

Ambient Impact Analysis Guideline A Guideline for Performing Stationary Source Air Quality Modeling in Connecticut

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State of Connecticut

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# Introduction

## Background

This Ambient Impact Analysis Guideline (AIAG) has been written as a detailed supplement to the modeling procedures contained in the Environmental Protection Agency’s (EPA) Guideline on Air Quality Models (GAQM), as incorporated in [Appendix W of 40 CFR Part 51](https://www.epa.gov/sites/default/files/2020-09/documents/appw_17.pdf), and certain EPA clarification/guidance memorandums which supplement Appendix W. The EPA guidance addresses a broad range of modeling issues such as model selection, input data requirements, and technical considerations that are appropriate for assessing impacts from stationary sources, mobile sources, photochemical processes, and long-range transport. Whereas this guidance document focuses on modeling procedures that pertain to short-range (i.e., <50 kilometers (km)) stationary source modeling in Connecticut. The Connecticut Department of Energy and Environmental Protection (CT DEEP) will periodically update this guidance document to reflect any substantive changes to EPA or CT DEEP preferred modeling techniques. Readers should check both the EPA and CT DEEP websites to ensure that modeling analyses are conducted in accordance with the latest revisions to modeling guidelines. Users of this document are encouraged to contact CT DEEP staff before undertaking any regulatory modeling analysis in Connecticut. Applicants and their consultants are also encouraged to check the [Support Center for Regulatory Atmospheric Modeling (SCRAM) website](https://www.epa.gov/scram) for any new or revised versions of the AERMOD modeling system, and EPA policy guidance documents before undertaking New Source Review (NSR) National Ambient Air Quality Standards (NAAQS) and Prevention of Significant Deterioration (PSD) Permit Modeling Analyses in Connecticut.

The latest version of Connecticut’s AIAG is available on the CT DEEP Air Quality Modeling website at:

[DEEP: Air Permitting - Air Quality Modeling](https://portal.ct.gov/DEEP/Air/Modeling/Dispersion).

## Web-Based Modeling Guidance

In addition to this document, the CT DEEP website includes links to pre-processed meteorological data, criteria air pollutant databases, and links to other relevant CT DEEP and EPA modeling guidance and support documents not explicitly contained herein. Our web-based interface has been created to enhance efficiency and consistency in regulatory modeling. The public and regulated-community are encouraged to use our web-based modeling guidance and databases at their convenience.

Guidance documents and databases currently available on the website are:

* Connecticut’s AIAG,
* Links to EPA’s [SCRAM Website](https://www.epa.gov/scram) and EPA’s [Appendix W](https://www.epa.gov/sites/default/files/2020-09/documents/appw_17.pdf) Guideline on Air Quality Models, latest available five years of pre-processed AERMOD ready hourly meteorological datasets, and measured ambient monitoring data for use as background concentrations including:
* Most recent design value concentrations at CT DEEP operated monitoring locations for all criteria pollutants;
* 99th and 98th percentile season by hour of day monitored values for 1-hour SO2 and NO2 respectively; 98th percentile seasonal PM2.5 24-hour average measured values, and;
* Five years of hourly background ozone data used for approved Tier3 NO2 modeling.

## Summary/Overview

Section 22a-174-3a of the Regulations of Connecticut State Agencies (RCSA) requires the owner of certain stationary sources of air pollution to apply for and obtain a permit prior to the construction, modification, and operation of the source. Permit applicability is defined in RCSA section 22a-174-3a (a). RCSA Section 22a-174-3a(d)(3)(B) and (C) requires the owner of any source for which an application for an air permit has been submitted to demonstrate that the operation of the source will not cause or contribute significantly to a violation of any federal or state air quality standard or prevention of significant deterioration (PSD) increment. RCSA Section 22a-174-3a(i)(2), requires this demonstration to include estimates of air quality impacts that follow procedures approved by the CT DEEP Commissioner. This document describes the approved procedures for performing stationary source air quality impact analyses. The recommended procedures conform to EPA’s modeling guidance contained in [Appendix W of 40 CFR Part 51](https://www.epa.gov/sites/default/files/2020-09/documents/appw_17.pdf).

[Section 2](#_Model_Applicability) contains model applicability rules including major and minor source emission threshold requirements for PSD and NAAQS modeling.

[Section 3](#_Air_Quality_Criteria) contains the air quality criteria including the NAAQS, PSD increments, and Significant Impact Levels (SILs) for all regulated pollutants.

[Section 4](#_Modeling_Analyses_for) contains Good Engineering Practice (GEP) Stack Height recommended analyses, modeling analyses that include user-supplied input data to characterize the source of emissions, meteorology, and receptor geometry and background air quality. This section details the recommendations on the preparation and use of model input data, interpretation of results via a three-step process that includes a screening assessment, modeling of the subject source alone, compliance demonstration with the SILs, and, if necessary, defining the significant impact area (SIA). Section 4 defines the multi-source refined modeling and inventory requirements for NAAQS and PSD modeling analyses.

Background air quality procedures and analyses for all regulated pollutants are provided in [Section 5](#_Background_Air_Quality).

Analysis and interpretation of modeled results and compliance demonstration with the NAAQS and PSD increments are presented in [Section 7](#_Presentation_of_Compliance).

A list of referenced literature is provided in [Section 8](#_References).

# Model Applicability

As mentioned in Section 1.2 above, RCSA section 22a-174-3a(d)(3)(B) and (C) requires the owner of any source applying for an air permit to demonstrate that the operation of the source will not cause or contribute significantly to a violation of any federal or state air quality standard or PSD increment. RCSA section 22a-174-3a(i) requires this demonstration to include estimates of air quality impacts that follow procedures approved by the CT DEEP Commissioner. Definitions applicable for estimating air quality impacts can be found in RCSA section 22a-174-1. Owners of sources that are not required to obtain an air permit, such as sources that limit their emissions under RCSA section 22a-174-3b (Permit by Rule), are not subject to the modeling requirements of RCSA section22a-174-3a.

# Air Quality Criteria (Modeling for NAAQS and PSD Compliance)

## National Ambient Air Quality Standards

Table 3-1 displays the National Ambient Air Quality Standards that have been established for the criteria air pollutants. In addition, a single Connecticut Ambient Air Quality Standard (CAAQS) was established for total Dioxin (see RCSA section 22a-174-24(m)) that is also listed in Table 3-1. Each NAAQS is defined in terms of pollutant, averaging time, and level above which health is at risk (primary standard).

Compliance with each NAAQS is determined by adding the appropriate modeled predicted impacts to background design values (for the applicable pollutant, short- and long-term averaging times), and comparing the combined values from each receptor modeled to the NAAQS (see Table 3-1 footnotes). The modeled impacts used in this determination represent impacts not only from the applicant source, but also other nearby sources, if required, (source inputs are reviewed and approved CT DEEP), plus background levels, which are also provided by CT DEEP, unless monitoring is required.

If there are violations with any applicable NAAQS, applicants must demonstrate that a source does not cause or significantly contribute to any violation for a permit to be issued.

**TABLE 3-1**

**National and Connecticut Ambient Air Quality Standards**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Primary Standards** | | |
| **Pollutant** | **Level** | **Averaging Time** | **Notes on demonstrating compliance with NAAQS via modeling** |
| Carbon  Monoxide (CO) | 10,000 µg/m3 | 8-hour | Not to be exceeded more than once per year |
| 40,000 µg/m3 | 1-hour | Not to be exceeded more than once per year |
| Dioxin | 1.0 picogram/m3 | Annual Average | Not to be exceeded |
| Lead (Pb) | 0.15 µg/m3 (1) | Rolling 3-Month Average | Not to be exceeded |
| Nitrogen  Dioxide (NO2) | 100 µg/m3 | Annual (Arithmetic Mean) | Not to be exceeded |
| 188 µg/m3 | 1-hour | The 5-year average (1-year for on-site MET data) of the 98th percentile of 1-hour maximum daily concentrations |
| Particulate  Matter (PM10) | 150 µg/m3 | 24-hour | Not to be exceeded more than once per year on average over 5 years (1-year for on-site MET data) |
| Particulate  Matter (PM2.5) | 12.0 µg/m3 | Annual (Arithmetic Mean) | Not to be exceeded (See Section 4.4) |
| 35 µg/m3 | 24-hour | The 5-year average (1-year for on-site MET data) of the 98th percentile of the 24-hour concentrations (See Section 4.4) |
| Ozone (O3) | 0.070 ppm | 8-hour (2) | O3 – (See Section 4.4) |
| Sulfur  Dioxide (SO2) | 196µg/m3 | 1-hour | The 5-year average (1-year for on-site MET data) of the 99th percentile of the 1-hour maximum daily concentrations |

1 National lead standard, rolling 3-month average, signed October 15, 2008

2 To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.070 ppm (effective October 26, 2015)

## Prevention of Significant Deterioration (PSD)

Connecticut’s NSR PSD program is implemented by CT DEEP as a federally approved program. The objectives of the PSD program are: to ensure that economic growth will occur in harmony with the preservation of existing clean air resources; to protect public health and welfare at air quality levels that are cleaner than the NAAQS; and to preserve and protect air quality in natural recreational, scenic or historical areas including but not limited to national parks and wilderness areas. Additional PSD requirements for a new major source or major modification also include an analysis of impairment of visibility, soils, and vegetation. These objectives are accomplished by not allowing significant incremental degradation of air quality beyond baseline concentrations in an area. A Baseline concentration is the ambient concentration level of an air pollutant at the time of the first PSD permit application submittal affecting an area.

