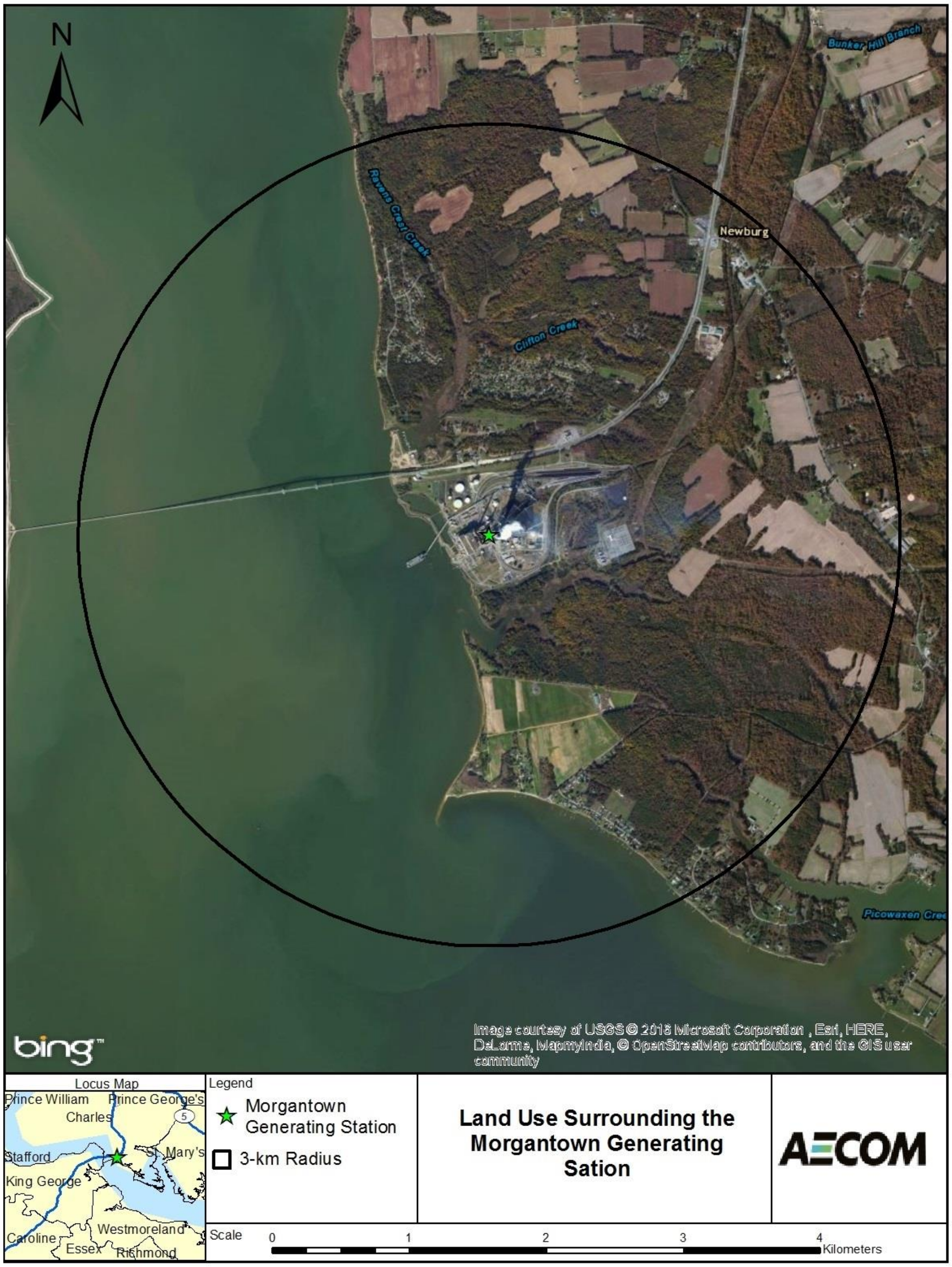


Figure 3-2 Near-Field Receptors for AERMOD Modeling

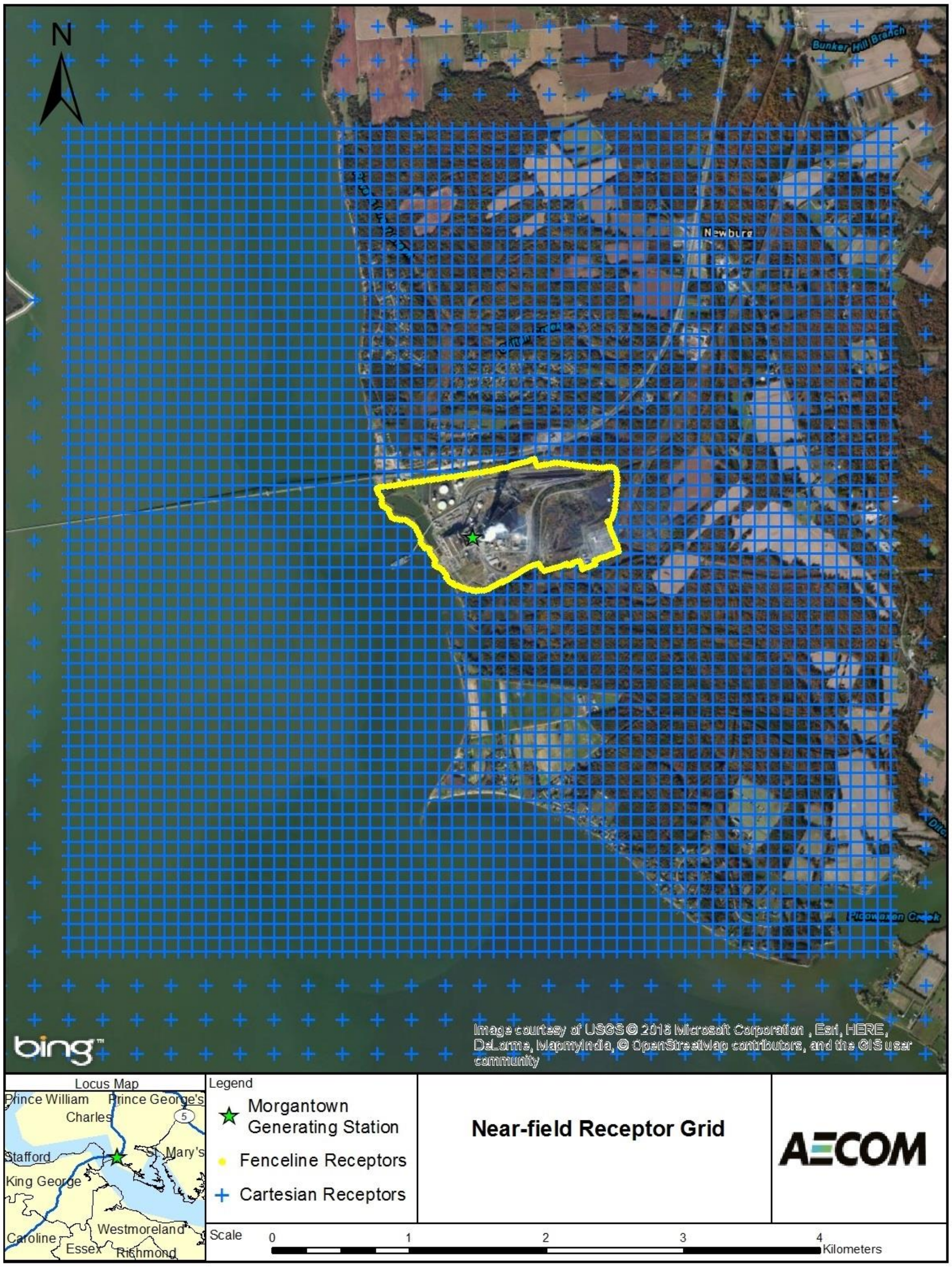
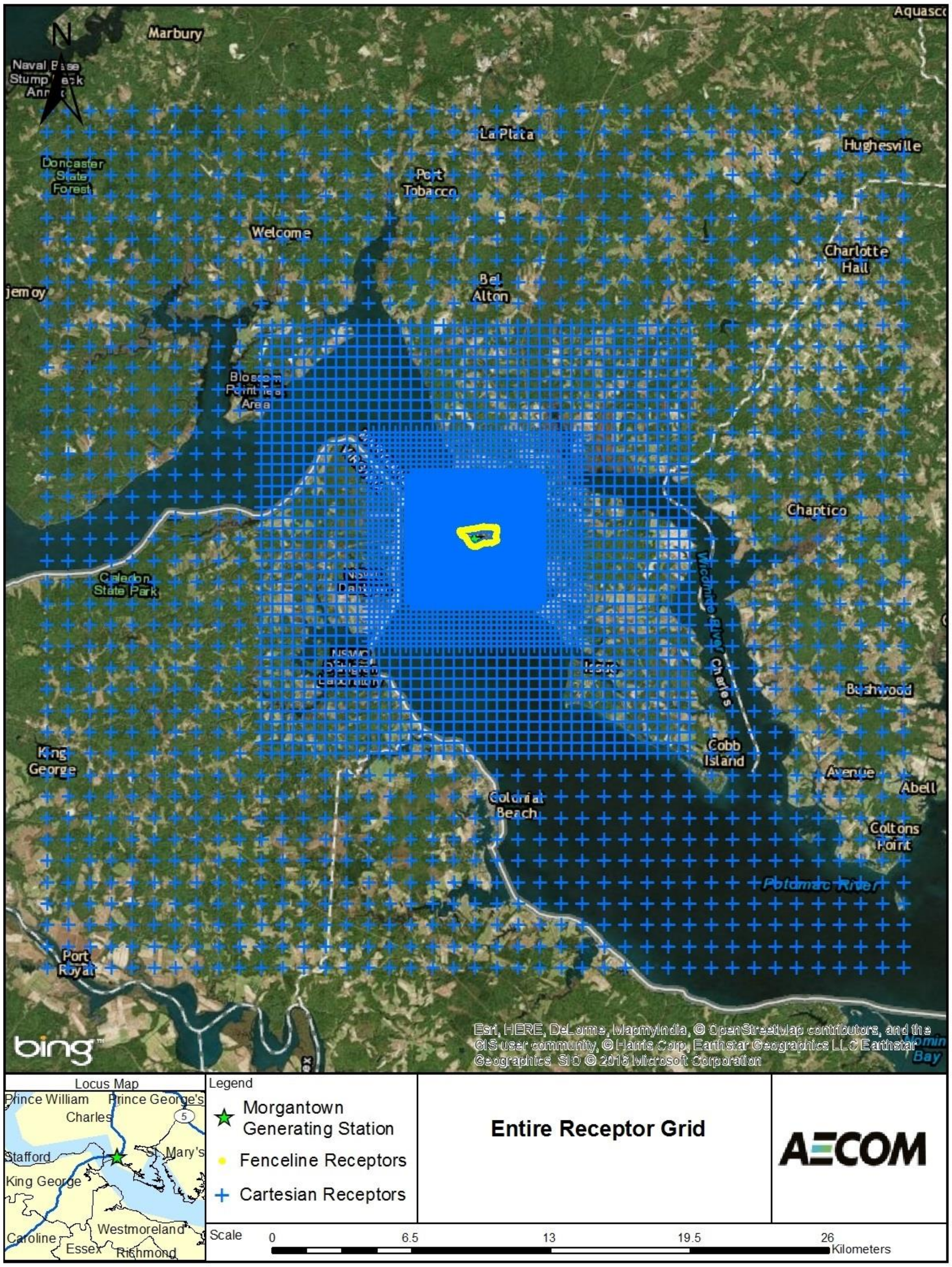


Figure 3-3 Entire Receptor Grid for AERMOD Modeling



3.4 Meteorological Data for Modeling

Meteorological data required for AERMOD include hourly values of wind speed, wind direction, and ambient temperature. Since the AERMOD dispersion algorithms are based on atmospheric boundary layer dispersion theory, additional boundary layer variables are derived by parameterization formulas, which are computed by the AERMOD meteorological preprocessor, AERMET (USEPA 2004b). These parameters include sensible heat flux, surface friction velocity, convective velocity scale, vertical potential temperature gradient, convective and mechanical mixing heights, Monin-Obukhov length, surface roughness length, Bowen ratio, and albedo. The meteorological data processing was performed with the latest version of AERMET (Version 15181).

3.4.1 Available Meteorological Data

The modeling utilized three recent years (2012-2014) of meteorological data from the Calvert Cliffs, MD 60-meter meteorological measurement tower which is located just over 45 kilometers east-northeast of Morgantown. There were alternative sources of meteorological data available from nearby Automated Surface Observing System (ASOS), such as Reagan National Airport. Reagan National airport is located just over 50 kilometers to the north of Morgantown. In addition to being further away, the meteorological observations available at Reagan National Airport only consists of data at a single level (10-meters) compared to the multiple levels of meteorological data available from the Calvert Cliffs meteorological tower.

Compared to the Reagan National Airport data, the Calvert Cliffs meteorological data provides (1) a superior estimate of stack-top winds due to the availability of data at 60-meters, (2) a thermal profile with temperature measurements at 10 and 60 meters, and (3) a superior estimate of lateral plume dispersion due to sigma-theta measurements at 60 meters. In addition, given its coastal location, the Calvert Cliffs data should accurately reflect local scale sea-breeze phenomenon experienced at the Morgantown site.

Specifically, the Calvert Cliffs meteorological data meets the requirements contained in USEPA's *Meteorological Monitoring Guidance for Regulatory Modeling Applications* (February 2000) by which a minimum one-year data set is to be used in a modeling analysis. In this instance three years were used to be consistent with the DRR. The location of the 60-meter meteorological tower is shown in **Figure 3-4**.

The data available on the 60-meter tower includes the following variables:

1. Wind speed @ 10 and 60 meters;
2. Wind direction @ 10 and 60 meters;
3. Sigma Theta @ 10 and 60 meters; and
4. Temperature @ 10 and 60 meters.

These variables are used by AERMET/AERMOD in the parameterization of the boundary layer and ultimately used to quantify the atmospheric dispersion for this application.

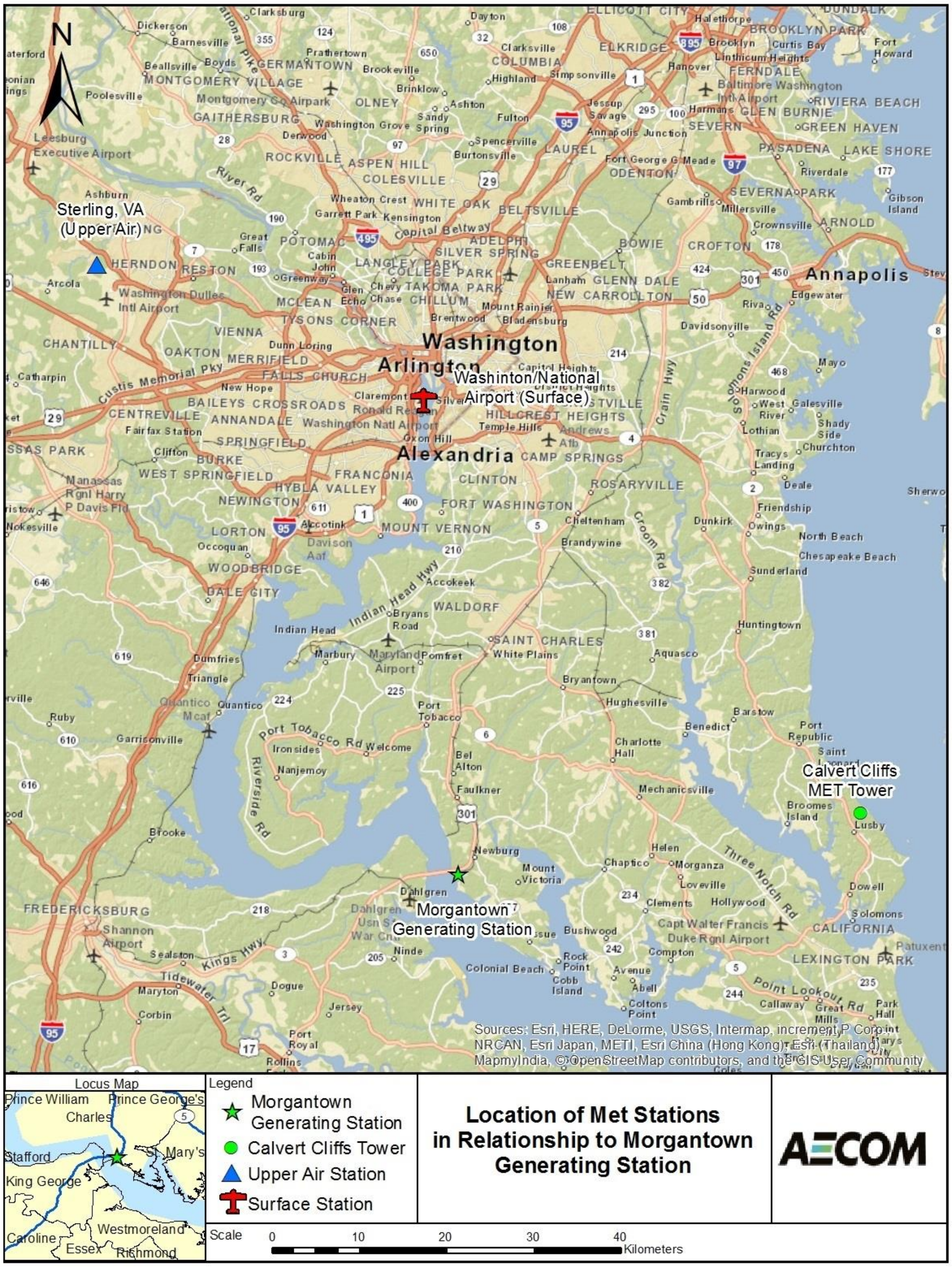
The lowest measured wind speed in the 3-year dataset was 0.7 m/s at both the 10 and 60 meter levels. Therefore the wind speed threshold in AERMET Stage 1 was set to be 0.5 m/s, less than any observed values at both the 10 and 60 meter levels. The 60-meter tower data was supplemented with night-time cloud cover observations from Washington/National Airport and upper air observations from Sterling, VA. The locations of the meteorological stations used for this analysis in relationship to the Morgantown Generating Station are shown in **Figure 3-4**.

Table 3-1 provides the coordinates and base elevations of all the meteorological stations used for this analysis, including the Calvert Cliffs 60-meter tower. The hourly data from Washington/National Airport was only used to supply cloud cover observations. Temperature and wind observations from Washington/National Airport were not substituted when data from the 60-meter tower was missing.

Table 3-1 Meteorological Data Used in Running AERMET

Met Site	Latitude	Longitude	Base Elevation (m)	Data Source	Data Format
Calvert Cliffs Meteorological Tower	38.430N	76.448W	38.0	Excel Spreadsheet	Free Format
Washington National	38.848N	77.034W	20.0	NCDC	ISH
Sterling, VA	38.98N	77.47W	85.0	NOAA/ESRL Radiosonde Database	FSL

Figure 3-4 Location of Meteorological Stations Relative to Morgantown Generating Station



3.4.2 AERSURFACE Analysis – Meteorological Site Land Use Characteristics

AERMET requires specification of site characteristics including surface roughness (z_o), albedo (r), and Bowen ratio (B_o). These parameters were developed according to the guidance provided by USEPA in the recently revised AERMOD Implementation Guide (AIG) (USEPA, 2015).

The revised AIG provides the following recommendations for determining the site characteristics:

1. The determination of the surface roughness length should be based on an inverse distance weighted geometric mean for a default upwind distance of 1 kilometer relative to the measurement site. Surface roughness length may be varied by sector to account for variations in land cover near the measurement site; however, the sector widths should be no smaller than 30 degrees.
2. The determination of the Bowen ratio should be based on a simple un-weighted geometric mean (i.e., no direction or distance dependency) for a representative domain, with a default domain defined by a 10-km by 10-km region centered on the measurement site.
3. The determination of the albedo should be based on a simple un-weighted arithmetic mean (i.e., no direction or distance dependency) for the same representative domain as defined for Bowen ratio, with a default domain defined by a 10-km by 10-km region centered on the measurement site.

The AIG recommends that the surface characteristics be determined based on digitized land cover data. USEPA has developed a tool called AERSURFACE (USEPA 2008) that can be used to determine the site characteristics based on digitized land cover data in accordance with the recommendations from the AIG discussed above. AERSURFACE incorporates look-up tables of representative surface characteristic values by land cover category and seasonal category. AERSURFACE will be applied with the instructions provided in the AERSURFACE User's Guide.

The current version of AERSURFACE (Version 13016) supports the use of land cover data from the USGS National Land Cover Data 1992 archives[1] (NLCD92). The NLCD92 archive provides data at a spatial resolution of 30 meters based upon a 21-category classification scheme applied over the continental United States.

The AIG recommends that the surface characteristics be determined based on the land use surrounding the site where the surface meteorological data were collected. As such, for surface roughness, the 1-km radius circular area centered at the meteorological station site was divided into sectors for the analysis; each chosen sector has a mix of land uses that is different from that of other selected sectors. The sectors used to define the meteorological surface characteristics for the Calvert Cliffs meteorological tower are shown in **Figure 3-5**.

In AERSURFACE, the various land cover categories are linked to a set of seasonal surface characteristics. As such, AERSURFACE requires specification of the seasonal category for each month of the year. Based on the climatology of high and low daily temperatures (**Figure 3-6**) for a 30-year period of record (1971-2000) in LaPlata, MD, the following five seasonal categories, as offered by AERSURFACE, were mapped to the following months[2]:

- Midsummer with lush vegetation (May-September);

[1] http://edcftp.cr.usgs.gov/pub/data/landcover/states/

[2] For the winter-to-spring designation a month needed approximately more than 50% of the low temperatures > freezing; conversely the transition from autumn-to-winter occurred when the low temperatures dipping below freezing exceeded approximately 50% of the time.