PSD applicability determination is based on whether a source is a new major stationary source or if a modification to an existing source is considered a major modification. However, the PSD program also requires an assessment of minor source growth on increment consumption. An increment is the maximum allowed increase in SO2, NO2, PM10, and PM2.5 concentrations above the baseline concentration in an area. Connecticut’s approach to tracking increment consumption from minor sources is to require every permitted source to demonstrate compliance with the existing increments regardless of its level of annual emissions.

CT DEEP maintains PSD inventories for each pollutant for the purpose of tracking PSD increment consumption. An applicant must assess PSD increment consumption from the subject source and from the inventory of nearby increment consuming sources. The baseline concentration for PSD modeling purposes is defined as the minor source baseline date. These dates are June 7, 1988, for NO2 and PM10, December 17, 1984, for SO2, and August 24, 2014, for PM2.5. Table 3-2 displays the current PSD increments that have been promulgated for the criteria pollutants.

**TABLE 3-2**

**Class II PSD Increments (µg/m3)**

|  |  |  |  |
| --- | --- | --- | --- |
| **POLLUTANT** | **Annual1** | **24-Hour2** | **1-Hour** |
| SO23 | 20 | 91 | \* |
| NO2 | 25 |  | \* |
| PM10 | 17 | 30 |  |
| PM2.5 | 4 | 9 |  |

1 Not to be exceeded

2 Not to be exceeded more than once per year

3 Compliance with the annual and 24-hour SO2 PSD increments are required until a 1-hour SO2 increment is promulgated

## Significant Impact Levels

Significant Impact Levels (SILs) are used to determine if a new or modified stationary source may cause or contribute to a violation of the NAAQS or PSD increments. If a new or modified stationary source’s predicted impacts are greater than or equal to the SIL values listed in Table 4-3, then a cumulative impact analysis is required. A cumulative impact analysis considers other nearby sources within the Significant Impact Area (SIA) of the proposed or modified stationary source as well as existing ambient pollution background levels. Modeled impacts from a source of air pollution are considered significant if they equal or exceed the SIL values listed in Table 3-3.

Model results should be compared to the SILs based on 5 years of NWS met data (1-year for site-specific met data, or 3 years of prognostic met data) in the following manner:

* For 1-hour NO2 ((Tier1 Full Conversion), or Tier2 (ARM2) Screening Methods)) and SO2: the highest of multi-year averages of the maximum modeled daily 1-hour concentrations predicted each year at each receptor;
* For 24-hour PM10: The highest first high 24-hour average concentrations predicted at each receptor;
* For 24-hour PM2.5: The highest of multi-year averages of the maximum modeled 24-hour concentrations predicted at each receptor;
* For annual PM2.5 & NO2: The highest of multi-year averages of the maximum modeled annual concentration predicted at each receptor, and
* For 1-hour and 8-hour CO: The highest-first-high 1-hour and 8-hour average concentrations predicted at each receptor.

If maximum source impacts are predicted to be below the SIL values shown in Table 3-3, additional multi-source modeling may not be required and compliance with the applicable NAAQS or PSD increment is demonstrated.

**TABLE 3-3**

**Class II Significant Impact Levels (µg/m3)** (1)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **POLLUTANT** | **Annual** | **24-Hour** | **8-Hour** | **3-Hour** | **1-Hour** |
| SO2 | 1.0 | 5.0 |  | 25.0 | 7.8 (2) |
| NO2 | 1.0 |  |  |  | 7.5 (3) |
| PM10 | 1.0 | 5.0 |  |  |  |
| PM2.5 (4) | 0.2 | 1.2 |  |  |  |
| CO |  |  | 500 |  | 2,000 |

1 Source impacts must be less than the appropriate significance impact levels to be considered “insignificant or de minimis”.

2 On August 23, 2010, EPA recommended a SIL of 3 ppb (7.8µg/m3) for the 1-hour SO2 NAAQS.

3 On June 28, 2010, EPA recommended a SIL of 4 ppb (7.5µg/m3) for the 1-hour NO2 NAAQS.

4 On April 17, 2018, EPA issued Guidance on Significant Impacts Levels for Ozone and Fine Particulates in the Prevention of Significant Deterioration Permitting Program.

# Modeling Analyses for NAAQS/PSD Compliance Demonstration

This section provides applicants detailed requirements and procedures for performing an ambient impact analysis for the purpose of demonstrating compliance with the NAAQS and PSD increments. CT DEEP intends to update this document periodically; however, applicants are encouraged to consult with CT DEEP prior to conducting ambient impact analyses to confirm that guidance given herein reflects all current state and federal modeling requirements.

The latest version of EPA’s approved regulatory air dispersion model (AERMOD) is required to predict ambient impacts from proposed new and modified existing permitted stationary sources in Connecticut. EPA’s AERMOD screening model AERSCREEN is used to perform screening modeling analyses to determine worst-case operating conditions from proposed new and modified existing sources, and to assess for adverse impacts from minor sources. AERMOD is the recommended refined single and multi-source dispersion model, to predict ambient impacts on flat, simple, intermediate, and complex terrain within 50 kilometers (km) of the source modeled. AERSCREEN and AERMOD input requirements, modeling procedures, and analyses are discussed in more detail below.

## Screening Modeling Analysis

AERSCREEN is the preferred regulatory screening model for air permitting applications that is used to estimate ambient impacts from point, area, volume sources, and flares out to 50 km. AERSCREEN is a single-source screening version of AERMOD that produces conservative impact estimates that has the capability to handle building downwash without the need for refined meteorological data.

Screening modeling is conducted to assess worst case impacts from new minor sources or minor modifications whose annual allowable emissions fall within ranges shown Table 4-1.

**TABLE 4-1**

**Screening Modeling Allowable Emissions Thresholds (TPY)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Pollutant | > 0.5 & < 10 | > 3 & <15 | > 1 & < 40 | > 5 & < 100 |
| NO2 |  |  | X |  |
| SO2 |  | X |  |  |
| PM10 |  | X |  |  |
| PM2.5 | X |  |  |  |
| CO |  |  |  | X |

Each source should be modeled at a minimum of 50, 75 and 100% loads when determining if maximum impacts are below the CT DEEP’s Screening Adverse Impact Levels (AILs). Sources within these emissions ranges can demonstrate compliance with the NAAQS and PSD increments by simply demonstrating that the maximum predicted impacts (without the addition of background concentrations) are below the AILs shown in Table 4-2.

**TABLE 4-2**

**Adverse Impact Levels (µg/m3)** (1)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Pollutant | Annual average | 24-hour average | 8-hour average | 1-hour average |
| NO2 | 12.5 |  |  | 24 |
| SO2 |  |  |  | 25 |
| PM10 |  | 15 |  |  |
| PM2.5 | 2.0 | 4.5 |  |  |
| CO |  |  | 1,250 |  |

1 CT DEEP’s Screening Adverse Impacts Levels were originally derived from CTDEP’s 1979, 1991, and 1996 Stationary Source Stack Height Guideline, based on half the PSD Increments, and 12.5% of the NAAQS for 8-hour CO, 1-hour NO2 and SO2, respectively.

If a source cannot demonstrate compliance with the AILS, either reduce emissions below modeling thresholds or perform refined modeling to demonstrate compliance with the NAAQS and PSD increments

### Screening Modeling Inputs

NAAQS, PSD increments and SILs cover a variety of averaging periods depending on the air pollutant of concern. General input requirements can be found in the AERSCREEN user’s guide. Additional screening modeling guidance is discussed in the remainder of this section.

**Emissions**

A source should be modeled (at a minimum) at its 50, 75 and 100% proposed or modified maximum allowable hourly and annual emission rates with stack parameters corresponding to the modeled load rates to determine the maximum short-term screening impacts. Annual and daily emissions may be scaled as a surrogate for allowable hourly emissions to show compliance with short term standards for minor sources that will have federal and or state enforceable permit emission limits. However, consultation with CT DEEP modeling staff is recommended prior to undertaking such minor source screening modeling using annual or daily emissions as a surrogate for maximum allowable hourly emissions.

**Stack Parameters**

The following inputs parameters must be used in AERSCREEN:

* Stack location coordinates;
* Pollutant specific proposed/modified maximum allowable hourly emission rate;
* Stack base elevation (height of stack base above mean sea level);
* Stack height - height of stack-top above stack base;
* Stack top exit temperature of effluent exiting the stack;
* Stack gas velocity of effluent exiting the stack;
* Stack inside diameter at top of stack;
* Worst case building dimensions;
* Urban or rural option, and;
* Minimum distance to “ambient air.”

**Building Downwash/Cavity Considerations**

The presence of structures in the vicinity of a stack can influence the behavior of the plume emitted from that stack. To determine the extent to which local structures affect plume dispersion, a GEP stack height analysis must be performed. EPA’s “Guideline for the Determination of GEP Stack Height” (EPA, 1985) is the recommended procedure to assess whether emissions from a stack will be influenced by the turbulent wake zones created by nearby buildings or terrain. If a stack height is less than its formula GEP height, then the stack is subject to building downwash. There can be some building downwash even for stacks above formula GEP height. According to Appendix W section 7.2.2.1: “Since the definition of GEP stack height defines excessive concentrations as a maximum ground-level concentration due in whole or in part to downwash of at least 40 percent in excess of the maximum concentration without downwash, the potential air quality impacts associated with cavity and wake effects should also be considered for stacks that equal or exceed the EPA formula height for GEP.”

The building height, the maximum horizontal dimension, and minimum horizontal dimension of all nearby buildings on or near the premise should be used in the AERSCREEN model. In some instances, it may be necessary to run the model multiple times for the same source (stack) to assess impacts from multiple structures on or off the premise. Building dimensions can be input to AERSCREEN individually in the interactive input stream of the model or EPA’s Building Profile Input Program for PRIME (BPIPPRIM) can be run to assist the user in complex building situations.

When documenting a GEP stack height analysis, a scaled plot plan of the facility that shows the location of each structure and stack, an aerial photograph, or a Google Earth/Map overhead snapshot view showing the facility layout must be included. The facility layout should also include: a north arrow, an accurate scale ruler, all structure heights, and horizontal dimensions, the facility boundaries, and any fenced areas in/around the facility. Great care must be taken with photo-copied plot plans, or Google Earth/Maps to ensure that the scale is accurate and correct across the entire plot plan.

**Screening Receptors**

Screening receptors should be selected based on detailed horizontal and vertical resolution of the terrain surrounding the source being modeled. When running AERSCREEN applicants must download terrain data in National Elevation Dataset (NED) in GeoTIFF format from the United States Geological Survey (USGS, 2002) for input to the model. The reference datum for NED is usually NAD83 and therefore the user must be extremely careful not to mix coordinate systems such as inputting the stack coordinates in NAD27 and generating receptors in NAD83. Note that AERSCREEN has default receptor spacing of 25m out to a user specified downwind distance (i.e., probe distance). The probe distance input to the model must be set to a distance that captures the maximum impact of the source being modeled. The recommended probe distance should be no less than 5km up to 10km. If screening modeling results show that concentrations are not decreasing at the outer extent of the receptor network at 10km, then the grid must be extended further until concentrations begin to decrease. Since AERSCREEN can determine if the stack effluent will be re-circulated into the part of the building wake known as the cavity zone, additional receptors must be placed inside the cavity zone, where the public has access defined as “ambient air.” This approach to developing a receptor network requires that the user accurately represents the location of the source and receptor network origin.

**Screening Meteorological Data**

Meteorological data is generated via inputs to the AERSCREEN model which in turn executes the MAKEMET program (a tool which generates a set of screening modeling met data based on user input data). It is recommended that the user specify the default values for minimum/maximum ambient temperatures, minimum wind speed, and anemometer height. In addition, the user should direct AERSCREEN to specify the default surface characteristics based on either the AERMET seasonal tables (which requires the user to specify a single dominant land use type in the area surrounding, the source being modeled, and average moisture type), or site-specific surface characteristics generated by AERSURFACE.

### Screening Modeling Results

NAAQS, PSD increments and SILs cover a variety of averaging periods depending on the air pollutant in question. Therefore, EPA developed conversion factors to adjust screening modeling results to get the appropriate averaging time depending on the pollutant being modeled. In 2011, EPA revised and hard coded the screening conversion factors in AERSCREEN to produce 1-hour screening concentration values to get the appropriate averaging time depending on the pollutant being modeled shown Table 4-3.

**TABLE 4-3**

**Screening Conversion Factors**

|  |  |
| --- | --- |
| **1-Hour Conversion Factor** | **Averaging Time** |
| 1.0 | 3-hour |
| 0.9 | 8-hour |
| 0.6 | 24-hour |
| 0.1 | Annual |

AERSCREEN calculates impacts from single sources only. Therefore, if two or more sources are being permitted or modified on the same premise, conduct screening modeling for each source separately, add each sources’ impact, and then compare the total impacts to Table 4-2. If the impacts are less than the values shown in Table 4-2, then compliance with the NAAQS and PSD increments is demonstrated and refined modeling is not required.

## Refined Modeling Procedures

Refined modeling is required for all sources whose allowable annual emissions are above the screening modeling emission ranges listed in Table 4-1. Refined modeling is also required for sources that cannot demonstrate compliance with the AILs listed in Table 4-2 in a screening analysis.

### AERMOD Modeling System Programs

AERMOD is an all-terrain steady-state dispersion model for determining ambient impacts within 50 km of a stationary source. AERMOD is based on Gaussian and planetary boundary layer concepts, and is designed for flat, simple, intermediate, and complex terrain applications. Therefore, applicants must use AERMOD if refined modeling is required to obtain a new or modified air permit in Connecticut. The AERMOD modeling system, including preprocessors, users’ guides, and associated guidance documents are available for download on EPA’s [SCRAM](https://www.epa.gov/scram) website. The AERMOD modeling system includes the use of the following programs:

* **AERMOD** – EPA’s preferred regulatory dispersion model requires that various user-selected parameters, as well as incorporates the input data created in BPIPPRIM, AERMAP and AERMET,
* **AERMAP** - terrain pre-processor for AERMOD,
* **AERMET** - meteorological pre-processor for AERMOD,
* **AERMINUTE** - a program that uses 1-minute and 5-minute archived wind data to calculate hourly missing wind speed and direction for input to AERMET,
* **AERSURFACE** - utility program designed to calculate estimates of surface characteristics based on most recent Land Cover information for input to AERMET, and
* **BPIPPRIM** - multi-building dimensions program incorporating the GEP technical procedures for PRIME downwash applications.

### AERMOD Input Requirements

**AERMOD Control Options**

Control options contain the keywords that effectively execute AERMOD to calculate maximum impacts based on such options as urban/rural dispersion, type of pollutant, averaging times, and terrain height. The following AERMOD default regulatory control options are required to demonstrate compliance with both the NAAQS and PSD increments:

* Use elevated terrain algorithms;
* Stack-tip downwash (except for building downwash cases);
* Calm and missing meteorological data processing routines;
* Use of a 4-hour half-life for exponential decay of SO2 (for urban sources only);
* Vertical potential temperature gradients;
* ARM2 for 1-Hour and Annual NO2 modeling; and
* Urban/rural dispersion coefficients

Section 5.1 of the AERMOD Implementation Guide, and Section 7.2.1.1 of EPA’s latest Guideline on Air Quality Models in Appendix W, should be followed to determine urban/rural dispersion coefficients based on land use, total population of the urban modeling domain, and or population density within 3 km around the subject source. The preferred method to determine urban/rural dispersion coefficients is based on total population across the urban modeling domain along Connecticut’s coastline due to proximity to Long Island Sound.

**Source Emissions**

Sources should input the proposed and or permitted maximum allowable hourly emission rates for compliance with the applicable NAAQS and PSD increments short term standards, with averaging times of less than a year. The maximum allowable annual emission rates may be used to show compliance with annual average based standards.

**Source Parameters**

The following input source location and parameters are required to be modeled in AERMOD:

* Stack location - X coordinate (UTM-X grid in meters), Y coordinate (UTM-Y grid in meters),
* Stack base elevation - height (m) of stack base above mean sea level,
* Pollutant emission rate (g/s),
* Stack height - height of stack-top above stack base (m),
* Stack top exit temperature - temperature (K) of effluent exiting the stack,
* Stack gas velocity - (m/s) of effluent exiting the stack, and
* Stack diameter - at the inside top of stack (m).