- Autumn with un-harvested cropland (October-November);
- Late autumn after frost and harvest, or winter with no snow (December-February);
- Winter with continuous snow on ground (none); and
- Transitional spring with partial green coverage or short annuals (March-April).

For Bowen ratio, the land use values are linked to three categories of surface moisture corresponding to average, wet and dry conditions. The surface moisture condition for the site may vary depending on the meteorological data period for which the surface characteristics will be applied. AERSURFACE applies the surface moisture condition for the entire data period. Therefore, if the surface moisture condition varies significantly across the data period, then AERSURFACE can be applied multiple times to account for those variations. As recommended in AERSURFACE User's Guide, the surface moisture condition for each month will be determined by comparing precipitation for the period of data to be processed to the 30-year climatological record, selecting "wet" conditions if precipitation is in the upper 30th-percentile, "dry" conditions if precipitation is in the lower 30th-percentile, and "average" conditions if precipitation is in the middle 40th-percentile. The 30-year precipitation data set used in this modeling was taken from a COOP precipitation monitor near the Calvert Cliffs Tower, the Patuxent River NAS. **Appendix A** contains the 30-years of monthly precipitation data.

The monthly designations of surface moisture input to AERSURFACE are summarized in **Table 3-2**.

Table 3-2 AERSURFACE Bowen Ratio Condition Designations

Month	2012	2013	2014
January	Dry	Average	Average
February	Average	Dry	Wet
March	Dry	Average	Dry
April	Average	Wet	Wet
May	Average	Dry	Wet
June	Dry	Wet	Dry
July	Dry	Average	Average
August	Wet	Average	Average
September	Average	Dry	Average
October	Wet	Wet	Average
November	Dry	Average	Average
December	Average	Wet	Average

3.4.2.1 Representativeness of Land Use

To verify representativeness of the Calvert Cliffs land use, AERSURFACE was applied for a single 1 km sector around both the Calvert Cliffs Tower and the Morgantown Generating Station using average moisture conditions and seasonal classifications as follows:

Jan, Feb, Dec = Late autumn after frost and harvest, or winter with no snow
Mar, April = Transitional spring (partial green coverage, short annuals)
May, Jun, Jul, Aug, Sep = Midsummer with lush vegetation
Oct, Nov = Autumn with unharvested cropland

The results of the two AERSURFACE runs are presented in **Table 3-3**. **Table 3-3** shows the albedo and Bowen ratio are very similar between the Calvert Cliffs Tower and the Morgantown Generating Station. The surface roughness is different slightly different, however, still representative.

Table 3-3 AERSURFACE Land use Comparison

Site	Annual Average Land Use		
	Albedo	**Bowen**	**Z_0**
Morgantown Generating Station	0.13	0.23	0.268
Calvert Cliffs Tower	0.13	0.27	0.459

3.4.3 AERMET Data Processing

AERMET (Version 15181) was used to process data required for input to AERMOD. Boundary layer parameters used by AERMOD, which also are required as input to the AERMET processor, include albedo, Bowen ratio, and surface roughness. The land classifications and associated boundary layer parameters were determined following procedures outlined in **Section 3.4.2**

A check of the quarterly data recovery with respect to the minimum USEPA (USEPA 2000) requirement of at least 90% for each parameter at one level (wind speed, wind direction, and temperature) is provided in **Table 3-4**. The 10-meter level has at least 90% data capture for all variables, except for the Q4 wind direction in 2014, which is just below 90% at 88.8%. The 60-meter level has very good data capture as well with most months exceeding 90% for all variables except the wind direction for some quarters. The 2014 Q4 wind direction is the only quarter with one level of data that individually does not meet the 90% data capture requirement. A closer examination of the wind observations during Q4 of 2014 shows that both wind speed and direction collectively are present 95.2% of the time from at least one of the levels (i.e. the missing wind data hours do not always overlap at both levels).

AERMET was applied to create two meteorological data files required for input to AERMOD:

Surface: A file with boundary layer parameters such as sensible heat flux, surface friction velocity, convective velocity scale, vertical potential temperature gradient in the 500-meter layer above the planetary boundary layer, and convective and mechanical mixing heights. Also provided are values of Monin-Obukhov length, surface roughness, albedo, Bowen ratio, wind speed, wind direction, temperature, and heights at which measurements were taken.

Profile: A file containing multi-level meteorological data with wind speed, wind direction, temperature, sigma-theta (σ_θ) and sigma-w (σ_w) when such data are available. For this application, the profile file will contain two levels of wind data, turbulence, and temperature at 10 and 60 meters.

A wind-rose for the Calvert Cliffs 10 and 60-meter levels is provided in **Figure 3-7**. As shown in the wind rose, the predominant wind direction for the site is from the southwest, although winds out of the northeast are also common.

Table 3-4: Data Recovery for the Calvert Cliffs Tower

Quarter	Wind Speed 10m	Wind Direction 10m	Temperature 10m	Wind Speed 60m	Wind Direction 60m	Temperature 60m
			2014			
Q1	100.0%	99.8%	100.0%	96.9%	90.2%	100.0%
Q2	97.4%	97.3%	97.6%	93.8%	69.8%	96.5%
Q3	99.9%	99.9%	99.8%	92.8%	84.3%	99.8%
Q4*	97.3%	88.8%	97.3%	97.3%	49.8%	97.3%
			2013			
Q1	100.0%	99.5%	98.9%	98.9%	89.0%	98.9%
Q2	95.6%	94.0%	95.7%	95.6%	84.5%	95.7%
Q3	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Q4	98.2%	98.6%	98.8%	92.3%	84.9%	92.6%
			2012			
Q1	100.0%	100.0%	99.8%	99.8%	94.3%	99.8%
Q2	95.5%	95.5%	95.5%	95.5%	95.5%	95.5%
Q3	94.2%	93.9%	90.0%	92.0%	88.2%	93.7%
Q4	100.0%	100.0%	100.0%	99.9%	94.3%	100.0%

* Q4 of 2014 has 95.2 percent data recovery of wind speed and direction collectively from at least one available level.

Figure 3-5 Sectors Used for Surface Characteristics at Calvert Cliffs Meteorological Tower

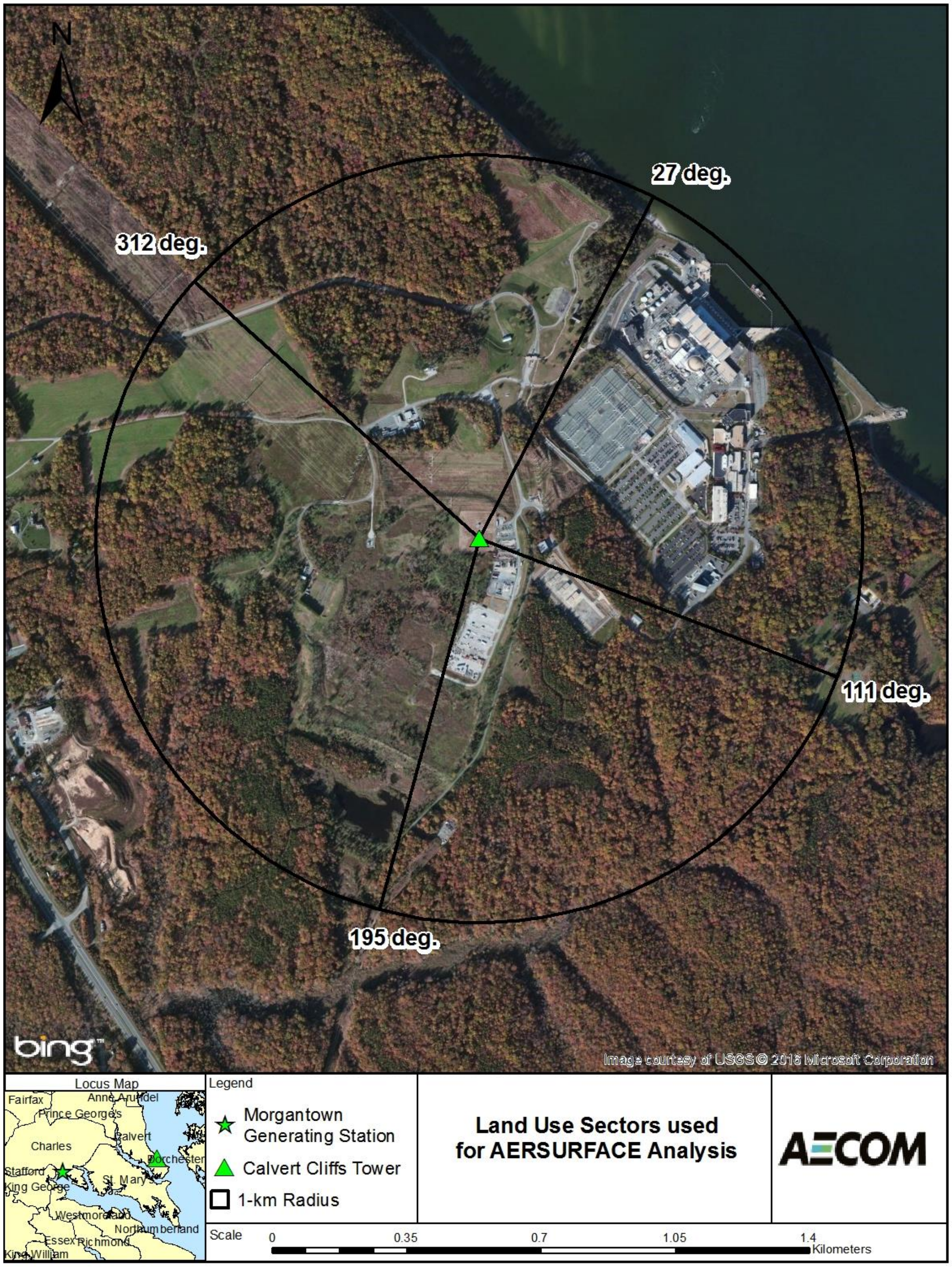
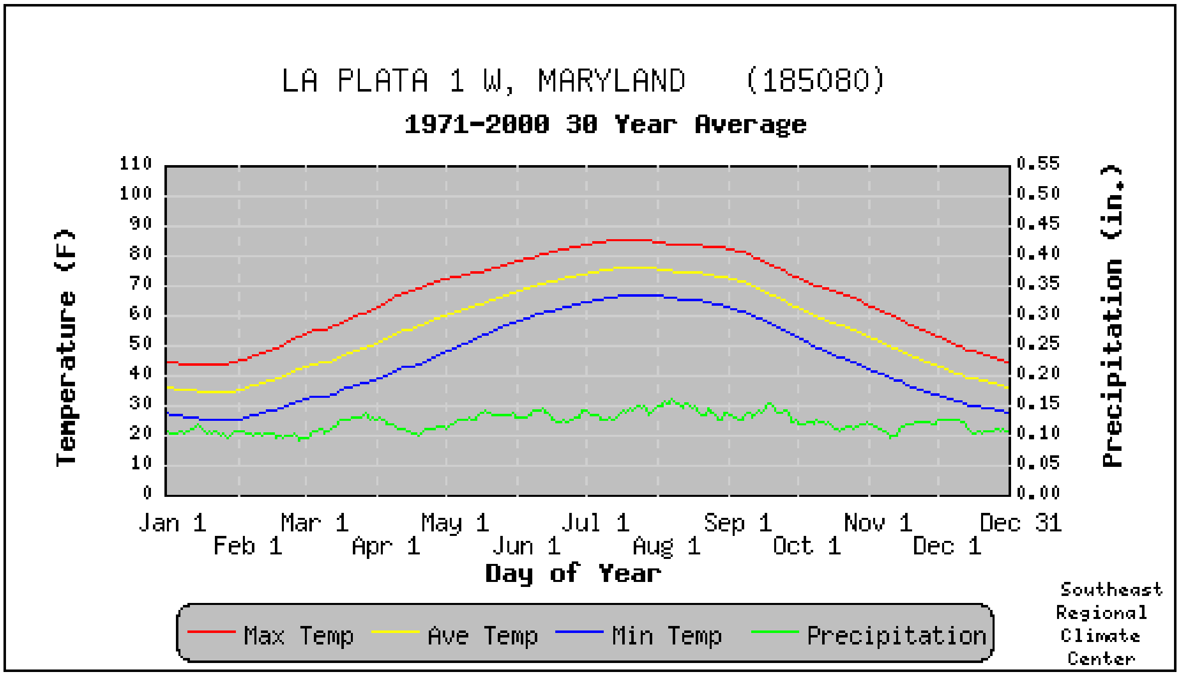
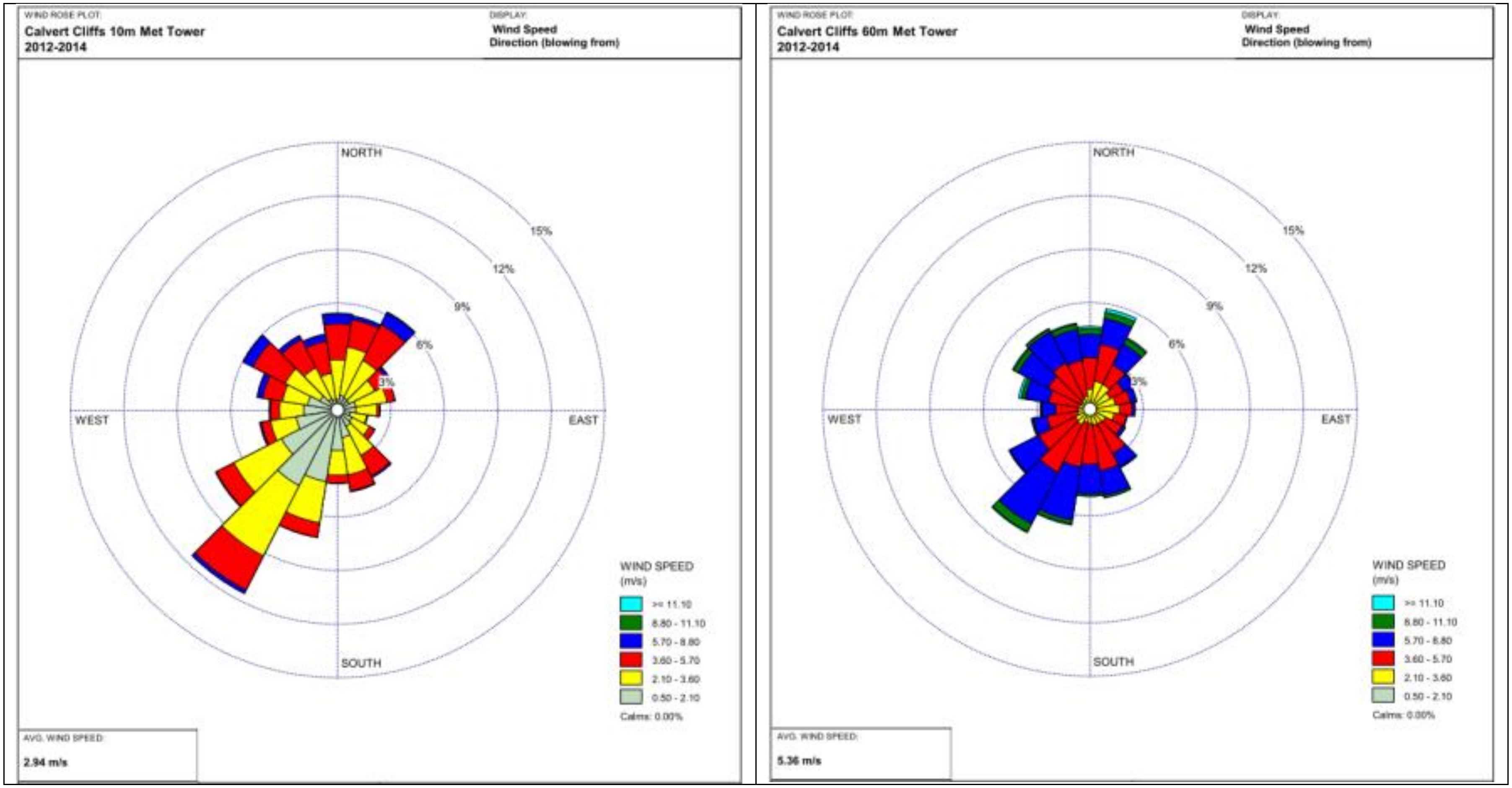