**BPIPPRIM – Building Downwash**

CT DEEP recommends procedures described in the EPA’s “[Guideline for Determination of Good Engineering Practice Stack Height](https://www.epa.gov/sites/default/files/2020-09/documents/gep.pdf)” (EPA, 1985) for GEP stack height calculations. To address building downwash, a GEP stack height analysis should be performed on each source to be modeled at the applicant’s premise. The lesser of actual or GEP stack height should be used for modeling each source. The latest version of EPA’s Building Profile Input Program for PRIME (BPIPPRIM) must be used to generate wind-direction-specific building dimensions for calculating downwash impacts in AERMOD from each source subject to building downwash.

**AERMAP – Receptor Data**

AERMAP is the terrain pre-processor that creates an elevation and height scale (the terrain height and location that has the greatest influence on dispersion) for each “ambient air” receptor, except where the atmosphere over land owned or controlled by the stationary source where the owner or operator of the source employs “measures, which may include physical barriers, that are effective in deterring or precluding access to the land by the general public” across the modeling 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.

The latest version of AERMAP is designed to process National Elevation Dataset (NED) data, which is available on the U.S. Geological Survey (USGS) website. Applicants should use at least 1 arc second (30 meter resolution), preferably 1/3 arc second (10 meter) resolution NED data to develop a Cartesian type of receptor grid to determine all near and far field receptor elevations. The goal of designing a receptor network is to convincingly capture the area of maximum impact. As an initial starting point, construct a Cartesian receptor grid centered on the source with 50m receptor spacing out to 2 km. For a distance from the source of 2 km to 5 km, place receptors with 500 m spacing, and for a distance from the source of 5km to 10km, use 1 km spacing. CT DEEP recommends a maximum receptor spacing of 25 m for calculating impacts in cavity regions of structures and within property boundaries (that have public access), or around facility property or fence-line (where public access is prohibited). If modeling results show significant impacts at 10 km, then the grid should be extended to a distance of insignificant impacts, using 2 km spacing out to 20 km and 5 km spacing beyond 20 km. Additional 1 km receptor grid(s) in 50 m increment spacing should also be developed around maximum impacts beyond the inner receptor grids of 2 km to identify the point of maximum impact. Additional discrete receptors may also be required at locations designated as sensitive, such as schools and hospitals, or in environmental justice communities, which provide enhanced public participation requirements, and may require additional information about potential environmental and health impacts.

**AERMET – Meteorological Data**

Meteorological data for refined modeling should be representative of wind flow and dispersion characteristics that affect source emissions across the modeling domain. AERMET uses meteorological measurements of several boundary layer parameters to compute vertical profiles of wind direction, wind speed, temperature, vertical potential temperature gradient, vertical turbulence (sigma-w), and horizontal turbulence (sigma-theta), and radiation measurements. One year of site-specific meteorological data is always preferred to off-site NWS data for dispersion modeling near a source (EPA’s Meteorological Monitoring Guidance, 2000). However, applicants may use the most recent five years of NWS data or three years of prognostic meteorological data to adequately characterize year-to-year meteorological variability, in lieu of one year of site–specific data. For a more detailed discussion of data representativeness considerations, see Section 3.1.1 of the AERMOD Implementation Guide, and Section 8.4 of EPA’s Appendix W of 40 CFR Part 51 Guideline on Air Quality Models.

AERMET is designed to accept data from any of the following sources:

* Upper air sounding data from the NWS upper air station in Albany, NY for inland areas and Brookhaven, NY for coastal areas,
* Hourly surface data from the most representative NWS ASOS sites,
* Hourly prognostic meteorological data, and
* Hourly surface site-specific wind, temperature, turbulence, pressure, and radiation measurements (if available).

AERMET has the capability of accepting hourly averaged 1-minute and 5-minute NWS wind data output from the above mentioned AERMINUTE program to reduce the number of calm hours. AERMET produces a profile file that consists of single and multiple-level observations of wind speed, wind direction, temperature, site-specific turbulence data such as standard deviation of the fluctuating wind direction, and vertical wind speed. AERMET also produces an hourly surface file of boundary layer parameter estimates and surface characteristics (albedo, Bowen ratio, and surface roughness length) of the area being modeled. The user must first specify monthly (seasonal) variations of these surface characteristics for up to 12 different contiguous non-overlapping sectors. Each wind sector can have a unique Albedo (r), Bowen ratio (Bo), and Surface Roughness (Zo) value.

AERMET processes meteorological data in one stage:

**Stage 1** extracts upper air sounding, hourly and one minute surface meteorological data from archive data files and processes the data through various quality assessment checks; reads the meteorological data and estimates the necessary boundary layer parameters and then processes the data in AERMOD-ready format.

**AERSURFACE – Surface Characteristics**

The AERSURFACE pre-processor tool is used to obtain realistic and reproducible surface characteristic values for input to AERMET. Surface characteristics generated for AERMET should reflect the land use characteristics where the meteorological data are collected. AERSURFACE requires the input of most recent available land cover data from the USGS National Land Cover Data archives (NLCD) to determine the land cover types for user-specified locations. The following methodologies are recommended to determine surface characteristics:

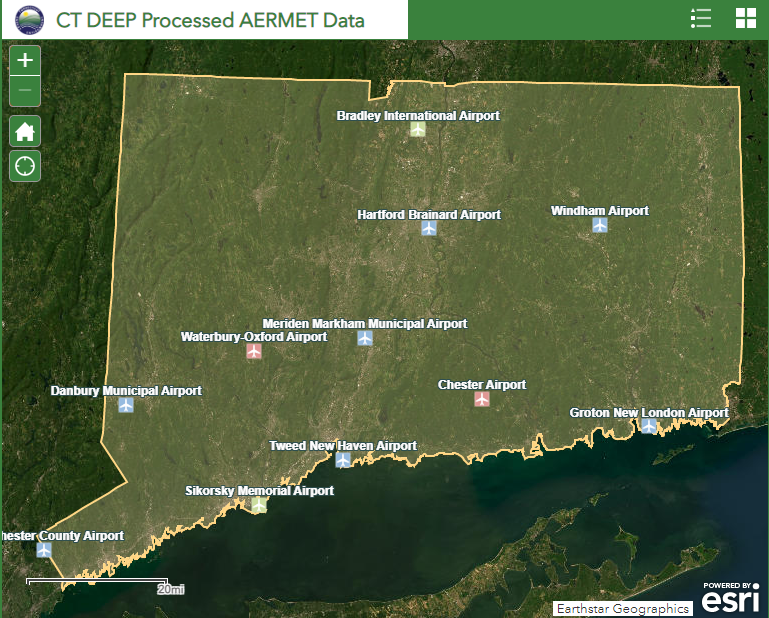
* Surface roughness length is determined based on an inverse-distance weighted geometric mean for a default upwind distance of 1km relative to the meteorological site and divided up by sectors to account for variations in land cover and airport versus non-airport use; however, the sector widths should be no less than 30°;
* Bowen ratio is based on a simple un-weighted geometric mean for a representative domain, with a default of 10 km by 10 km region centered on the meteorological site, and
* Albedo is based on a simple un-weighted arithmetic mean for the default 10 km by 10 km domain defined by the Bowen ratio.

Applicants are also encouraged to follow Section 3.1.2 and 3.1.3 in EPA’s latest version of the AERMOD Implementation Guide to determine surface characteristics around the meteorological sensor based on the latest version of AERSURFACE.

Depending on the source location, data from the following two upper air sites are required for AERMOD meteorological data processing: 1) Albany upper air sounding data for all sources located >10 km away from Connecticut’s shoreline; and 2) Brookhaven upper air sounding data for all sources located within 10 km along Connecticut’s shoreline.

We strongly encourage applicants to consult with CT DEEP modeling staff to discuss meteorological data requirements prior to performing refined dispersion modeling. However, for most permit modeling in Connecticut and consistent with the above discussion, CT DEEP has developed AERMOD ready preprocessed NWS ASOS/AWOS meteorological data shown in Figure 4-1 below. Applicants may download the available processed AERMOD ready meteorological data posted on the met data section of CT DEEP’s [modeling web page](https://portal.ct.gov/DEEP/Air/Modeling/Dispersion).

**FIGURE 4-1**



### Single Source Refined Modeling

The objectives of the single source refined modeling is: 1) to determine if a new or modified source may cause or significantly contribute to a violation of the NAAQS and PSD increments, and 2) if a new or modified source has model predicted significant impacts in order to determine the significant impact area (SIA) for cumulative modeling.