Figure 3-6 Regional Temperature Climatology



(1) Based on data from the South East Regional Climate Center (SERCC).

Figure 3-7 Wind Roses for Calvert Cliffs Meteorological Tower



4.0 Emission Rates and Source Characterization

There are two major SO_2 emission sources at the Morgantown Generating Station that were included in the 1-hour SO_2 modeling analysis. Those sources include (1) Unit 1 and (2) Unit 2, which are both supercritical steam coal -fired boilers.

SO_2 emissions from Units 1 and 2 are currently controlled with wet limestone FGD systems.

There are other potential small sources of SO_2 at the Morgantown Generating Station which include: four 65-megawatt oil-fired peaking combustion turbines (CTs 3, 4, 5, and 6), two 20-megawatt black start peaking turbines (CTs 1 and 2), and four oil-fired auxiliary boilers. **Table 4-1** shows the annual emissions and utilization for these additional emission sources. With the exception of 2014, all these units have either very low annual emissions and/or very low operating hours. The annual SO_2 emissions and operating hours in 2014 were higher than average for CTs 1-6 due to the cold “polar vortex” event in January. **Table 4-2** shows that CTs 1-6 all ran between 65 - 75% of their total operating hours for the year in the month of January. The operation of CTs 1-6 returned to normal levels in 2015 (as shown in **Table 4-1**) as the operating hours are consistent with 2012 and 2013 totals.

The combination of low emissions and low operating hours (shown in **Table 4-1**) supports the exclusion of these sources from the 1-hour SO_2 modeling as the operation of these units will not significantly impact the statistically based 1-hour SO_2 NAAQS.

As such, Units 1 and 2 were the only emission sources from the Morgantown Generating Station that were included in the 1-hour SO_2 modeling. Based on the current stack configurations, Units 1 and 2 exhaust primarily through a dual-flue 400-ft stack, which was modeled as a combined stack. When the FGDs are not available to control SO_2 emissions from Units 1 and 2, flue gases are emitted through individual 700-ft Bypass stacks.

Bypass stack operation is limited to brief periods when there are pressure excursions in the scrubber ductwork, during system upsets or equipment malfunctions. From 2012 through 2014, the Unit 1 Bypass stack did not operate and the Unit 2 Bypass stack operated a total of 1:41 hours. Given the extremely low frequency of usage of the Bypass stacks, they were not included in the modeling analysis as they will not significantly impact the statistical based form of the 1-hour SO_2 NAAQS.

The NAAQS modeling was performed with the actual stack heights in accordance with recommendations in the DRR and TAD. **Table 4-3** shows the physical stack parameters that were used in the modeling for the FGD Stack. The hourly exhaust flow rates, temperatures, and emission rates were based on the actual data available from the continuous emission monitor (CEM) systems, as provided from NRG. The emissions for modeling consisted of actual hourly data for three recent calendar years (2012-2014).

A description of installed SO_2 pollution control devices and plant emission limits is shown in **Table 4-4**.

The Morgantown units go through startups 8-10 times per year on average. **Table 4-5** shows the annual startups for each unit at Morgantown. These units have super-critical boilers, which require 8-16 hours to start up, depending on whether the turbines are hot (restarting from recent operation) or cold (starting up from an overhaul or reserve shut down). The startup fuel is #2 oil, which has no more than 0.3% sulfur content. Given the average startup times and frequency of occurrence, the units operate in "startup" model on average 64 – 160 hours per unit per year. Given the frequency at which Units 1 and 2 startup and shutdown and the fact that these emissions are already accounted for in the actual hourly emissions data over the 2012-2014 time period proposed for modeling, no additional consideration is required for startup and shutdown in this analysis.

Table 4-1 Annual Emissions for Insignificant Sources

Year	20 MW Black Start		65 MW Peaking Turbines				Auxiliary Boilers			
	CT1	CT2	CT3	CT4	CT5	CT6	AUX 1	AUX 2	AUX 3	AUX 4
SO2 – Tons/Year										
2015	1.3	1.7	3.9	4.0	3.2	3.9	0	4.6	0	0.2
2014	55.0* (7.3)	55.1* (7.3)	19.6	20.2	23.5	17.6	0	2.1	0	0
2013	1.0	1.3	9.0	10.9	9.8	7.1	0	6.5	0	0
2012	0.4	0.4	5.2	4.5	1.9	2.3	0	3.8	0	0
Operating Hours										
2015	25.7	36.3	38.2	37.3	29.6	37.5	0	585	0	49.1
2014	171.0	167.1	186.9	183.9	187.9	171.3	0	300	0	0
2013	50.6	53.0	59.5	66.9	65.0	44.9	0	794	0	0
2012	21.7	20.4	32.9	29.0	18.1	15.8	0	428	0	0

* A new emission factor was used for CT1&2 in 2014, which resulted in a step-change in estimated SO_2 emissions from these small 20 MW CTs. Corrected values appear in parenthesis

Table 4-2 CT Percentage of Operating Hours in January 2014

Percent of 2014 CT Operating Hours in January 2014						
2014	**CT1**	**CT2**	**CT3**	**CT4**	**CT5**	**CT6**
Jan. Hours	128.7	123.1	125.1	122.1	129.5	119.9
% of Annual	75.3	73.7	66.9	66.4	68.9	70.0

Table 4-3 Physical Stack Parameters

Unit	Description	Location (UTM Zone 18 NAD 1983)		Stack Base Elevation (feet)	Stack Height (feet)	Flue Diameter (feet)
		Easting (meters)	Northing (meters)			
Unit 1	FGD Stack(1)	327509.15	4247553.25	23.0	400.0	37.5
Unit 2						

(1) The dual-flue FGD stack was modeled as one combined source using an equivalent diameter of 37.5 ft which is based on the 26.5 ft diameter of the two individual flues.

Table 4-4 Emissions Control Devices

Unit	Pollutant	Device	Emission Limit	Control Efficiency	Year Installed
Unit 1	SO2	FGD	0.20 lb/MBtu, 30-day rolling	98%	2009
Unit 2	SO2	FGD	0.20 lb/MBtu, 30-day rolling	98%	2009

Table 4-5 Number of Startups per Year

Year	Unit 1	Unit 2
2012	12	5
2013	7	11
2014	7	6
2015	11	8
Average	9.25	7.5

5.0 Background Monitoring Data

Ambient air quality data are used to represent the contribution of non-modeled sources to the total ambient air pollutant concentrations. In order to characterize SO_2 concentrations in the vicinity of Morgantown Generating Station, the modeled design concentration was added to a measured ambient background concentration to estimate the total design concentration. This total design concentration was then used to characterize the area as attainment or non-attainment for the 1-hour SO_2 NAAQS.

For this analysis we considered data from several nearby monitors located in Washington DC, Virginia, and Maryland. The six monitors we considered are provided in **Table 5-1** along with their 2012-2014 design concentrations. **Figure 5-1** shows the location of Morgantown Generating Station in relationship to the nearby monitors.

According to USEPA's design concentration trend data based (available at http://www3.epa.gov/airtrends/values.html), several monitors do not have adequate data capture over the three-year period for calculating a design concentration. The Fairfax County monitor only has data starting in 2014. The Dorchester County monitor has incomplete data for 2 quarters in 2012 and 3 quarters in 2013. The Prince George's County (Powder Mill) monitor has incomplete data for 4 quarters in 2012 and 2 quarters in 2013. The DC (420 34th Street) monitor has incomplete data for 3 quarters in 2014. The two remaining monitors to consider are (1) the DC (2500 1st Street) monitor and (2) the Prince George's County Beltsville (Howard University) monitor.

As shown in **Table 5-1**, both the DC (2500 1st Street) the Prince George's County Beltsville (Howard University) monitors have the same design concentration of 11 ppb for 2012-2014. The data at both of these monitors should provide a conservative estimate of the ambient SO_2 background in the vicinity of the Morgantown Generating Station. Both monitors are located in areas that are more populated and industrialized compared to the area surrounding the Morgantown Generating Station.

The design value concentration of 11 ppb was added to the modeled design concentration to estimate the total impact.

Table 5-1 1-hour SO_2 Design Concentrations for Local Background Monitors

State	County	AQS Site ID	Address	2012-2014 Design Value (ppb)	2012-2014 Design Value Validity Indicator
District Of Columbia	District of Columbia	11-001-0041	420 34th Street N.E., Washington, DC 20019	10	N
District Of Columbia	District of Columbia	11-001-0043	2500 1ST Street, N.W. Washington DC	11	Y
Maryland	Dorchester	24-019-0004	University of Maryland for Environmental and Estuarine Studies	6	N
Maryland	Prince George's	24-033-0030	Howard University's Beltsville Laboratory, 12003 Old Baltimore Pike	11	Y
Maryland	Prince George's	24-033-9991	Powder Mill Rd, Laurel, MD 20708	14	N
Virginia	Fairfax	51-059-0030	STA. 46-B9, Lee Park, Telegraph Road	11	N

Figure 5-1 Location of Nearby Monitor in Relation to Morgantown Generation Station

6.0 Modeling Results

A summary of the 1-hour SO_2 modeling results is presented in **Table 6-1**. As shown in **Table 6-1**, predicted impacts for 1-hour SO_2 are less than the NAAQS at only 42 percent of the threshold. The modeling results indicate that the area surrounding the facility is in compliance with the applicable NAAQS standard and should be designated as attainment. In addition, because total (modeled + background) concentrations are less than 50 percent of the 1-hour SO_2 NAAQS and the SO_2 emissions are already controlled with a FGD system, the maintenance modeling requirement in the DRR is not necessary to track for this facility.

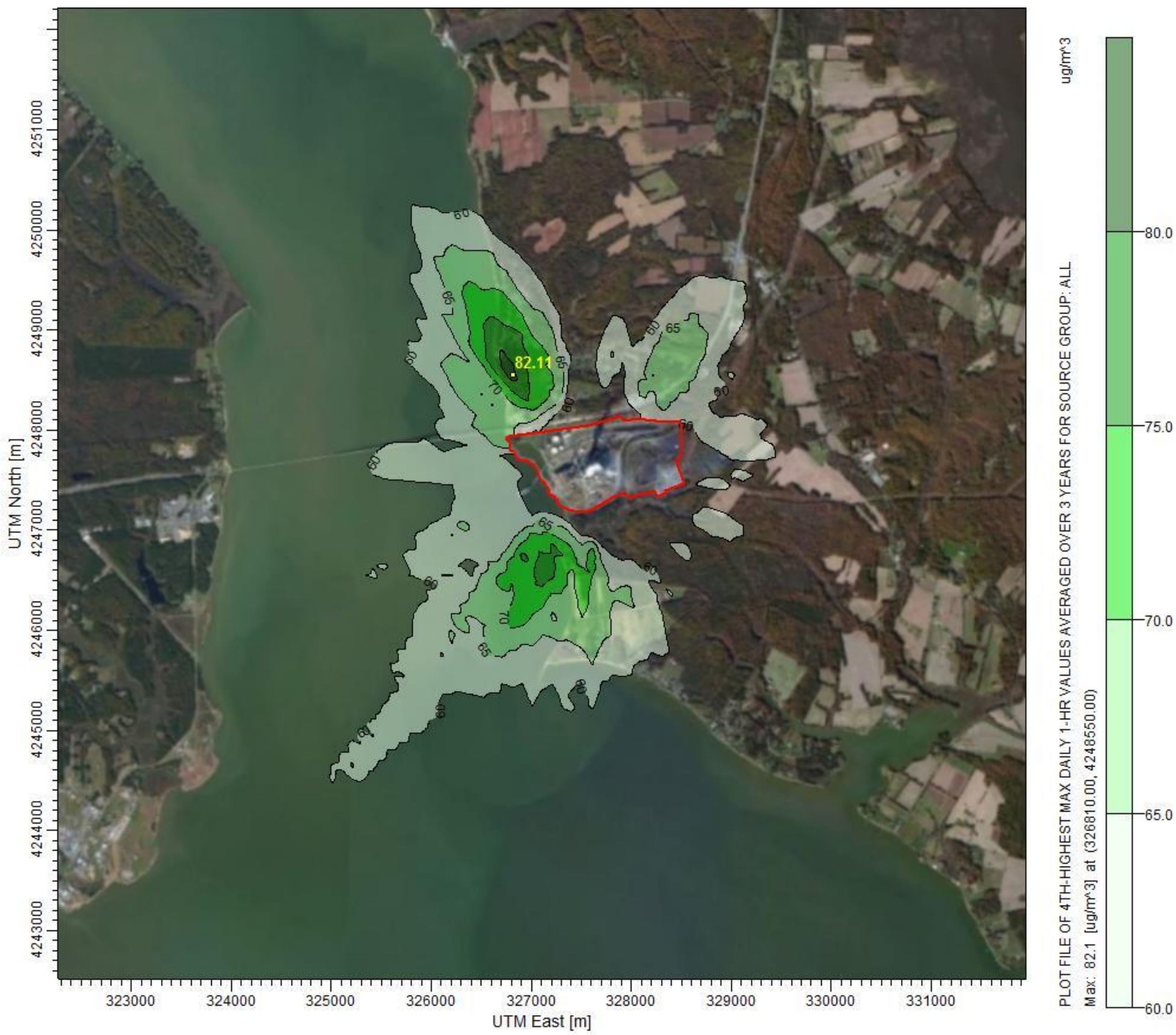
Figure 6-1 illustrates the overall pattern of the total SO_2 concentrations (modeled plus monitored background) along with the location of the total maximum design concentration . The maximum total design concentration is approximately 600 meters north of the facility, along the water's edge and occurs within 100-m receptor grid spacing.