**Significant Impact Area Determination**

The SIA is defined as the most distant location where air quality modeling predicts a significant ambient impact for a given pollutant, or the nominal 50 km distance, “**whichever is less**”. The SIA distance is the modeling domain (including all receptors) within the SIA that is used to determine which sources are to be included in a cumulative modeling analysis. If maximum impacts exceed the SIL for any pollutant and averaging time shown in Table 3-3, then a cumulative ambient impact analysis is required.

## 1-Hour NO2 NAAQS Compliance Options

The EPA promulgated a new 1-hour NO2 NAAQS based on the 3-year average (for modeling purposes based on the 5-year average) of the 98th percentile annual distribution of the maximum daily 1-hour concentration not to exceed 100 ppb (188 µg/m3) in 2010. Due to the complex chemical transformation from sources’ NOx emissions to form NO2 in the atmosphere, and the stringency of the 1-hour NO2 NAAQS, EPA issued several modeling guidance memorandums (EPA [2011](https://www.epa.gov/sites/default/files/2015-07/documents/appwno2_2.pdf) and [2014](https://www.epa.gov/sites/default/files/2020-10/documents/no2_clarification_memo-20140930.pdf)) regarding options for demonstrating compliance with the 1-hour NO2 NAAQS. These options include a multi-tiered screening modeling approach, certain modeling exemptions for intermittent sources, and start-up/shutdown emissions scenarios. Below is a summary of the multi-tiered screening approach and modeling exemptions to attain the NO2 NAAQS (see section 4.2.3.4 and Figure 4-1 in EPA’s Appendix W Revisions to the Guideline on Air Quality Models for a detailed discussion of the NO2 multi-tiered screening approach).

### NO2 Screening Methods

Tier 1 is a first tier (most conservative) “full conversion approach” of NO to NO2 without additional modeling inputs or options.

Tier 2 Ambient Ratio Method 2 (ARM2)

The model internally multiplies Tier 1 impacts by ARM2 using default ambient ratios, and or source-specific NO2/NOx in stack ratio (ISR) data as a surrogate for source-specific ambient ratios. The ARM2 national default minimum and maximum ambient ratios for the primary source are 0.5 and 0.9. For cumulative modeling, all sources located within the immediate vicinity (1-3 km) of the primary source being modeled is also 0.5. Preferably, source-specific NO2/NOx ISRs may be used if all quality assurance procedures for NO2/NOx within the typical range of measured ambient ratio values are satisfied, such as: EPA’s NO2/NOx ISR database, manufacturer test data, and peer-reviewed literature to justify a source’s anticipated NO2/NOx ISRs.

Tier 3 Plume Volume Molar Ratio/Ozone Limiting Method (OLM/PVMRM)

PVMRM/OLM screening methods are the most complex of the three tiers that require one additional model input: 1) default or source specific NO2/NOx ISRs, and 2) hourly ozone background data. For sources beyond 1-3 km of the subject source, the default value is 0.2. Preferably, source-specific NO2/NOx ISRs may be used if all quality assurance procedures for NO2/NOx within the typical range of measured ambient ratio values are satisfied, such as: EPA’s NO2/NOx ISR database, manufacturer test data, and peer-reviewed literature to justify a source’s anticipated NO2/NOx ISRs. For Major Source Permit Modeling, applicants must seek consultation and approval from CT DEEP modeling staff and EPA Region 1 prior to conducting a Tier 3 NO2 modeling analysis. For Minor Source Permit Modeling, applicants must seek consultation and approval from CT DEEP modeling staff prior to conducting a Tier 3 NO2 modeling analysis.

### NO2 Modeling Exemptions for Intermittent Sources

EPA provides flexibility and discretion to exempt intermittent emissions from ancillary sources such as emergency generators, fire pumps, small boilers, and engines because emission scenarios are not continuous enough to contribute significantly to the annual distribution of the maximum daily 1-hour NO2 concentrations. The CT DEEP will consider an intermittent source on a case-by-case basis with permit limits of up to 500 hours per year that could be potentially exempt from 1-hour NO2 modeling (also applicable for 1-hour SO2 modeling). All other major and (minor sources on a continuous basis) will be required to perform modeling analyses to show compliance with the applicable 1-hour NO2, and SO2 NAAQS. Applicants are strongly encouraged to consult with the CT DEEP modeling staff to seek clarification and approval for 1-hour modeling exemptions prior to undertaking modeling analyses.

### Startup/Shutdown Scenarios

All major sources and (minor sources on a continuous basis) are subject to perform a modeling analysis to show that startup/shutdown operating scenarios follow the applicable 1-hour NO2 andSO2, NAAQS. Only a limited number of minor sources such as emergency generators, fire pumps, aux boilers, small CHP engines, and flares may be exempt due to the infrequent number of startups and shutdowns per year. This type of source(s) limits the number of startups and shutdowns to less than or equal to 500 hours per year may be considered intermittent; and therefore, would not significantly contribute to maximum daily 1-hour NO2 and SO2 concentrations. CT DEEP will consider such modeling exemptions only if 500 hour per year or less limitations and restrictions are included and enforced in a new or modified NSR air permit. Applicants are strongly encouraged to consult with the CT DEEP modeling staff to seek clarification and approval for 1-hour modeling exemptions prior to undertaking modeling analyses.

## Guidance for Ozone and Fine Particulate Matter Permit Modeling

Compliance with PM2.5 NAAQS and PSD increment require modeling for both primary and secondarily formed PM2.5. AERMOD is EPA preferred dispersion air quality model for permit modeling for primary PM2.5 emissions to comply with the applicable PM2.5 NAAQS and PSD. AERMOD is a steady state Guassian Model and is not capable of modeling for secondary precursor PM2.5 emissions of NOx and SO2 such as CAMx and CMAQ photochemical models. EPA incorporated a two-tiered approach for addressing single-source O3 and secondary PM2.5 impacts in the revised Guideline on Air Quality Models (EPA, 40 CFR Part51, Appendix W 2017). Due to the intensive photochemical modeling systems, the EPA issued [guidance](https://www.epa.gov/sites/default/files/2019-05/documents/merps2019.pdf) on the development of Modeled Emission Rate for Precursors (MERPS) as a Tier 1 Demonstration Tool (reduced form models), entitled *“Guidance on the Development of Modeled Emission Rates for Precursors (MERPS) as a Tier 1 Demonstration Tool for Ozone and PM2.5 under the PSD Permitting Program”* (EPA 2019)*.* The first tier (Tier 1) utilizes existing empirical relationships between precursor emissions and impacts based on the most recent EPA’s photochemical air quality modeling results of hypothetical industrial sources with similar source emissions and atmospheric characteristics.

## Single Source Air Quality Assessments for Secondarily Formed Particulate Matter

EPA incorporated a two-tiered approach for addressing single-source O3 and secondary PM2.5 impacts in the revised Guideline on Air Quality Models (EPA, 40 CFR Part51, Appendix W 2017). Due to the intensive photochemical modeling systems, the EPA issued guidance on the development of Modeled Emission Rate for Precursors (MERPS) entitled *“Guidance on the Development of Modeled Emission Rates for Precursors (MERPS) as a Tier 1 Demonstration Tool for Ozone and PM2.5 under the PSD Permitting Program”* (EPA 2019)*.* The first tier (Tier 1) utilizes existing empirical relationships between precursor emissions and impacts based on the most recent EPA’s photochemical air quality modeling results of hypothetical industrial sources with similar source emissions and atmospheric characteristics.

The CT DEEP considers a Tier 1 demonstration adequate to estimate secondary impacts from new or modified existing single sources of significant SO2 and/or NOx precursor emissions for PM2.5 formation. The Tier1 demonstration tool equation is based on the ratio of the Project’s emissions to EPA’s hypothetical source emissions multiplied by the hypothetical source impacts to solve for the Project’s secondary air quality impact.

In summary, the Tier 1 demonstration tool provides a way for sources to add maximum downwind secondary PM2.5 impacts to AERMOD predicted primary impacts and compare total impacts to the applicable PM2.5 SILs, NAAQS and PSD Increments. Connecticut has been classified as non-attainment for Ozone, therefore all major sources must comply with non-attainment new source review (NNSR) requirements. Thus, all major and minor sources will not be subject to performing a secondary O3 impact analysis until EPA classifies all of Connecticut “Attainment” with the latest O3 NAAQS.

### Single Source Air Quality PM2.5 Tier 1 Impact Assessment

For any source subject to Ct permitting and modeling requirements, a Tier 1 PM2.5 impact assessment is required if precursors are significant.