Table 6-1: Summary of 1-hr SO_2 Modeling Analysis

Pollutant	Averaging Period	Modeled Concentration (µg/m^3)	Monitored Background Concentration (µg/m^3) (1)	Total Concentration (µg/m^3)	NAAQS (µg/m^3)	Percent of NAAQS (%)	Complies (Y/N)?
SO_2	1-Hour	53.29	28.82	82.11	196	42	Y

(1) Monitored background concentrations are taken from **Table 5-1**.

Figure 6-1 Total 1-hour SO2 Concentrations – Isopleth



7.0 References

US EPA 2000. Meteorological Monitoring Guidance for Regulatory Modeling Applications. EPA-454/R-99-005 (February 2000). Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina.

US EPA 2004a. User's Guide for the AMS/EPA Regulatory Model (AERMOD). EPA-454/B-03-001 (September 2004 – Addendum March 2011). Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina.

US EPA 2004b. User's Guide for the AERMOD Meteorological Preprocessor (AERMET). (EPA-454/B-03-002, November 2004 – Addendum February 2011). Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina.

US EPA 2004c. User's Guide for the AERMOD Terrain Preprocessor (AERMAP). (EPA-454/B-03-003, October 2004 – Addendum March 2011). Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina.

US EPA 2008. AERSURFACE User's Guide. (EPA-454/B-08-001, January 2008). Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina.

US EPA 2011. Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-hour NO_2 NAAQS. (March 1, 2011). Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina. Available at: http://www.epa.gov/ttn/scram/Additional_Clarifications_AppendixW_Hourly-NO2-NAAQS_FINAL_03-01-2011.pdf

US EPA 2015. Docket ID No. EPA–HQ–OAR–2013–0711, August 10, 2015. Available at: http://www.epa.gov/oaqps001/sulfurdioxide/pdfs/so2_drr__final_081215.pdf.

US EPA 2015. AERMOD Implementation Guide (Revised). US EPA, Research Triangle Park, NC. August 3, 2015 (Last Revised).

US EPA 2016. SO_2 NAAQS Designations Modeling Technical Assistance Document. (August 2016 - Draft). Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina. Available at: https://www.epa.gov/sites/production/files/2016-06/documents/so2modelingtad.pdf.

Appendix A

30-years of Monthly Precipitation Data

Year	Precipitation (inches) Amount for Patuxent River NAS												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1980	3.69	1.16	7.01	3.40	2.13	0.96	4.70	2.18	2.47	6.61	2.49	0.68	37.48
1981	0.45	4.39	1.38	4.48	4.88	4.14	5.66	1.31	3.27	2.40	0.67	3.91	36.95
1982	3.39	4.46	3.56	3.85	3.77	6.07	4.02	2.96	5.46	2.02	4.44	2.51	46.49
1983	1.88	3.54	6.81	8.23	5.17	7.39	0.83	2.98	3.97	5.14	4.54	7.12	57.61
1984	3.23	4.22	10.16	4.76	11.00	1.77	3.30	4.49	1.50	5.25	3.65	1.60	54.94
1985	2.90	3.39	2.02	0.43	4.15	1.76	2.19	6.98	6.14	4.07	5.67	0.56	40.26
1986	3.15	2.67	0.92	0.96	1.92	1.40	1.69	5.82	1.23	2.50	2.94	6.96	32.18
1987	6.88	2.30	2.35	3.99	4.32	3.82	1.70	0.74	5.08	1.78	3.14	3.19	39.29
1988	2.99	4.81	3.40	2.90	3.87	1.33	3.50	2.57	1.83	2.25	5.13	0.76	35.33
1989	2.29	3.90	7.04	4.75	4.59	6.48	7.46	3.15	4.71	4.30	2.52	2.28	53.47
1990	4.22	3.02	5.97	4.63	11.26	5.12	5.37	6.26	1.69	3.94	1.37	5.42	58.28
1991	5.67	1.69	4.94	2.59	1.13	4.47	4.69	5.55	3.79	2.67	0.69	4.55	42.41
1992	1.50	3.34	5.21	1.85	3.96	4.61	7.59	6.65	6.11	1.74	2.77	4.57	49.91
1993	3.37	2.75	8.28	2.82	3.81	1.91	1.24	4.38	2.16	2.41	2.59	3.17	38.89
1994	3.87	4.84	12.42	3.31	2.62	4.37	5.79	3.51	3.00	1.73	3.15	1.10	49.70
1995	2.89	1.83	2.26	2.72	2.83	3.96	3.97	0.96	3.38	5.15	3.56	2.48	35.99
1996	4.37	2.66	3.15	8.67	4.66	4.69	7.62	3.80	6.47	5.70	2.33	6.10	60.24
1997	2.49	3.32	4.19	3.36	1.67	3.11	6.20	5.71	3.31	2.36	7.39	3.06	46.18
1998	6.78	7.54	5.52	3.20	3.77	5.30	1.51	1.19	1.50	0.92	1.00	2.50	40.75
2001	1.98	2.30	3.98	1.97	3.75	4.37	5.57	4.85	1.61	0.81	0.22	2.93	34.34
2002	2.81	0.83	5.31	3.10	1.92	2.27	2.00	2.99	3.52	7.41	5.25	4.33	41.74
2003	2.48	4.59	4.76	3.36	8.33	5.44	4.76	7.32	8.38	4.05	3.80	4.86	62.14
2004	2.78	2.18	3.28	9.56	3.25	6.50	12.00	7.54	4.35	0.73	3.09	2.78	58.03
2005	1.47	3.72	4.56	4.22	4.53	2.91	5.97	5.95	0.83	8.24	1.86	3.81	48.07
2007	2.63	1.86	1.70	3.45	1.59	3.90	0.80	3.90	0.80	4.46	1.14	3.87	30.11
2008	1.48	2.58	2.46	1.44	5.63	9.35	4.26	3.29	3.08	1.06	3.96	3.78	42.38
2009	1.85	0.45	2.53	3.24	4.61	5.05	5.11	4.94	4.17	8.04	7.84	7.16	54.99
2010	2.57	2.66	5.17	2.33	1.86	2.31	2.07	2.80	14.47	4.24	1.39	1.95	43.84
2011	1.71	1.81	4.44	3.46	2.35	5.19	4.05	11.41	4.17	2.33	2.23	2.66	45.81
2012	1.42	3.28	1.37	3.98	3.02	1.79	1.21	6.66	3.30	9.00	0.40	3.89	39.32
2013	3.15	1.64	3.07	4.49	1.33	7.28	4.89	4.36	1.50	6.02	2.85	5.45	46.03
2014	2.54	3.83	2.82	4.33	5.27	2.00	3.65	4.15	2.41	3.19	2.93	3.42	40.53