The contribution from both primary and secondary impacts should be compared to the PM2.5 SILs shown in Table3-3. If the impacts are above the SILs, then compare the total impacts plus monitored background to determine if a source’s total PM2.5 ambient impacts comply with the applicable 24-hour and annual NAAQS shown in Table 3-1. Sources that are subject to PM2.5 PSD increment modeling are required to combine the primary and secondary impacts (without background) to comply with the applicable 24-hour and annual increments shown in Table 3-2. If MERP analysis shows that a source’s impacts are above the applicable PM2.5 SILs, then a cumulative modeling analysis will be required to determine compliance with the applicable PM2.5 NAAQS and PSD Increments. If there are violations to the PM2.5 NAAQS and PSD Increments, then a culpability analysis is required to show that the subject source does not contribute significantly to any violation. Consultation with DEEP modeling staff is recommended before undertaking additional secondary PM2.5 assessments.

## Multi-Source Refined Modeling and Inventory Requirements

Multi-source modeling analysis is required when single-source refined modeling shows significant impacts from a new or modified source seeking a permit. In any NAAQS and PSD increment multi-source modeling analyses, the subject source must use proposed short- and long-term allowable emission rates. All other existing permitted stationary sources within the subject source’s SIA may be modeled using typical representative actual emissions based on the most recent 2-years of normal source operation. For any nearby existing NAAQS and PSD increment consuming sources, source parameters and emission rates can be downloaded from the radius search tool on CT DEEP’s web page (for PSD cumulative modeling, sort the data based on date PERMIT ISSUANCE of a facility/source and compare that date to PSD minor-source baseline date for the applicable pollutant to be modeled). Consultation with CT DEEP is strongly recommended prior to performing multi-source modeling to ensure the data is accurate from the point source inventory database.

The radius search program retrieves the following sources for the pollutant requested:

* For NAAQS modeling:
* All stacks with actual PM2.5 emissions of >= 10 tons per year (TPY) that fall within the radius of significance of the subject source.
* All stacks with actual SO2, NO2, PM10, and CO emissions of ≥ 15 tons per year (TPY) that fall within the radius of significance of the subject source.
* For PSD Increment modeling:
* All sources affecting PSD increment (defined in RCSA sections 22a-174-3a(k)(5) and 22a-174-3a(k)(6)) that fall within the radius of significance of the subject source for the applicable pollutant.

For short term compliance demonstrations, assume continuous operation from most nearby sources unless there are enforceable permit conditions limiting hours of operation/year, and defining periods when a nearby source is not in operation. If actual emissions are not available, applicants should use the latest permitted allowable emissions, or estimated emissions from fuel use data in consultation with CT DEEP. The applicant is responsible for performing a GEP analysis and input building downwash from facilities included in the multi-source modeling.

If the SIA of a source extends beyond the Connecticut state line, the applicant must obtain existing source information from the neighboring state, submit a copy of the source emissions data to the CT DEEP, and include these sources in the modeling.

In addition to the inventory provided by CT DEEP for PSD increment modeling, the applicant may be required to address the effects of area-wide emissions growth on increment consumption, particularly when modeled concentrations approach the available increments in areas where existing measured ambient air quality levels are increasing.

## Additional PSD Impact Analyses

The Federal PSD program requires that the owner of any new major source or a source undergoing a major modification provide an analysis of additional impacts that would occur as a direct result of the general, residential, commercial, industrial, and/or other growth associated with the construction and operation of the source.

In addition, an analysis of impairment of visibility, soils, and vegetation that would occur because of the source is also required (use of VISCREEN for a visibility screening modeling analysis is sufficient as a screening tool for Connecticut sources). Further guidance relating to these analyses are provided in the EPA documents entitled: “A Screening Procedure for the Impacts of Air Pollution Sources on Plants, Soils and Animals” (EPA, 1980), “PSD Workshop Manual” (EPA, August 1980).

## Air Quality Related Values

The 1990 CAA Amendments gives the Federal Land Manager’s (FLMs) “affirmative responsibility” to protect Class I areas from adverse impacts caused by major sources of air pollution, and to provide the appropriate air analysis techniques. If a proposed or modified major source in Connecticut is located within 300 km of the following Class I areas across the northeast such as: Lye Brook Wilderness, Vermont, Great Gulf Wilderness Area New Hampshire, the Presidential Range-Dry River, New Hampshire, and Brigantine National Wildlife Refuge, New Jersey, the applicant should consult with CT DEEP staff, complete the FLM’S Class I PSD Modeling Form, and send it to the northeast regional FLM’s for the purpose of determining if a Class I area Air Quality Related Values (AQRV) analysis is required. Please consult with the of the FLMs for the Class 1 Areas in New England can be found CT DEEP and the appropriate FLM will determine if an AQRV modeling demonstration is necessary on a case-by-case basis, considering such factors as:

* current conditions of sensitive AQRV,
* magnitude of emissions,
* distance from the Class I area,
* potential for source growth in an area/region,
* existing/prevailing meteorological conditions, and
* cumulative effects of several sources to AQRV.

If an AQRV refined modeling analysis is required, the applicant, CT DEEP, and the FLM will work together to formulate an appropriate modeling demonstration. For a general description of what is expected of an AQRV analysis, see the latest [document](https://fws.gov/guidance/sites/guidance/files/documents/FLAG%20Air%20Quality%20Phase%201%20report.pdf) entitled Federal Land Managers’ “Air Quality Related Values Workgroup (FLAG) Report”.

# Background Air Quality

Background air quality levels are added to modeled impacts to determine compliance with the NAAQS for the appropriate pollutant and averaging time. Recommendations for estimating pollutant specific background concentrations from CT DEEP monitoring sites are summarized in this section below. The most recent three years of available data from representative federal reference method (FRM) or equivalent CT DEEP monitoring sites located within or nearest to the modeling domain, should be added to the modeled predicted impacts to demonstrate compliance with the NAAQS.

## Monitored Design Concentrations

The monitored design concentrations are added to the modeled results as a conservative approach to estimating total predicted concentrations. Both short and long term monitored design values are calculated based on 3-year average concentrations. However, this does not preempt or alter the Appendix W requirement for use of 5-years of representative NWS meteorological data or at least 1-year of site-specific data for modeling. There may be occasions where a more refined short-term average background estimate is needed in a modeling review, particularly when modeled concentrations plus the design background value exceeds the NAAQS. For modeling reviews that cannot demonstrate compliance using ambient monitored design concentrations as background, more refined approaches may be considered and consultation with the CT DEEP modeling staff is paramount.

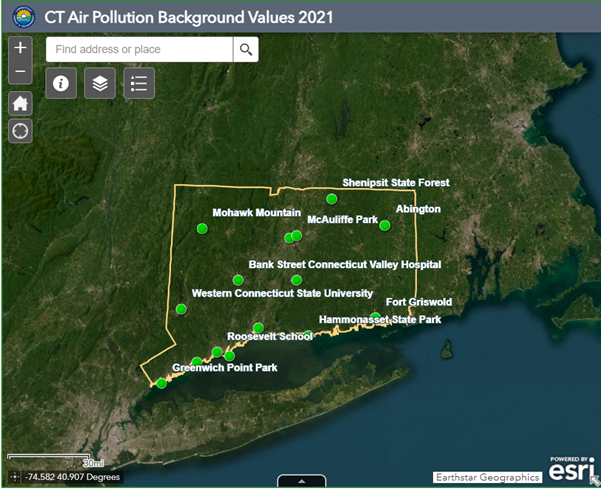
Background concentrations for a specific project should be based on one or more monitoring sites that are most representative of background levels expected at the source location. Since AERMOD allows for multi monitoring sites to be used based on wind direction from the subject source to upwind and downwind monitors, applicants may use multi-monitoring sites to add background to the modeled predicted concentrations to demonstrate compliance with the applicable NAAQS.

Proximity of monitoring site(s) to the source location is the main criteria used to choose the monitoring sites to include in your background estimate. A secondary consideration would involve a comparison of the land use surrounding the source and a monitoring site. If the SIA of a proposed source extends across the Connecticut border to a neighboring state, or the source being modeled is located close to a neighboring state border, the applicant may need to obtain monitored data from the neighboring state to establish a representative background value for the project impact area.

Sources subject to federal PSD requirements should contact CT DEEP to determine whether pre- or post-construction monitoring will be required for some pollutants if existing CT DEEP monitored data are deemed non-representative. This determination will be made on a case-by-case basis following EPA’s Appendix W and monitoring guidance.

The latest available measured SO2, NO2, PM10, PM2.5 and CO design concentrations calculated from CT DEEP’s ambient monitors are available in Figure 5-1 below. On the [DEEP Air Modeling Website](https://portal.ct.gov/DEEP/Air/Modeling/Dispersion), click on the applicable monitoring site to download the data to show compliance with the NAAQS.

**FIGURE 5-1**

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## Hazardous Air Pollutants

Background levels for hazardous air pollutants regulated under Connecticut’s hazardous air pollution program are expected to be quite low. For example, background levels for dioxin (currently the only hazardous air pollutant with a Connecticut Ambient Air Quality Standard (CAAQS)) have been barely detectable. Therefore, CT DEEP recommends that background levels for hazardous air pollutants for which a CAAQS exists be defined as one half of the standard for these pollutants until more data become available.

# Analysis and Interpretation of Modeled Results

## Short-Term Averages

Predicted AERMOD modeled short-term average impacts are based on averaging times of 1, 3, 8, and 24-hours. These values are compared directly to the applicable PSD short term increments or added to background levels for comparison with applicable short-term NAAQS.

## Long-Term Averages

Predicted long-term average modeled impacts are based on averaging times from one month to a year.

For the lead NAAQS, the largest of the three-month average concentrations is added to a lead background concentration for comparison with the Pb NAAQS, which is a three-month rolling average not to be exceeded. Using five years of AERMOD model results three-month rolling averages can be calculated from the monthly averages.

Annual average concentrations are predicted by AERMOD for comparison with the applicable annual PSD increments or added to background levels for comparison with the annual NAAQS.

# Presentation of Compliance Demonstration

Air quality dispersion modeling analyses are performed to demonstrate compliance with all applicable NAAQS and Class II PSD increments in Connecticut. Once compliance with all the applicable standards has been demonstrated, the applicant must submit a detailed report that clearly describes the modeling procedures, methodologies, analyses, results, and databases used in the process. Applicants should submit the final modeling report as part of the permit application.

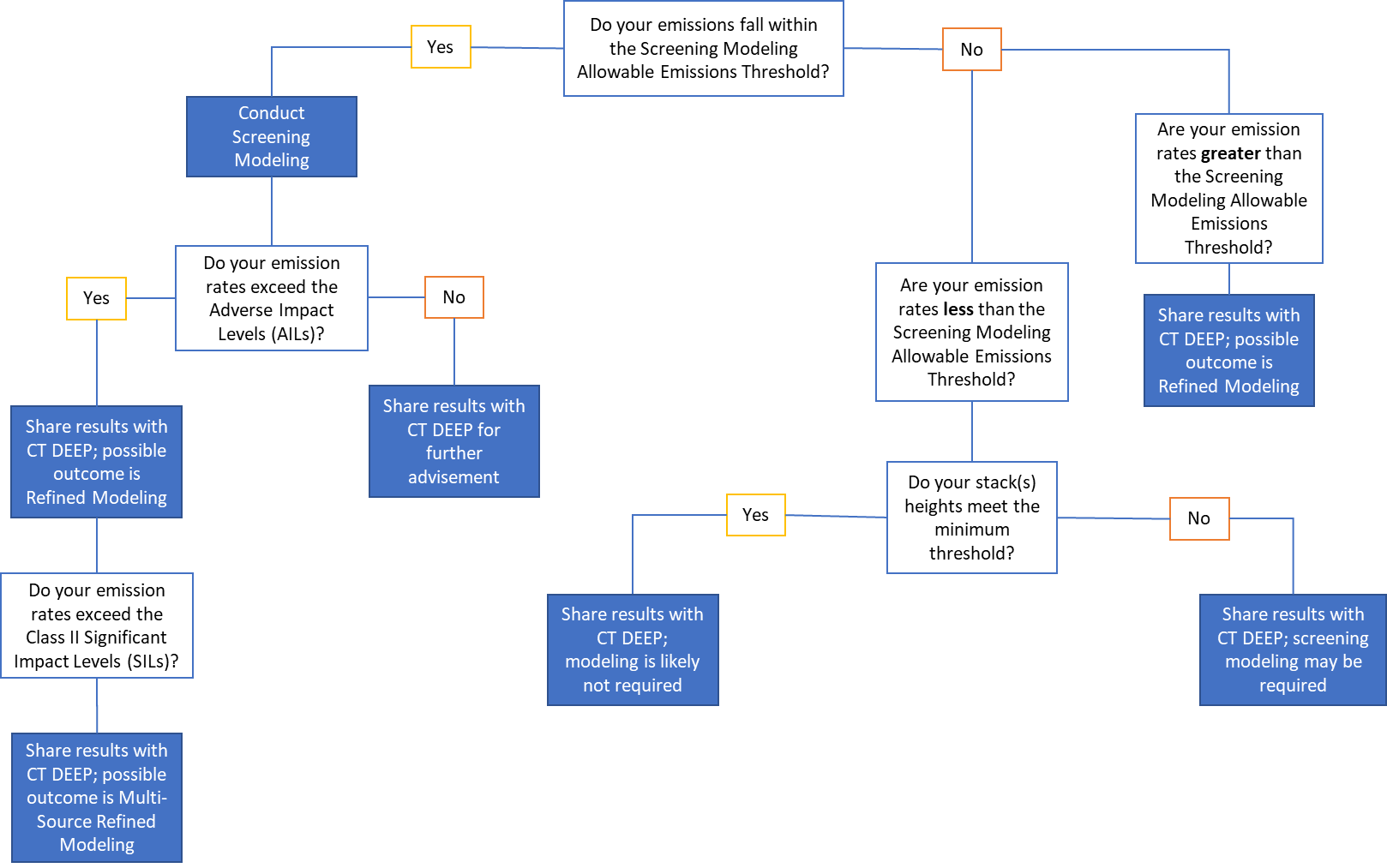
The final modeling report submitted to CT DEEP should have, at a minimum, the following contents:

* Scope of the project,
* Modeling approach,
* Models used to demonstrate compliance,
* Land use analysis,
  + Urban/ Rural designation
  + Population
  + Land use within 3 km of source
* Meteorological data,
* Building related input data (GEP analysis),
* Receptor grid/surrounding terrain,
* Preparation of input parameters,
* Selection of modeled load cases,
* Background data used/processed,
* All other analyses/data needed to demonstrate compliance,
* Tables of stack inputs (physical stack parameters, emission rates, flows) for all modeled sources,
* Tables that list the maximum impact depending on the pollutant/averaging period (highest for SILs, 98th and 99th percentiles for the 1-hour NO2 and SO2 NAAQS respectively, H2H for 24-hour PSD increments, H2H for 24-hour PM10 NAAQS, 24-hour average 98th percentile for PM2.5 NAAQS, and highest annual impacts for all pollutants’ NAAQS and PSD increments), the corresponding receptor location (Easting/Northing coordinates) and elevation, and the meteorological period associated with the maximum impact for each pollutant/averaging period, and
* Comparison of final modeling results to applicable NAAQS and Class II PSD increment standards.

Applicants must also submit copies of the following electronic files: all dispersion model input/output files; input/output files from the applicable AERMOD preprocessors used such as AERMAP, AERSURFACE, AERMET, AERMINUTE and BPIPRIME; any raw meteorological data used; any post-processor programs used to calculate ambient impacts or background data such as access data bases, excel spreadsheets, and or computer code such as PYTHON, R or FORTRAN. Please include a directory of file(s) submitted files, and a “Readme” text file describing file naming conventions that are clearly identified.

###### Appendix A

**Modeling Procedure Flowchart**



###### Air Quality Modeling Check List

1. **Pre-application Meeting**

Please be prepared to discuss the following with a Senior Modeler at CT DEEP as you begin your application process:

* Proposed new/modified facility emission source characterization
* Plant layout w/property/fence line, stack (s) location, controlling structures for GEP
* Areas not considered ambient air - no fence line, property barrier and or signage
* Monitor(s) used for background
* Met data (NWS, Prognostic, or Site Specific). CT DEEP will provide NWS processed Met data
* Other major/minor existing sources on premises
* Emissions inventory–CT DEEP will provide data as appropriate
* PSD Class I areas
* Environmental Justice areas

1. **Modeling Procedures**

When modeling, please consider/ account for the following:

Source Characterization

* Source type, fuel type, size, number of units, location of source(s)
* Auxiliary equipment (*e.g.*, emergency generators, fire pumps)

Source location maps identifying topographic features, other sources, monitoring locations, and met site used

* Building dimensions and location included for GEP analysis
* Stack Parameters for varying loads/scenarios
* Urban/Rural determination consistent with AIAG
* Startup/shutdown emissions appropriately addressed, if applicable
* Indicate any of the following:
  + Point Sources – location (UTM’s with zone and datum identified), stack height, inside stack diameter, exit velocity, exit temperature, base elevation. Note if stacks are obstructed with rain caps or feature a downward/horizontal release.
  + Area Sources – size and location of area, release height
  + Volume Sources – size and location of volume, release height, sigma values
  + Table of short-term and annual emission rates for criteria pollutants to be modeled
  + Consideration of fugitive emissions

1. **AERMOD Model Options**

* Regulatory Default (including ARM2 for NO2 modeling)
* For nitrogen dioxide, which multi-tiered screening approach was used to determine the 1-hour and annual average impacts ARM2, OLM or PVMRM.
* If a Tier 1 secondarily formed particulate matter assessment is required, EPA’s **MERPs Guidance should be** followed in addition to CT DEEP consultation

1. **Modeling Domain and Receptors**
   * Scaled maps of nearby terrain showing areas of complex terrain.
   * Plot of receptor grid(s) with corresponding coordinates.
   * Ensure receptors are appropriately included for all accessible locations (ambient air).
   * Receptor coordinate system consistent with source coordinate system?
   * Fence line receptors with appropriately representative spacing (*e.g.*, no greater than 25m)
   * Discrete receptors placed in sensitive areas and/or above ground (flagpole) used?
   * Terrain data to be used – latest version of NED and resolution?
   * Modeling domain includes all receptors (within the SIA) where emissions from the new or modifying source(s) causes a significant ambient impact?
2. **Meteorological Input Data**

* NWS Meteorology
* Five (5) years of representative NWS surface data and concurrent representative upper air data (provided by CT DEEP)
* Options used for filling missing NWS temperature and cloud cover (SUB\_CC, SUB\_TT).
  + - Wind speed threshold of 0.5m/s used for the surface data
* Adjusted surface friction velocity (u\*) option used

Prognostic Meteorology

* + Three (3) years of representative prognostic meteorological data
  + Grid resolution of the underlying prognostic meteorological data
  + Prognostic data processed for input into AERMET, per guidance
  + Model performance evaluation performed on the prognostic met data, consistent with the MMIF guidance
  + MMIF used to process the prognostic data for input into AERMET, as per MMIF guidance
  + Adjusted surface friction velocity (u\*) option used

Site-Specific Meteorology

* 1 year of site-specific and concurrent representative upper air data
* Concurrent representative National Weather Service (NWS) surface data used for data substitution
* Options used for on-site data processing – Bulk Richardson Method, missing data
* Tower Height
* Does data processing and QA follow the recommendations of the *Meteorological Monitoring Guidance for Regulatory Modeling Applications* (EPA-454/R-99-005)?
* Adjusted surface friction velocity (u\*) option only used appropriately if turbulence parameters are not passed through AERMOD?

Representativeness and surface characteristics using AERSURFACE

* Primary surface characteristics (NWS site)
* Secondary surface characteristics (source site)
* Latest NLDC

1. **Background Concentration (Provided by CT DEEP)**

* Discussion of monitored value(s) used for background, including location(s)
* Representativeness of monitored values used.
* Nearby source list determined using Significant Concentration Gradient with professional judgement criteria?
* Concentrations by pollutant.
* Averaging time (*e.g.*, short-term, and long-term).

1. **Compliance Demonstration and Results**

Single-Source Impact Analysis

* Is screening modeling used to estimate a new or modifying source’s impact; do worst-case ambient impacts from the source exceed Connecticut’s Screening Adverse Impact Levels (AILs)?
* Is refined modeling used to estimate a new or modifying sources’ impact, are the predicted impacts show that the source will not cause or contribute to any potential violation of a NAAQS or PSD increment; are the predicted impacts above any SILs?
* Was AERMOD used for the refined modeling analysis?

Cumulative Impact Analysis

* Receptors that show significant impacts should be used to define the modeling domain used in the cumulative impact analysis.
* The resulting design concentrations should be used to determine whether the source will cause or contribute to a NAAQS or PSD increment violation. This determination should be based on:
  1. The appropriate design concentration for each applicable NAAQS (and averaging period); and
  2. whether the source’s emissions cause or contribute to a violation at the time and location of any modeled violation (i.e., when and where the predicted design concentration is greater than the NAAQS).
* For PSD increments, the cumulative impact analysis should also consider the amount of the air quality increment that has already been consumed by other sources, or, conversely, whether increment has expanded relative to the baseline concentration.

Analysis of Class I Area Impacts

The applicant is required to provide an air quality analysis for any Class I area that may be affected by the emissions from the proposed new source or modification. There are two components for this analysis the NAAQS and Class I increments analysis, and the air quality related values (AQRV) analysis.

* Reference 40 CFR 52.21(p) and 51.166(p)
* Has the appropriate FLM been notified based on source characteristics and proximity to Class I area?
* Distance to the closest to Class I area (km)?

Additional Impact Analysis

Additional Impact Analysis is required per 40 CFR 52.21(o) of the PSD regulations on the proposed facility's impact on soils, vegetation, and visibility; the expected general commercial, residential, and industrial growth associated with a new major source. The analysis can be qualitative and designed to provide the basis for this determination.

* Yes
* No – Minor Source Permit Modeling

Results

* All applicable NAAQS and PSD increments should be represented in these results (*e.g.*, tables with maximum and/or significant impacts, associated receptor location, meteorological data, and modeling scenario) based on the corresponding form of each NAAQS (*i.e.*, averaging times) or the PSD increment.
* Concentration plots of maximum and/or significant impacts overlaid on previous discussed source location maps identifying topographic features, Class I areas, nonattainment areas, other major sources, monitoring locations, met sites, etc.
* Modeled concentrations should not be rounded before comparing the resulting design concentration to the NAAQS or PSD increment

# References

CT DEP, 1989: Ambient Impact Analysis Guideline.

CT DEP, 2009: Ambient Impact Analysis Guideline. A Guideline for Performing Stationary Source Air Quality Modeling in Connecticut.

CT DEEP, 2018: Ambient Impact Analysis Guideline. A Guideline for Performing Stationary Source Air Quality Modeling in Connecticut.

EPA, 1980: A Screening Procedure for the Impacts of Air Pollution Sources on Plants, Soils, and Animals. EPA Publication No. EPA 450/2-81-078. Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC.

EPA, August 1980: Prevention of Significant Deterioration 40 CFR 52.21, August 7, 1980

EPA, 1985: Guideline for Determination of Good Engineering Practice Stack Height (Technical Support Document for the Stack Height Regulations) – Revised. EPA Publication No. EPA-450/4-80-023R. Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC.

EPA, 2000: Meteorological Monitoring Guidance for Regulatory Modeling Applications (EPA-454/R-99-005), Office of Air Quality Planning & Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC.

EPA, 2010: Guidance Concerning the Implementation of the 1-hour NO2 NAAQS for the Prevention of Deterioration Program. Memorandum dated June 28, 2010, Office of Air Quality Planning & Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC.

EPA, 2010: Guidance Concerning the Implementation of the 1-hour SO2 NAAQS for the Prevention of Deterioration Program. Memorandum dated August 23, 2010, Office of Air Quality Planning & Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC.

EPA, 2011: Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-hour NO2 National Ambient Air Quality Standard. Memorandum (March 1, 2011), Office of Air Quality Planning & Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC.

EPA, 2014: Clarification on the Use of AERMOD Dispersion Modeling for Demonstrating Compliance with the NO2 National Ambient Air Quality Standard. Memorandum dated September 30, 2014, Office of Air Quality Planning & Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC.

EPA, 2017: Revisions to the Guideline on Air Quality Models: Enhancements to the AERMOD Dispersion Modeling System and Incorporation of Approaches to Address Ozone and Fine Particulate Matter. 40 CFR Part 51 Appendix W.

EPA, 2018: Guidance on Significant Impact Levels for Ozone and Fine Particle in the Prevention of Significant Deterioration Permitting Program. Memorandum dated April 17, 2018, Office of Air Quality Planning & Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC.

EPA, 2019: Guidance on Additional Methods, Determinations, and Analyses to Modify Air Quality Data Beyond Exceptional Events. Memorandum dated April 4, 2019, Office of Air Quality Planning & Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC.

EPA, 2019: Guidance on the Development of Modeled Emission Rates for Precursors (MERPS) as a Tier 1 Demonstration Tool for Ozone and PM2.5 under the PSD Permit Modeling Program. Memorandum dated April 30, 2019, EPA-454/R-19-003, Office of Air Quality Planning & Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC.

EPA, 2019: Guidance, Revised Policy on Exclusions from “Ambient Air”. Memorandum dated December 2, 2019, Office of Air Quality Planning & Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC.

EPA, 2022: Guidance for Ozone and Fine Particulate Matter Permit Modeling, dated July 29, 2022, Office of Air Quality Planning & Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC.