Connecticut Department of
ENERGY &
ENVIRONMENTAL
PROTECTION

Revision to Connecticut's State Implementation Plan

8-Hour Ozone Attainment Demonstration for the Greater Connecticut Nonattainment Area

Technical Support Document

DRAFT FOR HEARING

Connecticut Department of Energy and Environmental Protection
October 2016

Executive Summary

This document presents Connecticut's air quality state implementation plan (SIP) revision for attaining the ozone standards established in 2008. With this plan, the Greater Connecticut area will attain the 2008 standard, by the required deadline. This plan contains elements required under section 182(b) of the Clean Air Act (CAA) applicable to the Greater Connecticut nonattainment area which consists of the five counties of Hartford, Litchfield, New London, Tolland and Windham. Additionally, certain elements of the plan are applicable state-wide including the motor vehicle emissions budgets and other control measures which will enhance ozone attainment in the Greater Connecticut area as well as the remaining three counties of the state.

This attainment demonstration includes all of the required elements which are outlined below:

The Conceptual Model. The conceptual model includes an analysis of analyses of air quality trends, local and regional ozone enhancing meteorology and emissions. The analyses show that ozone exceedances generally occur when precursor emissions are transported into the area from emissions rich areas to the south and west on warm sunny days when the meteorology is favorable to ozone formation. While emissions reductions locally and upwind have caused ozone levels to decrease, the downward trend has leveled off in recent years.

Base and Future Year Emissions Inventories. The base year inventory of emissions is 2011. The year was selected because it is a year for which a Periodic Emissions Inventory (PEI) was required to be developed for submittal to EPA and it is near the year when the area was designated nonattainment. Emissions of the ozone precursors for 2011 in the Greater Connecticut Area were determined to be 91.9 tons per day for nitrogen oxides and 106.1 tons per day of volatile organic compounds. Emissions were projected out to the required year of attainment -- 2017. The future emissions were estimated to be 56.4 tons per day for nitrogen oxides and 84.6 tons per day for volatile organic compounds. Emission reductions came mainly from the mobile source sector due to federally mandated engine emission limits.

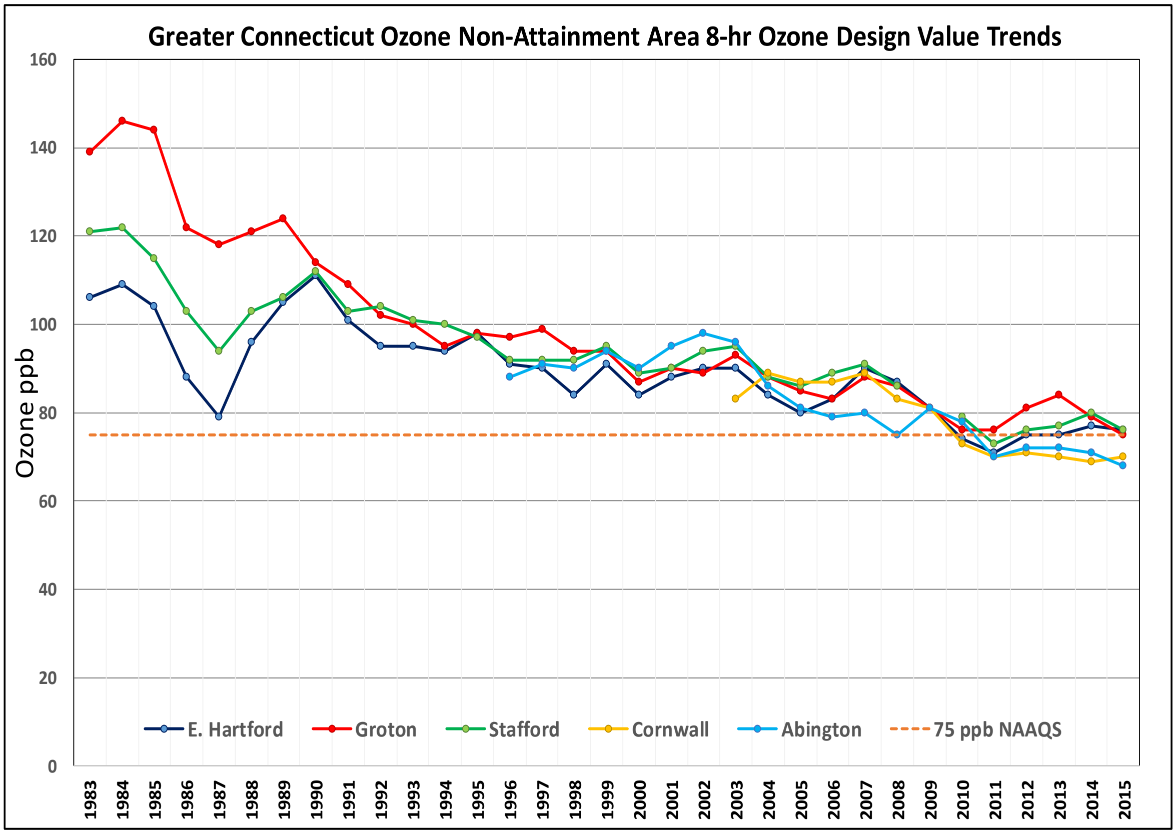
Reasonable Further Progress. Reasonable further progress toward emission reduction goals are required at a rate of three percent per year. This requirement is satisfied, and exceeded, through the mobile source emission reductions required by federal measures.

Analysis of Control Strategies. All control strategies mandated by the CAA are being implemented in the area. State-wide rules are in place which conform to the Control Techniques Guidelines (CTG) and Alternative Control Technologies (ACT) requirements for all source categories which operate within the state. Appropriate rules were adopted beginning in 2011 and Reasonable Available Control Technologies (RACT) and Reasonable Available Control Measures (RACM) were submitted to EPA for approval on July 17, 2014. Additional rules to are being adopted to ensure maintenance and continued improvement in air quality beyond 2017 which include reduction in nitrogen oxide emissions from waste combustors and fuel burning sources as well as reductions in volatile organic compounds from consumer products and industrial coatings. Further reductions result from Connecticut's adoption of the California Low Emissions Vehicle III program.

Motor Vehicle Emissions Budgets. State-wide motor vehicle emissions budgets were established in collaboration with the Department of Transportation. The Greater Connecticut area is budgeted 15.9 tons of volatile organic compounds per day and 22.2 tons of nitrogen oxides per day. The three counties outside of the Greater Connecticut area are budgeted 17.6 tons of volatile organic compounds per day and 24.6 tons of nitrogen oxides per day. Annual transportation improvement plans subject to transportation conformity will adhere to these budgets.

Air Quality Modeling Analyses. Connecticut relied on the results of the EPA's modeling analysis for the Cross-State Air Pollution Rule update to demonstrate that compliance with the 2008 ambient air quality standards for ozone will be met by the end of the 2017 ozone season. Other modeling exercises concur with these results and preliminary monitoring data from 2016 indicate that Greater Connecticut will likely be in attainment with the standard by the attainment deadline.

Contingency Plan. In the event that the area does not meet attainment by the end of the 2017 ozone season, additional reductions beyond the necessary three percent per year are available. These emissions reductions result from federally required emissions limits on the mobile source sector.



The measures adopted and referenced in this plan have resulted in the downward trend in ozone concentrations indicated in the above chart. As indicated by modeling data this trend is likely to continue and lead to attainment.

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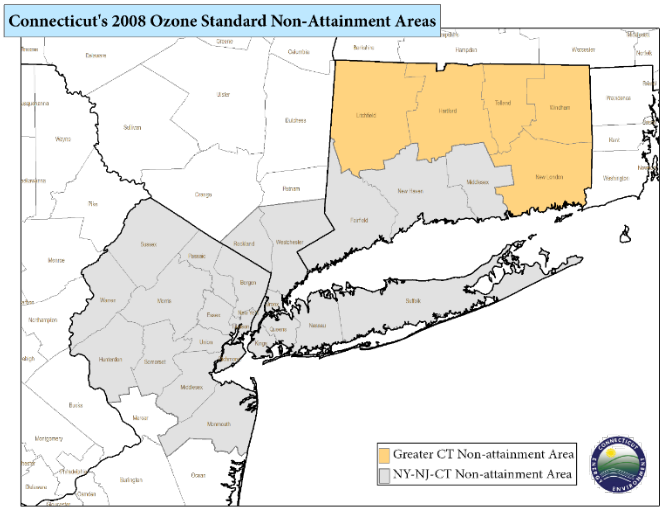
1. Introduction and Background

1.1 Purpose of Document

This document presents the Connecticut Department of Energy and Environmental Protection's (CT DEEP) air quality state implementation plan (SIP) revision for attaining the federal 8-hour National Ambient Air Quality Standard (NAAQS) for ground-level ozone which was revised in 2008. This plan describes the national, regional and local control measures to be implemented to reduce emissions and assesses the likelihood of reaching attainment in the Greater Connecticut nonattainment area (see Figure 1-1) by the July 20, 2018 attainment date deadline. This assessment relies on air quality modeling and other analyses to support its conclusions. A separate plan is being developed for the Southwest Connecticut portion of the greater New York City nonattainment area.

Figure 1-1 *Depiction of Connecticut Nonattainment Areas*



As described in detail in subsequent sections of this document, results of these analyses indicate that due to emission reductions achieved through federal and state control measures, attainment is likely to be achieved by the end of the 2017 ozone season in the five-county Greater Connecticut portion of the State. Because ozone levels in Connecticut are dominated by transport of ozone and its precursors from upwind areas, continued maintenance of the 2008 ozone NAAQS can be assured by securing additional emission reductions from upwind states that contribute significantly to Greater Connecticut.

1.2 Ozone Production and Effect on Health and the Environment

Ozone is a highly reactive gas, each molecule consisting of three oxygen atoms. It is formed naturally at high altitudes (in the stratosphere) in a reaction cycle that begins when ultraviolet solar radiation breaks the oxygen molecule (O2) into two separate oxygen atoms. The free oxygen atoms may then react with either oxygen (O2) to form ozone (O3) or with an ozone molecule to form two oxygen molecules. This reaction cycle beneficially absorbs potentially damaging ultraviolet solar radiation before it reaches the earth's surface. Protection of stratospheric ozone is addressed under Title VI of the Clean Air Act (CAA).

Tropospheric, or ground-level ozone is produced through a combination of atmospheric chemical reactions involving volatile organic compounds (VOCs) and nitrogen oxides (NOx) in the presence of sunlight. These ozone precursors are emitted from many human activities as well as from natural processes. Anthropogenic emissions of VOCs include evaporation and combustion of gasoline and VOC evaporation from consumer products and industrial and commercial solvents. VOCs emitted by vegetation and other biogenic sources in the Greater Connecticut area are estimated to be more than double the anthropogenic VOC emission levels in 2011. Nitrogen oxides are generally formed as a product of high temperature combustion such as in internal combustion engines and utility and industrial boilers. A small quantity of NOx is produced by lightning and emitted by microbial processes in soil. Variability in weather patterns contributes to considerable yearly differences in the magnitude and frequency of high ozone concentrations. Ozone and the pollutants that form ozone are often transported into Connecticut from pollution sources found as far as hundreds of miles upwind.

Ozone, a strong oxidant, damages living tissue and materials. Crop yield has been shown to be reduced and ornamental plants damaged with exposure to ozone. Plastic, rubber and paint become more brittle, paints and dyes fade, and materials generally deteriorate and corrode more readily in the presence of ozone.

The adverse effects of ozone exposure on human health have been well documented in recent decades. Results show that ground-level ozone at concentrations currently experienced in the U.S. can cause several types of short-term health effects. Ozone can irritate the respiratory system, causing wheezing and coughing, can irritate the eyes and nose, and can cause headaches. Ozone can affect lung function, reducing the amount of air that can be inhaled and limiting the maximum rate of respiration, even in otherwise healthy individuals. Exposure to high levels of ozone can also increase the frequency and severity of asthmatic attacks, resulting in more emergency room visits, medication treatments and lost school days. In addition, ozone can enhance people's sensitivity to asthma-triggering allergens such as pollen and dust mites. Other possible short-term effects resulting from exposure to high levels of ozone include aggravation of symptoms in those with chronic lung diseases, such as emphysema, bronchitis and chronic obstructive pulmonary disease (COPD) and increased susceptibility to respiratory infections due to impacts of ozone on the immune system. Studies have also raised the concern that repeated short-term exposure to high levels of ozone could lead to permanent damage to lung function, especially in the developing lungs of children.

1.3 Ozone NAAQS and SIP History

The 1970 Clean Air Act amendments established health and welfare protective limits, or national ambient air quality standards (NAAQS), for a number of air pollutants, including "photochemical oxidants", of which ozone was a key component (see Table 1-1). The 1977Clean Air Act amendments modified the photochemical oxidants standard to focus only on ozone, leading to the establishment in 1979 of a 1-hour average ozone NAAQS of 0.12 parts per million (ppm). The U.S. Environmental Protection Agency (EPA) classified areas as "nonattainment" if monitors in the area measured ozone levels exceeding the NAAQS on more than three days over a 3-year period. Nonattainment areas were required to adopt programs to provide for attainment of the ozone standard no later than 1987. Despite implementation of a variety of emission reduction strategies and significant improvement in measured ozone levels, many areas, including Connecticut, did not attain the standard by the 1987 deadline.

Recognizing the difficulties of attaining the standard and the regional nature of the ozone problem particularly in the northeast, Congress established through the 1990 amendments to the Clean Air Act (CAA), the Ozone Transport Region and the Ozone Transport Commission to help facilitate regional compliance strategies. These amendments also established different classification levels of 1-hour ozone nonattainment, based on the severity of the ozone problem in each area. Areas measuring more severe ozone levels were provided more time to attain but were also required to adopt more stringent control programs. Pursuant to the 1990 amendments, the EPA designated all of Connecticut as nonattainment for the 1-hour NAAQS. The Greater Connecticut area was classified as serious nonattainment with a required attainment date of 1999. Southwest Connecticut was classified as a part of a multi-state severe nonattainment area with portions of New York and New Jersey, with an attainment deadline of 2007. At that time, the Southwest Connecticut portion of the multi-state nonattainment area consisted of most of Fairfield County and a small portion of Litchfield County. The remainder of the state was included in the Greater Connecticut area.

The Department submitted initial attainment demonstrations for both the Southwest Connecticut and Greater Connecticut ozone nonattainment areas on September 16, 1998. The attainment demonstration for Greater Connecticut included a technical analysis showing that overwhelming transport of ozone and ozone precursor emissions from upwind areas precluded compliance by the required 1999 attainment date. Connecticut also requested that the compliance deadline be moved out to 2007. EPA issued final approvals for the 2007 attainment plans and the attainment date extension for Greater Connecticut on January 3, 2001 [66 FR 634].

The Clean Air Act requires EPA to review and revise, as appropriate, established criteria pollutant standards every five years.   Prompted by increasing evidence of health effects at lower concentrations over longer exposure periods, EPA promulgated a more stringent ozone health standard in 1997 based on an 8-hour averaging period. The revised NAAQS was established as an 8-hour average of 0.08 ppm. Compliance is determined in an area using the monitor measuring the highest 3-year average of each year's 4th highest daily maximum 8-hour ozone concentration (known as the design value). Due to lawsuits against EPA regarding the revised standards, the nonattainment designations did not become effective until June 15, 2004 [69 FR 23858; April 30, 2004].

For the 1997 standard, Connecticut was designated as nonattainment by EPA based on measured 8-hour ozone values from the 2001-2003 period. Portions of Connecticut were included in two nonattainment areas. Fairfield, New Haven, and Middlesex Counties were included as part of a moderate 8-hour ozone NAAQS nonattainment area, along with the New York and New Jersey counties that make up most of the metropolitan New York Consolidated Statistical Area. The remaining five counties in Connecticut were grouped as a separate moderate nonattainment area, known as the Greater Connecticut 8-hour ozone NAAQS nonattainment area. With these revisions to the ozone standard, Connecticut submitted revised implementation plans in 2008.

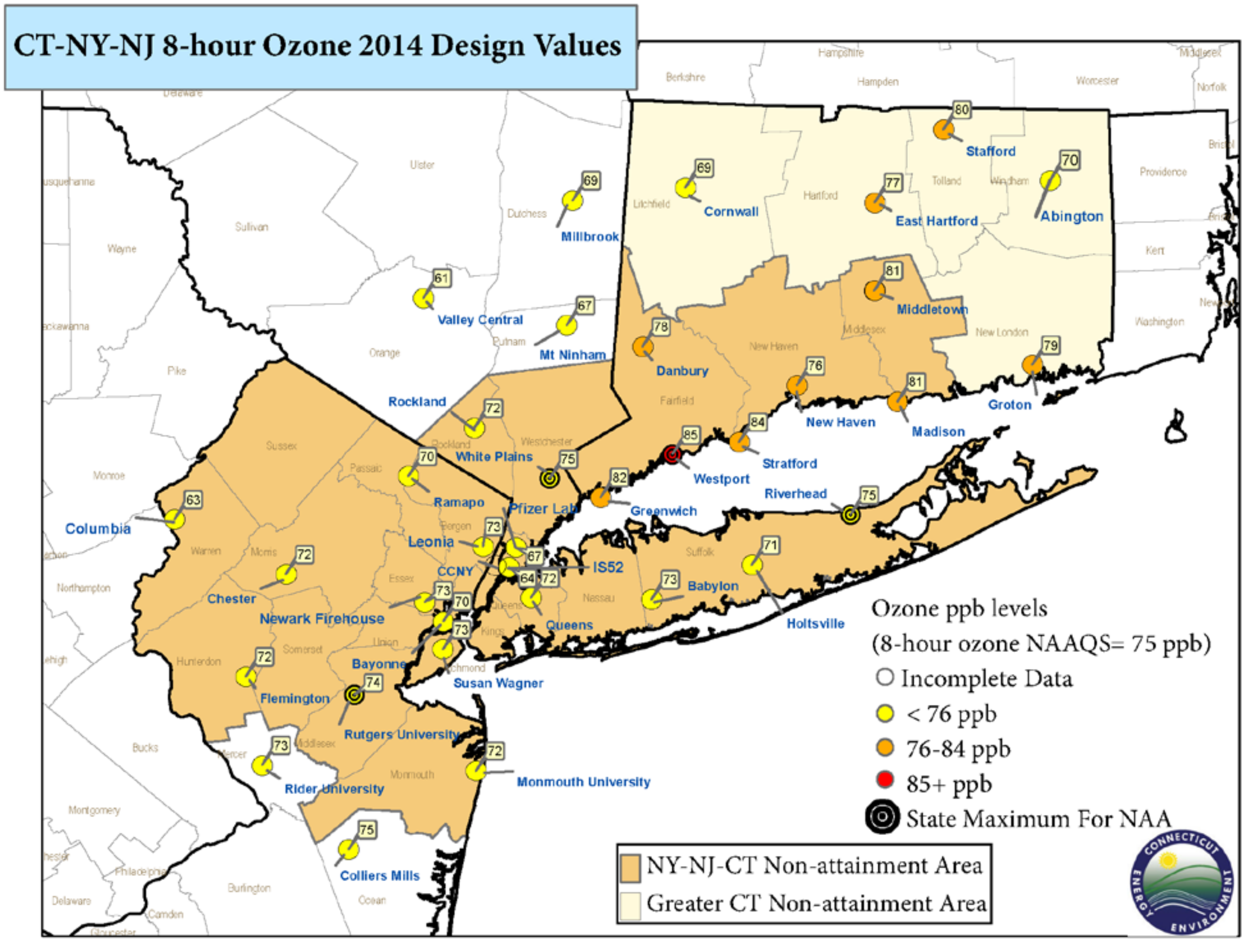
Table 1-1. *History of Ozone NAAQS from 1971 to Present.*

Final Rule/Decision	Primary/Secondary	Indicator	Averaging Time	Level	Form	Status of the Greater Connecticut Area
1971 36 FR 8186 Apr 30, 1971	Primary and Secondary	Total photochemical oxidants	1 hour	0.08 ppm	Not to be exceeded more than one hour per year	Standard Revoked in 1979.
1979 44 FR 8202 Feb 8, 1979	Primary and Secondary	O_3	1 hour	0.12 ppm	Attainment is defined when the expected number of days per calendar year, with maximum hourly average concentration greater than 0.12 ppm, is equal to or less than 1	Standard Replaced with 1997 Standard.
1990 CAA Amendments	Reiterated the 1979 standard. The 1990 CAA Amendments introduced the concept of classifications and varying requirements depending on the severity of the classification. Also recognizes need for multistate efforts and established ozone transport region.					Original Designation: Serious Nonattainment. Measuring Compliance since 2008.
1993 58 FR 13008 Mar 9, 1993	EPA decided that revisions to the standards were not warranted at the time					
1997 62 FR 38856 Jul 18, 1997	Primary and Secondary	O_3	8 hours	0.08 ppm	Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years	Original Designation: Moderate Nonattainment. Standard Revoked. Partially revoked July 20, 2013 and fully revoked April 6, 2015. [80 FR 12264] EPA Approval of Attainment Demonstration on January 27, 2014. [78 FR 78272] Measuring compliance since 2009.
2008 73 FR 16483 Mar 27, 2008	Primary and Secondary	O_3	8 hours	0.075 ppm	Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years	Original Designation: Marginal Nonattainment. Reclassified to Moderate Nonattainment in 2016. Attainment expected in accordance with this plan by the end of the 2017 ozone season.
2010 & 2011 75 FR 2938 Jan 19, 2010 Proposal	On Sept 2, 2011, President Obama directed EPA to withdraw the proposed reconsideration of the 2008 ozone NAAQS.					
2015 80 FR 65292 Oct 26, 2015	Primary and Secondary	O_3	8 hours	0.070 ppm	Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years	Attainment deadlines will be established based on EPA's final designation of nonattainment classifications, which are expected by October 1, 2017.

On March 27, 2008, EPA again revised the ozone standards. Consistent with past revisions, EPA set the primary health standard and secondary welfare standard for ozone at the same level. EPA concluded, based on their review of the scientific evidence at the time, that it was appropriate to revise the primary and secondary standards for ozone from the existing levels of 0.08 ppm to 0.075 ppm. Connecticut was initially designated marginal nonattainment for both the Greater Connecticut region and the Southwest Connecticut portion of the NY-NJ-CT nonattainment area.

Connecticut's nonattainment areas were two of nineteen marginal nonattainment areas nationwide that did not attain by the July 20, 2015 attainment date. When a nonattainment area does not attain the standard by the deadline, the area is either reclassified to the next higher nonattainment classification or, if data warrants, given a one year extension. Eleven marginal nonattainment areas, Greater Connecticut included, were not eligible for the one-year extension. On April 11, 2016, EPA finalized a rule reclassifying Greater Connecticut and the ten other marginal nonattainment areas as moderate based on data from 2012 through 2014 (see Figure 1-2). This reclassification, published in the Federal Register on May 4, 2016 [81 FR 26697], established a new timeline. This new timeline includes a new attainment deadline of July 20, 2018, which requires measured attainment by the end of the 2017 ozone season, and an additional state implementation plan submittal -- this Attainment Demonstration -- due January 1, 2017.

***Figure 1-2. 2014 Design Values**. Design Values for each of the monitors in the two Connecticut nonattainment areas. Data indicates violations of the standard in both areas and resulted in EPA's decision to reclassify the areas to the next higher classification of Moderate Nonattainment.*



Revised October 7, 2014

In 2015, EPA once again revised the ozone standard downward -- from 0.075 ppm to 0.070 ppm. While current and proposed implementation measures will assist with progress toward compliance with this newest standard, further plan revisions for the 2015 standard will be addressed as a separate process as required by the CAA and any related EPA rule making.

1.4 Attainment Plan Requirements

Section 172 of the CAA outlines the general nonattainment plan provisions, and CAA section 182 requires additional plan requirements for ozone nonattainment areas based on classification status. Nonattainment areas are classified based on the extent to which the area deviates from the standard in order of increasing severity, as marginal, moderate, serious, severe or extreme. Additionally, if the area is in the Ozone Transport Region (OTR), as Connecticut is, there are additional requirements under CAA section 184. Furthermore, implementation plans from earlier nonattainment designations may be required to remain in place to attain or maintain compliance with the previous standards.

The reclassification from marginal to moderate nonattainment in May of 2016 meant that Connecticut had to fulfill additional plan requirements under the CAA. While CAA section 182(i), which addresses reclassified areas, allows adjustments to the submittal schedules for attainment plan requirements, section 182(i) does not allow for extension to the required attainment date beyond the date for the new classification. CAA sections 182(a) & 182(b) outline the ozone plan requirements of a SIP submission for marginal and moderate areas. The implementation plan requirements specific to the 2008 Ozone NAAQS, adopted on May 21, 2012 [77 FR 30170] and amended March 6, 2015 [80 FR 12264], are codified in 40 CFR 51 Subpart AA.

In addition to prescribing the planning requirements for meeting the 2008 ozone standard, EPA's ozone implementation rules specified the process for transitioning from the 1997 standard to the 2008 standard. The transition included revocation of the 1997 standard, effective April 6, 2015, and EPA's approach to preventing backsliding from existing ozone requirements. Connecticut retains its more stringent requirements that were in effect for previous classifications as "severe" (in essentially Fairfield County) and "serious" (in the remainder of the State) for the 1-hour ozone standard and as "moderate" for the entire state for the 1997 8-hour standard.

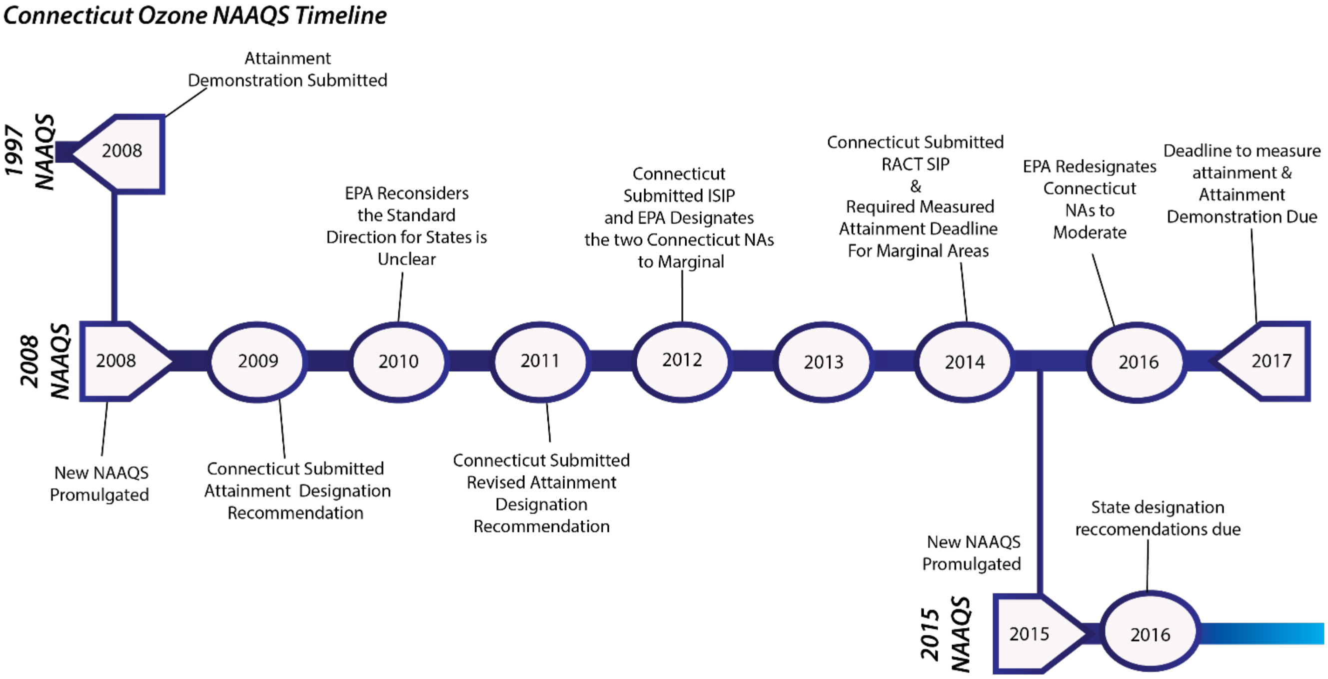
When EPA promulgated the 2008 ozone NAAQS, final attainment designations were initially expected to occur in 2010. However, these designations were delayed by EPA's reconsideration process and legal actions filed against EPA. On May 21, 2012 EPA published nonattainment designations and classifications in the Federal Register [77 FR 30088]. Designations were effective July 20, 2012. Both of Connecticut's nonattainment areas were designated as marginal. Marginal areas were required to attain the standard by July 20, 2015 and therefore measure attainment in the 2014 ozone season. Neither of Connecticut's nonattainment areas measured attainment of the 2008 standard by the end of the 2014 ozone season, which resulted in "bump-up" of each area and required that attainment plans meeting requirements for moderate nonattainment areas be submitted by January 1, 2017.

With this and prior submittals, the Greater Connecticut nonattainment area implementation plan fulfills the following requirements:

- Emission offsets from new major sources and modifications for marginal areas are required at a ratio of 1.1 to 1. When Connecticut was reclassified to moderate the ratio was required to be 1.15 to 1. However, because the Greater Connecticut area had, under prior designations, been classified as serious nonattainment, offsets have continued to be required at a more stringent ratio of 1.2 to 1. Because Connecticut is in the OTR, the new source review major source threshold is reduced from the usual 100 tons per year for a moderate area to 50 tons per year for sources emitting VOCs [CAA 184(b)(2)]. Connecticut's rules for obtaining offsets from new and modified sources, as well as other new source review requirements are contained in RCSA 22a-174-3a. Connecticut defines major sources and major modifications in RCSA 22a-174-1, and the thresholds are at least as stringent as required for moderate nonattainment areas located in the ozone transport region.

- Basic Inspection and Maintenance (I/M) is required for light-duty motor vehicles. Connecticut continues its more effective enhanced I/M program in place statewide since earlier more stringent nonattainment designations. Connecticut's I/M rules are established in RCSA 22a-174-27.
- Submittal of an inventory of sources and periodic emissions inventory updates every three years. Connecticut has been submitting periodic emissions inventories every three years and uses the 2011 inventory year as its base year for modeling and determining reasonable further progress in securing emissions reductions.
- Transportation conformity budgets are included that are consistent with the attainment plan are required to be established for the RFP year (i.e., 2017) and the attainment year (i.e., 2017).
- Plans to implement any necessary Reasonably Available Control Measures (RACM) and Reasonably Available Control Technology (RACT) are included. RACT is required for all EPA-defined control technique guideline (CTG) sources and all other major sources of VOC and NOx. Reasonably available control measures are required for all other sources.
- Reasonable Further Progress (RFP) plans to achieve 15% VOC reduction within 6 years after the baseline year of 2011 (i.e., reductions must occur by 2017). Equivalent NOx reductions can substitute for any portion of the required VOC reductions.
- An attainment demonstration using modeling and other technical analyses described in this report demonstrates that adopted control measures are sufficient to project attainment of the 2008 ozone standard by the end of the 2017 ozone season.
- Contingency measures are planned in the event that implementation of further emission reductions is required upon failure to meet RFP milestones or attainment. This report documents sufficient required contingency measures.

Figure 1-3. *Timeline of significant actions and requirements related to the Greater Connecticut nonattainment area with respect to the 2008 ozone standard revision. EPA decisions and other important documents and benchmarks related to this timeline can be found at the Department's Ozone Planning Web Page:* http://www.ct.gov/deep/cwp/view.asp?a=2684&q=322158&deepNav_GID=1619 .



1.5 Summary of Conclusions

The remainder of this document describes in detail the air quality trends analysis, emission inventories, emission control programs, photochemical modeling, and other weight of evidence evaluations that support the conclusion that the Greater Connecticut Area is expected to achieve full attainment by the end of the 2017 ozone season. Recently adopted control measures and those established under prior implementation plans under more stringent nonattainment designations remain in place and continue to be effective in reducing local ozone precursor emissions. However, despite the extensive measures adopted by Connecticut to reduce ozone precursor emissions, the downward trend in ozone levels has recently slowed as local options for meaningful, cost-effective reductions are largely exhausted. Maintenance of the 2008 NAAQS in Greater Connecticut, and timely compliance with the new 2015 NAAQS, are largely dependent on the need for new actions by upwind states and additional federal measures, including mobile source controls, to reduce ozone and precursor emissions that are transported into the Connecticut.

2. Nature of the Ozone Air Quality Problem in Connecticut and the Northeast

2.1 Introduction

In this section, a conceptual overview of the ozone problem is provided from both a regional and local perspective. The regional perspective provided in Section 2.2 is extracted verbatim from the Executive Summary of "The Nature of the Ozone Air Quality Problem in the Ozone Transport Region: A Conceptual Description," [NESCAUM, October 2006; Revised August 2010] a report developed by Northeast States for Coordinated Air Use Management (NESCAUM). Note that since the last update of the report in 2010, the extent and magnitude of ozone episodes have diminished, nevertheless the conceptual model remains valid for the region. The local perspective provides more recent data and details addressing the local aspects of ozone conducive emissions and meteorology, as recommended in EPA's "Modeling Guidance for Demonstrating Attainment of Air Quality Goals for Ozone, PM2.5, and Regional Haze" [DRAFT, December 2014].

2.2 Regional Conceptual Description of the Ozone Problem

The Ozone Transport Region (OTR) of the eastern United States covers a large area that is home to over 62 million people living in Connecticut, Delaware, the District of Columbia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, and northern Virginia. Each summer, the people who live within the OTR are subject to episodes of poor air quality resulting from ground-level ozone pollution that affects much of the region. During severe ozone events, the scale of the problem can extend beyond the OTR's borders and include over 200,000 square miles across the eastern United States. Contributing to the problem are local sources of air pollution as well as air pollution transported hundreds of miles from distant sources outside the OTR.

To address the ozone problem, the Clean Air Act Amendments require states to develop State Implementation Plans (SIPs) detailing their approaches for reducing ozone pollution. As part of this process, states are urged by the U.S. Environmental Protection Agency (USEPA) to include in their SIPs a conceptual description of the pollution problem in their nonattainment areas. This document provides the conceptual description of the ozone problem in the OTR states, consistent with the USEPA's guidance.

Since the late 1970s, a wealth of information has been collected concerning the regional nature of the OTR's ground-level ozone air quality problem. Scientific studies have uncovered a rich complexity in the interaction of meteorology and topography with ozone formation and transport.

The evolution of severe ozone episodes in the eastern U.S. often begins with the passage of a large high pressure area from the Midwest to the middle or southern Atlantic states, where it assimilates into and becomes an extension of the Atlantic (Bermuda) high pressure system. During its passage east, the air mass accumulates air pollutants emitted by a number of sources in upwind states, including large coal-fired power plants and mobile and area sources. Later, sources within the OTR make their own contributions to the air pollution burden. These expansive weather systems favor the formation of ozone by creating a vast area of clear skies and high temperatures. These two prerequisites for abundant ozone formation are further compounded by a circulation pattern favorable for pollution transport over large distances. In the worst cases, the high pressure systems stall over the eastern United States for days, creating ozone episodes of strong intensity and long duration.

One transport mechanism that can play a key role in moving pollution long distances is the nocturnal low level jet. The jet is a regional scale phenomenon of higher wind speeds a few hundred meters above the ground just above the stable nocturnal boundary layer. The jet has been observed just before or during ozone events. It can convey air pollution several hundreds of miles overnight from the southwest to the northeast, directly in line with the major population centers of the Northeast Corridor stretching from Washington, DC to Boston, Massachusetts. The nocturnal low level jet can extend the entire length of the corridor from Virginia to Maine, and has been observed as far south as Georgia. It can also act to bring pollutants from different directions compared to the prevailing airflow outside the low level jet. It can thus be a transport mechanism for bringing *ozone and other air pollutants into the OTR from outside the region, as well as move locally formed air pollution from one part of the OTR to another.*

Other transport mechanisms occur over smaller scales. These include land, sea, mountain, and valley breezes that can selectively affect relatively local areas. For example, sea breezes can differ in wind direction, thereby bringing air masses trapped in a thin layer over the cooler water back onto shore. Such mechanisms play a vital role in drawing ozone-laden air into some areas, such as coastal Maine, that are far removed from major source regions.

With the knowledge of the different transport scales into and within the OTR, a conceptual picture of bad ozone days emerges. After sunset, the ground cools faster than the air above it, creating a nocturnal temperature inversion. This stable boundary layer extends from the ground to only a few hundred meters in altitude. Above this layer, a nocturnal low level jet can form with higher velocity winds relative to the surrounding air. It forms from the fairly abrupt removal of frictional forces induced by the ground that would otherwise slow the wind. Absent this friction, winds at this height are free to accelerate, forming the nocturnal low level jet. Ozone above the stable nocturnal inversion layer is likewise cut off from the ground, and thus it is not subject to removal on surfaces or chemical destruction from low level emissions, the two most important ozone removal processes. Ozone in high concentrations can be entrained in the nocturnal low level jet and transported several hundred kilometers downwind overnight. The next morning as the sun heats the Earth's surface, the nocturnal boundary layer begins to break up, and the ozone transported aloft overnight mixes down to the surface where concentrations rise rapidly, partly from mixing and partly from ozone generated locally. By the afternoon, abundant sunshine combined with warm temperatures promotes additional photochemical production of ozone from local emissions. As a result, ozone concentrations reach their maximum levels through the combined effects of local and transported pollution. This combined air mass will then continue to blow along with the wind, carrying elevated concentrations of ozone to areas farther downwind, causing late afternoon and even overnight ozone peaks.

Ozone moving over water is, like ozone aloft, relatively isolated from destructive forces. This air pollution is also protected from vertical mixing and dilution by a relatively shallow mixing layer that occurs when the water is cooler than the air above it. When ozone is transported into coastal regions by bay, lake, and sea breezes arising from afternoon temperature contrasts between the land and water, it can arrive highly concentrated.

During severe ozone episodes associated with high pressure systems, these multiple transport features are embedded within a large ozone reservoir arriving from source regions to the south and west of the OTR. Thus a severe ozone episode can contain elements of long-range air pollution transport from outside the OTR, including nocturnal low level jets, regional scale transport within the OTR, and local transport along coastal shores due to bay, lake, and sea breezes.

From this conceptual description of ozone formation and transport into and within the OTR, air quality planners need to develop an understanding of what it will take to clean the air in the OTR. There are distinct regional and local components that would best be addressed by implementing national, regional, and local controls, respectively. Observed ozone levels in the elevated reservoir often are close to or exceed 0.060 - 0.070 ppm averaged over 8 hours, which is the range that EPA has proposed for the revised National Ambient Air Quality Standard (NAAQS) for ozone. Given that the regional and national load will continue to play a major role in ozone episodes as the ozone NAAQS is lowered, further strengthening of national rules will be critical in mitigating the ozone problem.

Because weather is always changing, every ozone episode is unique in its specific details. The relative influences of the transport pathways and local emissions vary by hour and day during the course of an ozone episode and between episodes. The smaller scale weather patterns that affect pollution accumulation and its transport underscore the importance of local (in-state) controls for emissions of nitrogen oxides (NOx) and volatile organic compounds (VOCs), the main precursors of ozone formation in the atmosphere. Larger synoptic scale weather patterns, and pollution patterns associated with them, support the need for NOx controls across the broader eastern United States.

Studies and characterizations of nocturnal low level jets also support the need for local and regional controls on NOx and VOC sources as locally generated and transported pollution can both be entrained in nocturnal low level jets formed during nighttime hours. The presence of land, sea, mountain, and valley breezes indicate that there are diverse aspects of pollution accumulation and transport that are area-specific and will warrant policy responses at the local and regional levels beyond a one-size-fits-all approach. In addition, over the course of a day, ozone can be NOx-sensitive during some hours, and VOC-sensitive during others, indicating temporally varying regional and local influences on ozone formation and transport. This further underscores the need for air quality regulators to adopt a combination of national, regional, and local emission controls to address the problem.

The type of emission controls is important. Regional ozone formation is primarily due to NOx, but VOCs are also important because they influence how efficiently ozone is produced by NOx, particularly within urban centers. While reductions in anthropogenic VOCs will typically have less of an impact on long-range ozone transport, they can be effective in reducing ozone in urban areas where ozone production may be limited by the availability of VOCs. Therefore, a combination of localized VOC reductions with additional regional NOx reductions will help to reduce ozone and precursors in nonattainment areas as well as downwind transport across the entire region. Photochemical air quality modeling is a powerful yet limited planning tool. While it has undergone considerable improvement over the past decade, it is far from perfect in its ability to replicate ozone transport. There can be large uncertainties in various inputs and processes used by the model, such as precursor emissions inventories, meteorology, and atmospheric chemistry, yet the models can provide useful directionally correct guidance. Given the more recent understanding of the myriad complexities of ozone transport events, it is important that decision-makers use a variety of data sources to characterize the problem and assess possible solutions.

The recognition that ground-level ozone in the eastern United States is a regional problem requiring a regional solution marks one of the greatest advances in air quality management in the United States. During the 1990s, air quality planners began developing and implementing coordinated regional and local control strategies for NOx and VOC emissions that went beyond the previous emphasis on urban-only measures. These measures have resulted in significant improvements in air quality across the OTR. Measured NOx emissions and ambient concentrations have dropped between 1997 and 2005, and the frequency and magnitude of ozone exceedances have declined within the OTR. With the National Ambient Air Quality Standards likely continuing to be lowered over time, inter-regional transport will play an even larger role in the future. To maintain the current momentum for improving air quality so that the OTR states can meet their attainment deadlines, there continues to be a need for additional regional NOx reductions coupled with appropriate local NOx and VOC controls.

2.3 Regional Emissions

Since the NESCAUM report was written in 2010, control strategies across the region have helped to lessen the severity and extent of ozone episodes. Although ozone levels have decreased in the region, precursor emissions from the region still impact the ability of downwind areas such as Connecticut to reach and maintain attainment.

This continues to be evident in the recent releases of various contribution modeling results, including those conducted by EPA to support the development of the Cross State Air Pollution Rule (CSAPR) and the CSAPR Update, which was finalized[1] in September 2016. Figure 2-1, based on the final CSAPR Update modeling, shows the 9 upwind states that contribute at least one percent of the standard (i.e. 0.75 ppb) to any Connecticut monitors projected by the modeling to have nonattainment or maintenance concerns in 2017. EPA's modeling indicates that the maximum contribution from Connecticut sources to the same set of monitors is 7.6 ppb (3.9 ppb at Westport, Connecticut's worst-case monitor). This leaves little possibility that emissions reductions from Connecticut sources alone can achieve attainment at the four monitors of concern, which are all located along the Long Island Sound coastline in the Southwest Connecticut portion of the NY/NJ/CT nonattainment area. Further regional level reductions will be required to secure statewide attainment for both the 2008 and 2015 ozone NAAQS.

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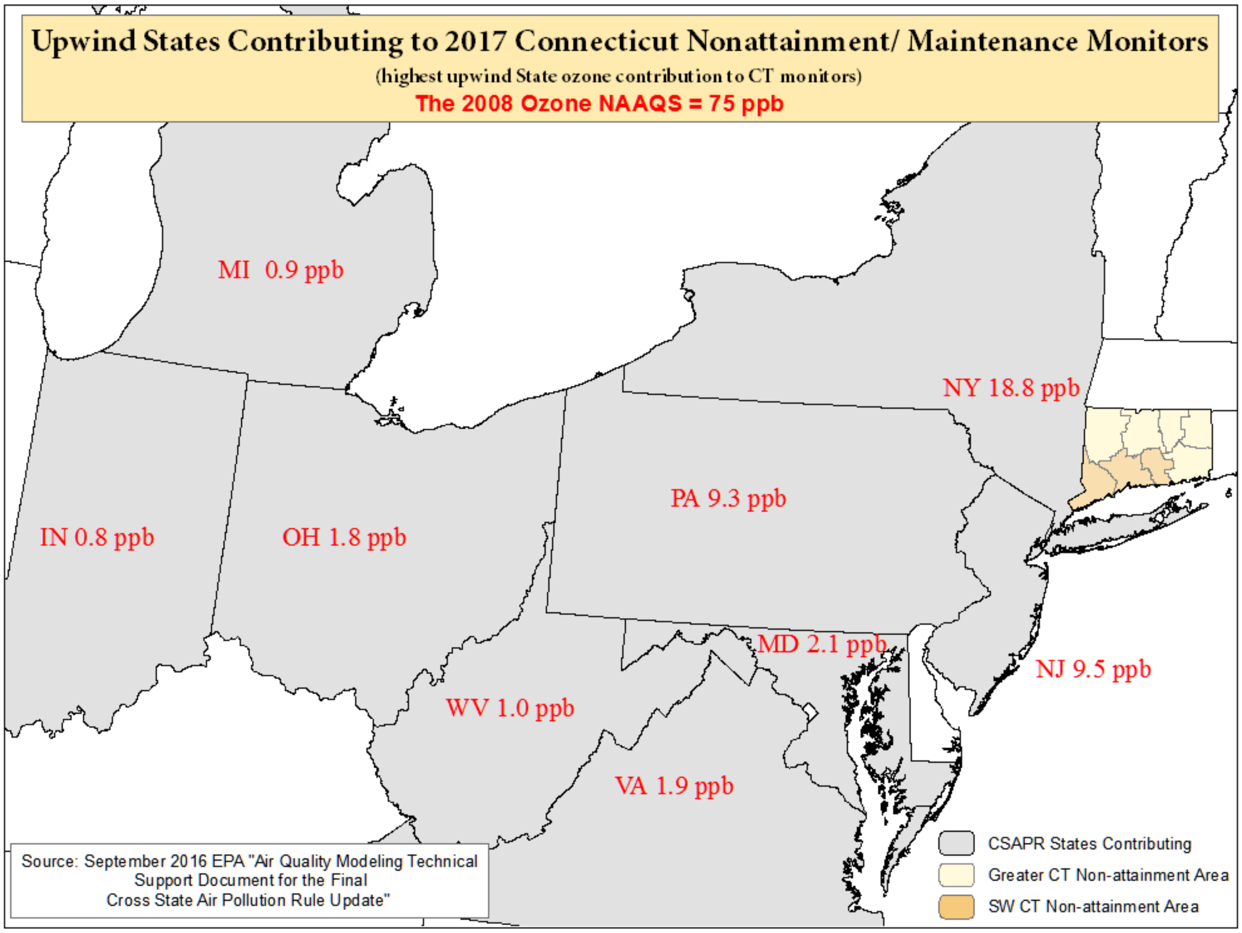
[1] For details about the final CSAPR Update, and associated modeling conducted by EPA, see: https://www.epa.gov/airmarkets/final-cross-state-air-pollution-rule-update.

Figure 2-1. *EPA Modeled Contributions from Upwind States that Significantly Contribute to Nonattainment/Maintenance Concerns in Connecticut*

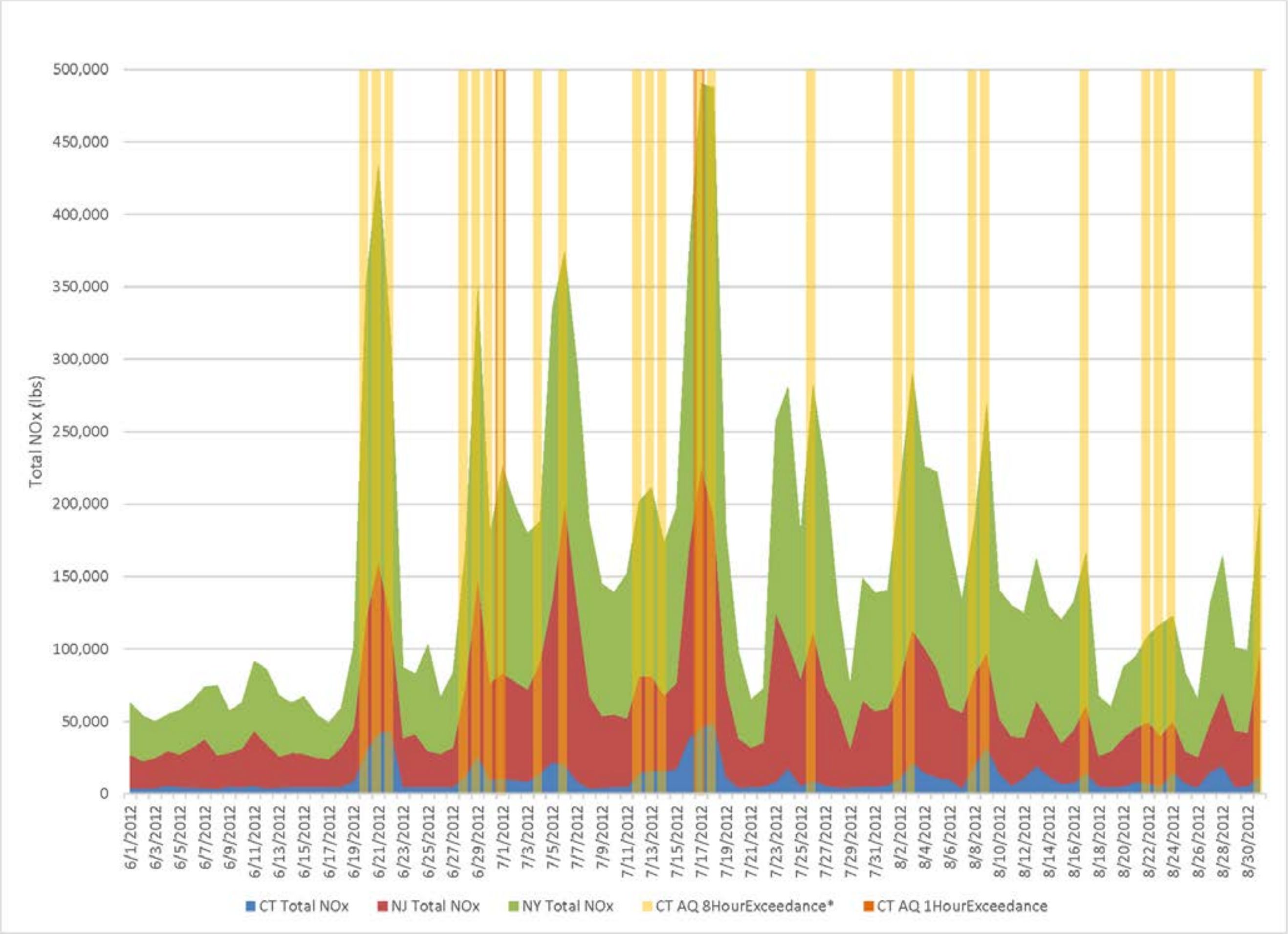


Source: September 2016 EPA "Air Quality Modeling Technical Support Document for the Final Cross State Air Pollution Rule Update"

EPA's final CSAPR Update requires ozone season NOx reductions in 22 states, including the 9 states found to significantly contribute to high ozone levels in Connecticut. Although the final rule will assist with lowering ozone levels across the Northeast, EPA acknowledges that it falls short of providing the full remedy required by the "good neighbor" provision of CAA section 110(a)(2)(D)(i)(I). A full transport remedy for the 2008 NAAQS (and the 2015 NAAQS) should require additional cost-effective emission reductions from the EGU sector that are not addressed by the CSAPR Update, as well as reductions from the non-EGU and mobile source sectors.

For the EGU sector, the CSAPR Update's focus on ozone season budgets does not directly address the need to reduce increased emissions that occur on high energy demand days, which often coincide with high ozone events. Figure 2-2 illustrates this concern, displaying daily EGU NOx emissions during the 2012 ozone season from southern New York, New Jersey and Connecticut as an example that also applies to other states. The emission spikes that occur correlate well with measured ozone exceedance days in Connecticut. EPA's seasonal CSAPR Update budgets do not limit EGU emissions on such days. The required full transport remedy should address this concern by including short-term emission standards or otherwise addressing high short-term NOx emissions related to high energy demand.

Figure 2-2. *Summer 2012 Daily EGU NOx Emissions (data from EPA's Clean Air Markets Division).*



In addition to securing available cost-effective reductions from stationary sources, the full transport remedy for both the 2008 and 2015 ozone NAAQS will require further reductions from mobile emission sources. Figure 2-3 and 2-4 display county-level NOx and VOC emission density maps (tons/square mile) in the Northeast for 2011, showing both total anthropogenic emissions and emissions from on-road vehicles. On-road vehicles make up a large proportion of total NOx and total VOC emissions, with the highest density of emissions occurring in urban areas. Although EPA has finalized more stringent vehicle engine, evaporative and gasoline fuel standards for light-duty vehicles, with implementation beginning in 2017, standards for heavy-duty vehicles were last revised in 2001, with phase-in completed by 2010. Connecticut and several other state and local agencies recently submitted a joint petition to EPA requesting that more stringent national heavy-duty vehicle standards be implemented by January 1, 2022[2]. Given the important role that mobile sources play in ozone formation, as well as the slow turnover rate typically seen in the heavy-duty vehicle fleet, it is important for EPA to take swift action to adopt more stringent, cost-effective standards for this source sector. EPA can also secure additional cost-effective reductions from the light-duty fleet by establishing more stringent federal requirements for aftermarket catalytic converters, as has been requested[3] by the OTC states.

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[2] A concise description of the petition, and other requests made by numerous parties for further action regarding heavy-duty vehicles, can be found in the preamble of EPA's August 16, 2016 final rule establishing a 2nd round of standards to reduce greenhouse gas emissions and improve fuel economy of medium- and heavy-duty vehicles. See the discussion starting on page 99 of the prepublication version of the rule at: https://www3.epa.gov/otaq/climate/documents/420f16044.pdf.

[3] The OTC formally requested that EPA update its policy on aftermarket catalysts on June 10, 2009, with specific recommendations for program design provided in a follow-up letter dated April 8, 2011.

Figure 2-3. *2011 County-level Anthropogenic NOx Emissions Density Maps for Northeast States.*

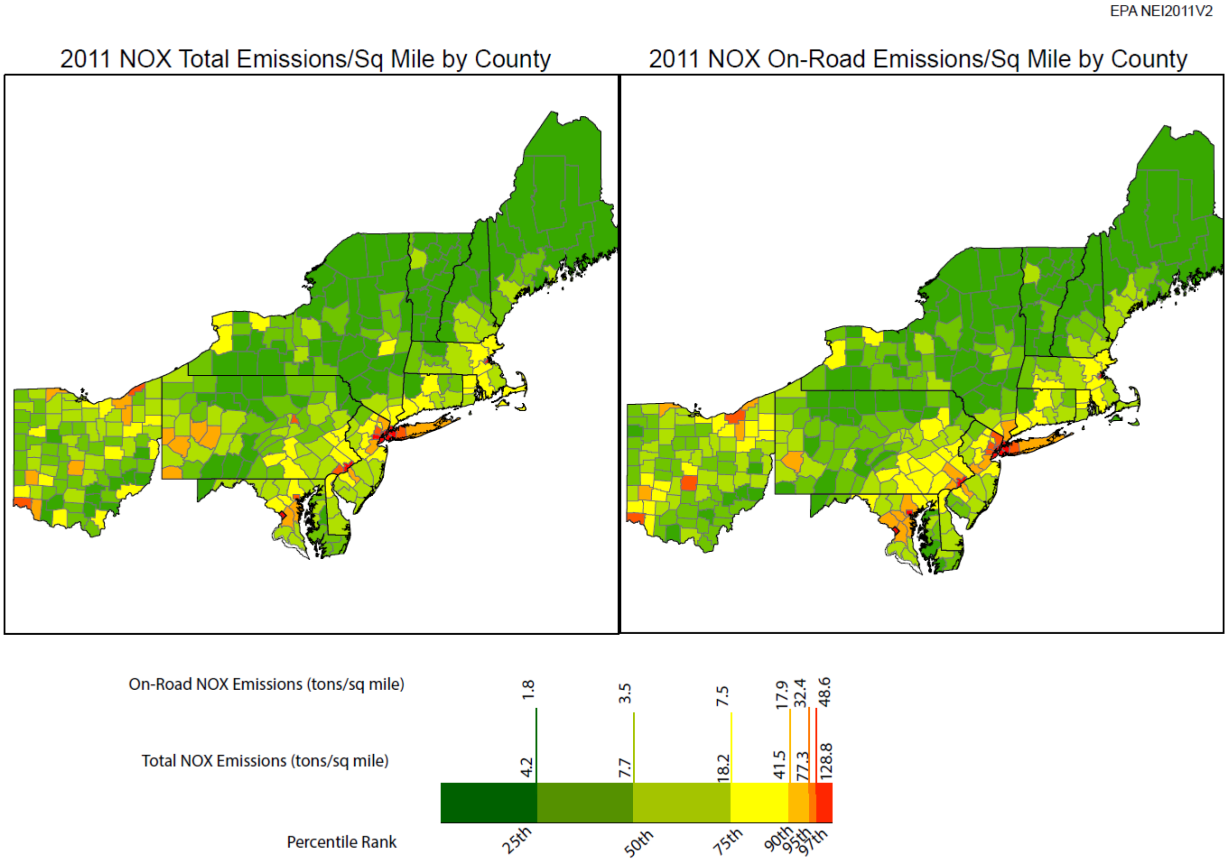
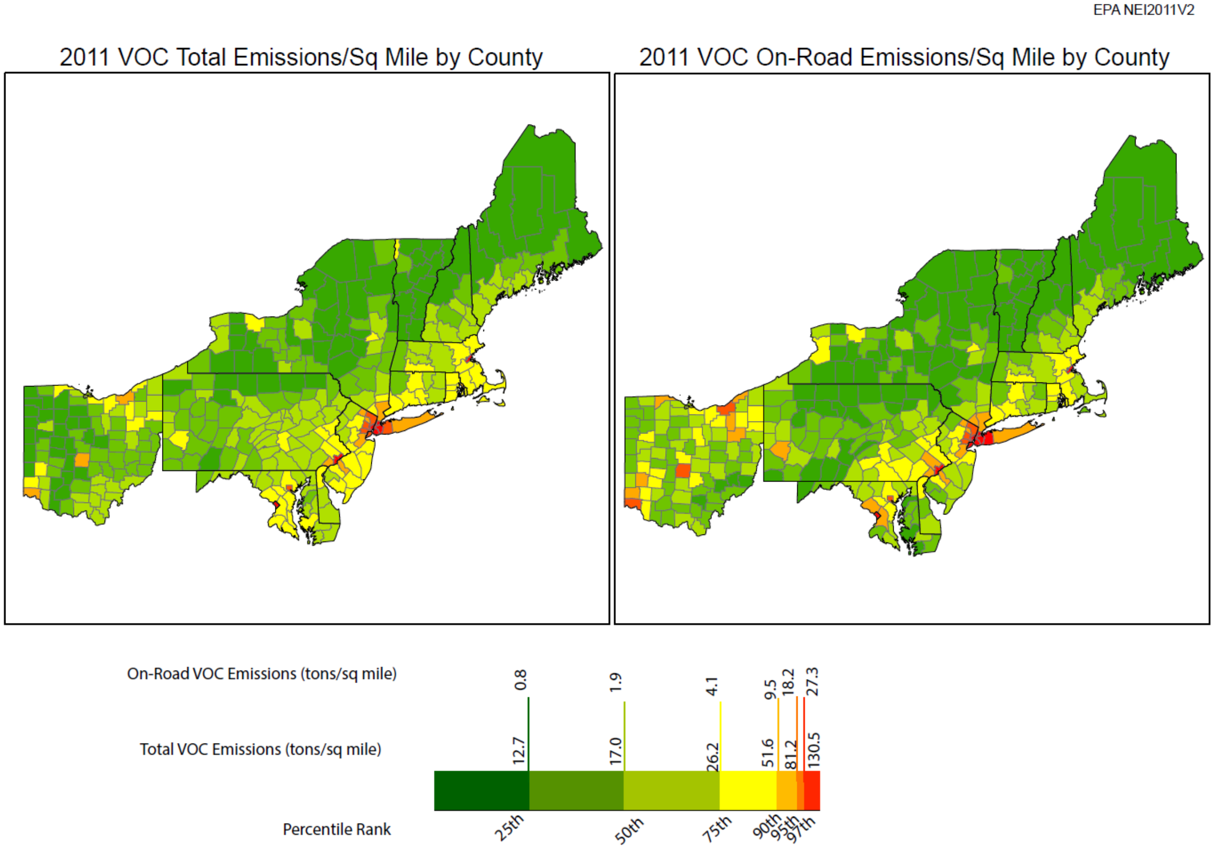


Figure 2-4. *2011 County-level Anthropogenic VOC Emissions Density Maps for Northeast States.*



2.4 A Connecticut Perspective on the Regional Ozone Problem

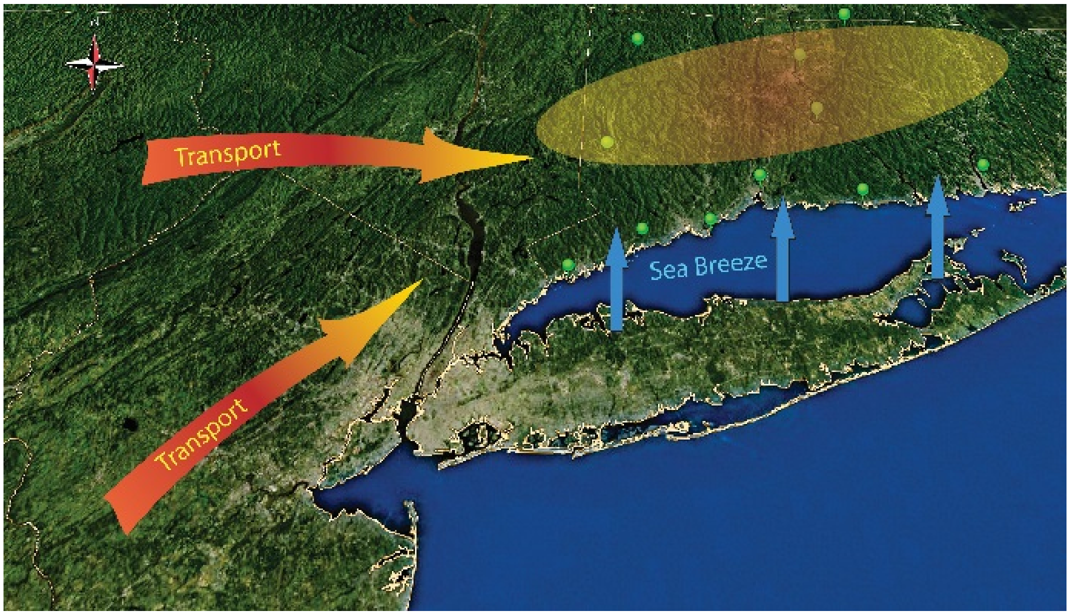
Although all of the states in the OTR are affected to some degree by ozone transport, Connecticut's location in relation to upwind emissions sources and ozone-favorable meteorological regimes makes the state particularly vulnerable to levels of transport that at times exceed the 8-hour ozone NAAQS at Connecticut's upwind border monitors, even before the addition of in-state emissions. Appendix A provides individual case studies of ozone exceedances in Connecticut with descriptions of the meteorological conditions that lead to those exceedances. A general description of meteorological conditions conducive to ozone exceedances in Connecticut is presented below.

Meteorological Regimes Producing High Ozone in Connecticut

Ozone exceedances in Connecticut can be classified into four categories based on spatial patterns of measured ozone and the contributing meteorological conditions. Typically, most exceedances occur on sunny summer days with inland maximum surface temperatures approaching or above 90°F, surface winds from the south and west (favorable for transport of pollutants from the Northeast Megalopolis) and aloft winds from the west-southwest to west-northwest (favorable for transport of pollutants from Midwest power plants).

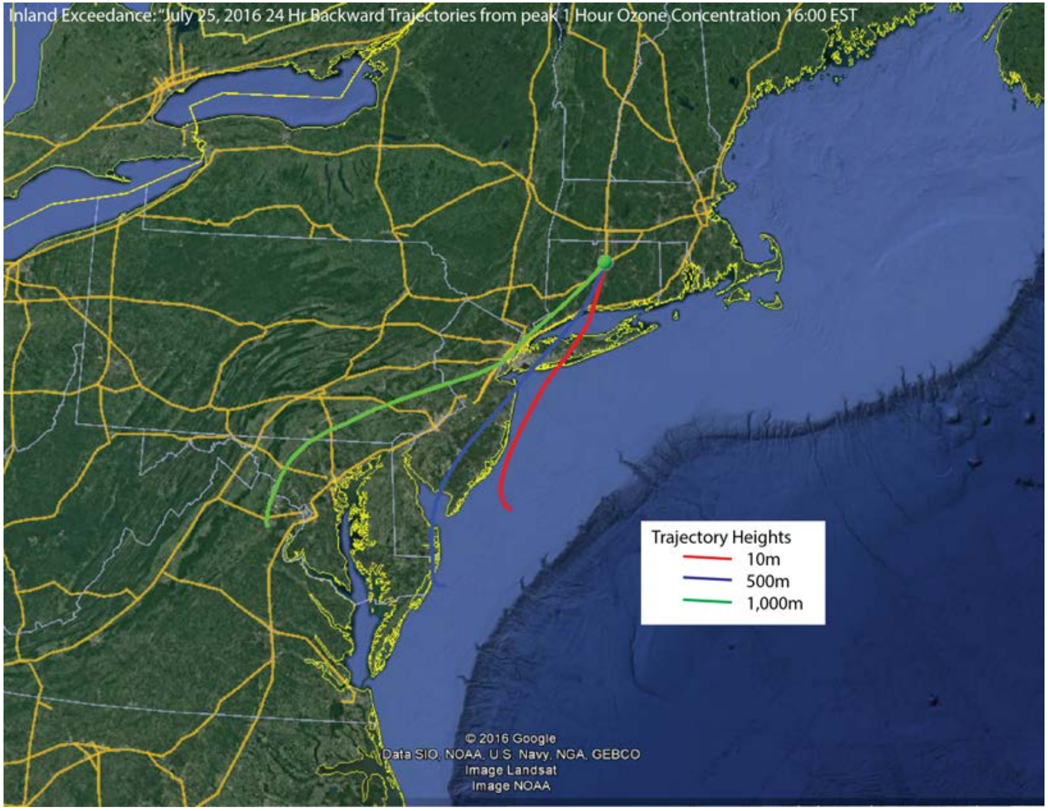
- **Inland-only Exceedances** (Figure 2-5)**:** Ozone is transported aloft from the west and mixed down to the surface as daytime heating occurs. At times, transport from the southwest can also occur overnight at lower levels aloft due to the formation of a nocturnal jet. Strong southerly surface winds during the day bring in clean maritime air from the Atlantic Ocean, resulting in relatively low ozone levels along the coast. The maritime front may not penetrate very far inland, and therefore does not mitigate transported and local pollutants' contribution to inland exceedances.

Figure 2-5. Depiction of Inland-only Exceedance Meteorological Regime



A recent example of an inland-only exceedance event occurred on July 25, 2016, as shown in Figure 2-6. Winds at the lowest levels were from the south, keeping coastal sites relatively clean. Mid-level transport from the southwest transported emissions up the I-95 corridor, with additional contributions from Connecticut sources, producing an exceedance of the 2015 NAAQS at East Hartford (72 ppb), with Middletown just below the new NAAQS level at 69 ppb.

***Figure 2-6.** Inland Exceedance at East Hartford: July 25, 2016 24-hr Backward Trajectories*

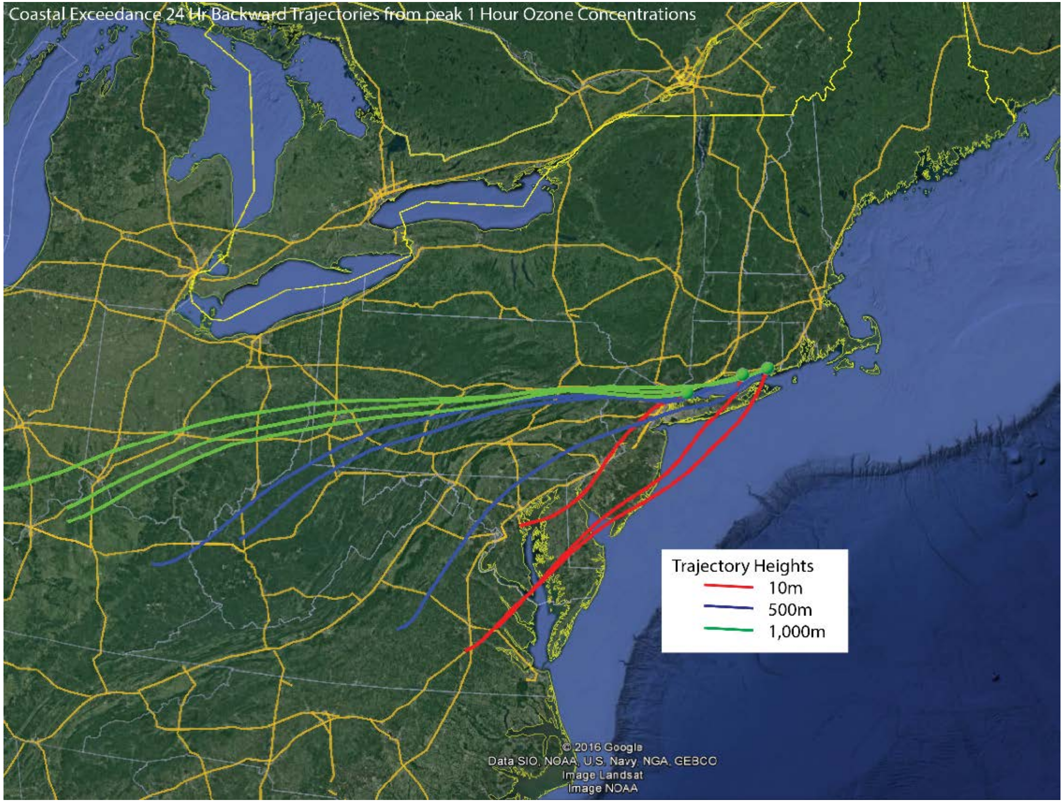


- **Coastal-only Exceedances** (Figure 2-7)**:** Strong westerly surface winds transport dirty air down Long Island Sound from source regions to the west (e.g., New York, New Jersey and beyond). The relatively cool waters of Long Island Sound confine the pollutants in the shallow and stable marine boundary layer. Afternoon heating over coastal land creates a sea breeze with a southerly component, resulting in ozone exceedances along the coast. Inland winds from the west prevent sea breeze penetration and can contribute to the formation of a convergence zone that can further concentrate ozone along the coast.

***Figure 2-7.** Depiction of Coastal-only Exceedance Meteorological Regime*

Figure 2-8 provides an example of a coastal-only exceedance. During this June 7, 2016 event, a fast-moving cold front from the southwest transported ozone and precursor emissions over Long Island Sound that were then carried into coastal sites with afternoon sea breezes, resulting in NAAQS exceedances at Greenwich, Westport, Stratford, Madison and Groton.

Figure 2-8. *Coastal Exceedance: June 7, 2016 24-hr Backward Trajectories*



- **Western Boundary-only Exceedances** (Figure 2-9)**:** Southerly maritime surface flow invades the eastern two-thirds of Connecticut, keeping ozone levels in that portion of the state low. The south-southwest urban winds out of New York City result in exceedances along Connecticut's western boundary. Winds aloft are often weak for this scenario.

__Figure 2-9:__ Depiction of Western Boundary-only Exceedance Meteorological Regime

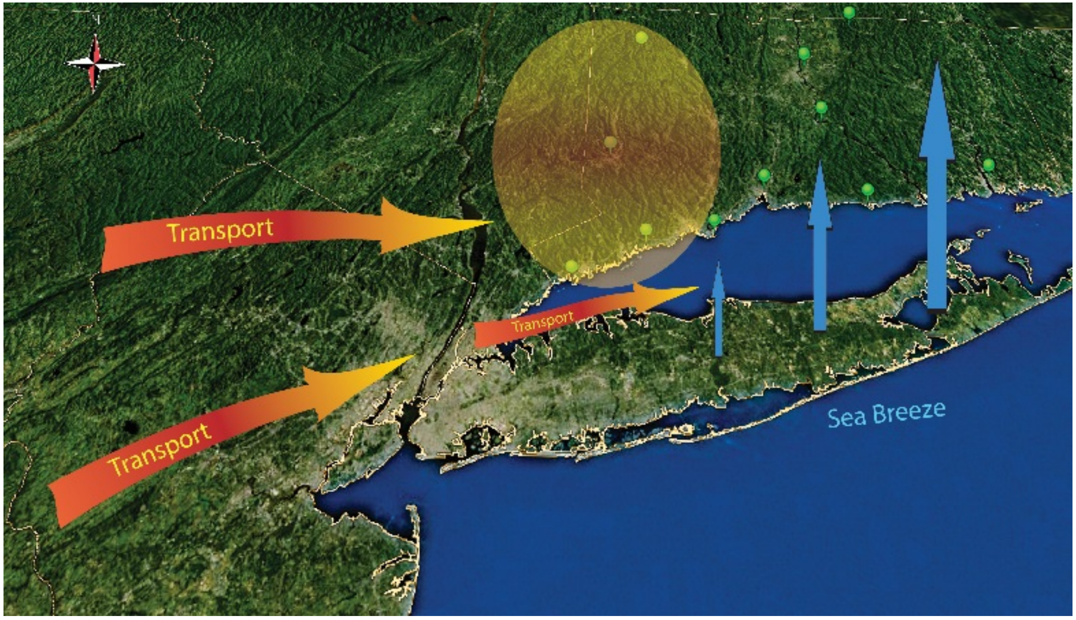
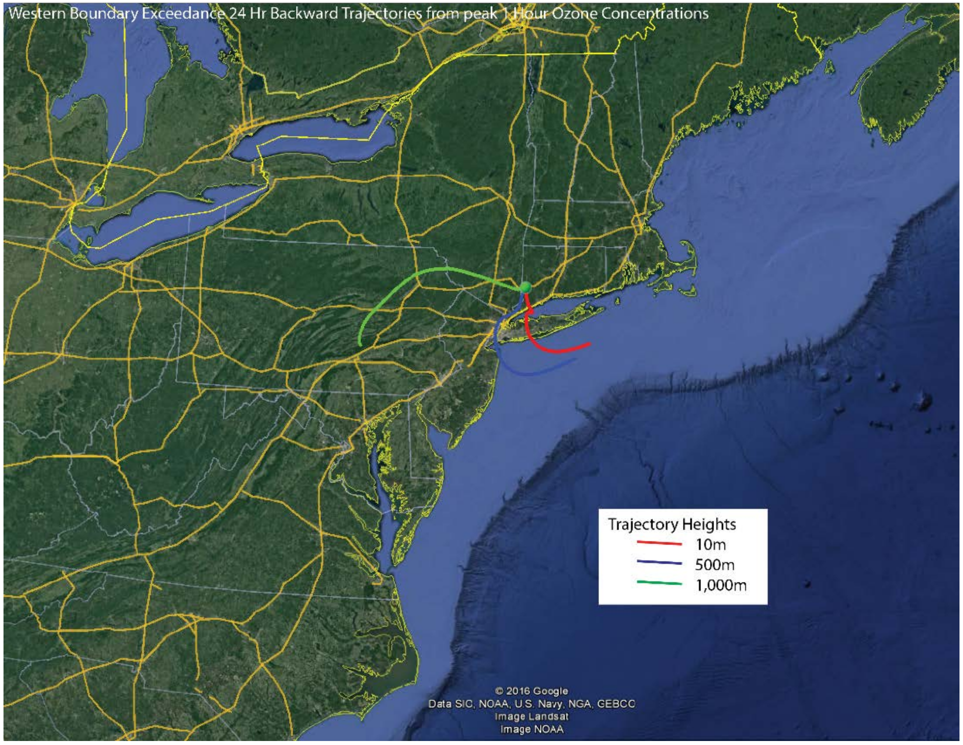


Figure 2-10 provides an example of a western boundary exceedance for June 26, 2016. South-southwesterly flow at low and mid-levels advected emissions from the New York City area into western Connecticut and the Hudson Valley area of New York, resulting in NAAQS exceedances in Danbury, Cornwall, White Plains, Mt. Ninham and Millbrook. Meanwhile, southerly flow drew cleaner maritime air into eastern portions of Connecticut.

__Figure 2-10.__ Western Boundary Exceedance: June 26, 2016 24-hr Backward Trajectories

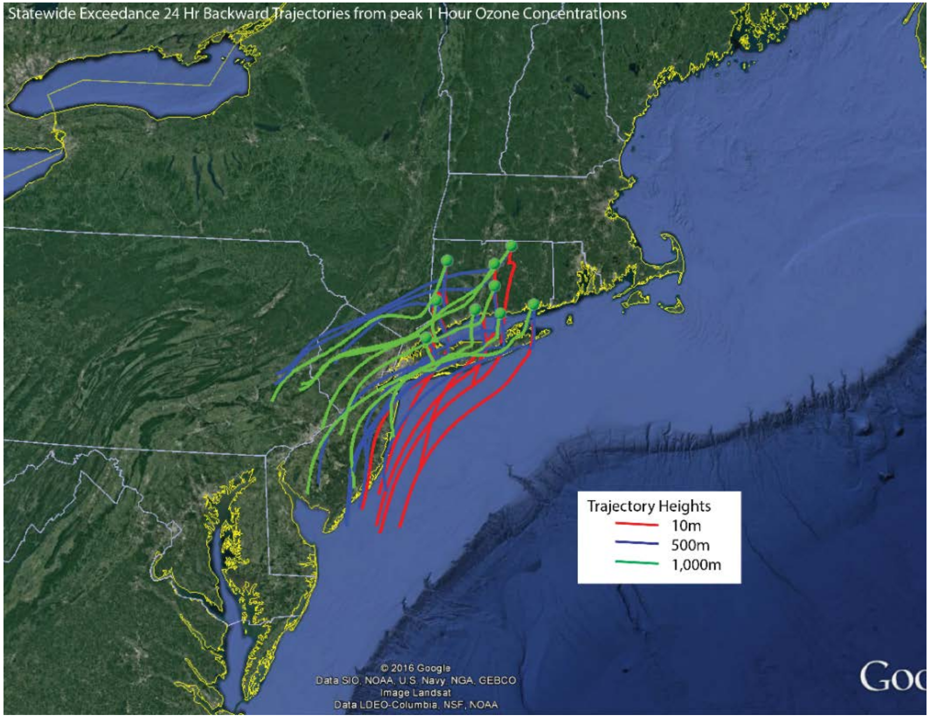


- **Statewide Exceedances** (Figure 2-11)**:** This is the classical worst-case pattern, with flow at the surface in the Northeast up the Interstate-95 corridor, transport at mid-levels also from the southwest via the low level jet and flow at upper levels from the west. All of these flows are from emission-rich upwind areas, serving to transport ozone precursors and previously formed ozone into Connecticut.

Figure 2-11. *Depiction of Statewide Exceedance Meteorological Regime*

Figure 2-12 provides an example of a statewide exceedance event from September 18, 2015. A persistent high pressure weather pattern trapped pollutants near the surface for several days. Exceedances first occurred on September 15th in the Washington DC area, gradually expanding northward along the I-95 corridor, with exceedance levels occurring on a widespread basis throughout the OTR region on September 17 and 18th (including in Connecticut). Peak 8-hour values in Connecticut occurred along the southwest coastline on September 17th, reaching 96 ppb at Westport. The highest value in Greater Connecticut occurred in East Hartford on September 18th (84 ppb).

Figure 2-12. *Statewide Exceedance: September 18, 2016 24-hr Backward Trajectories*

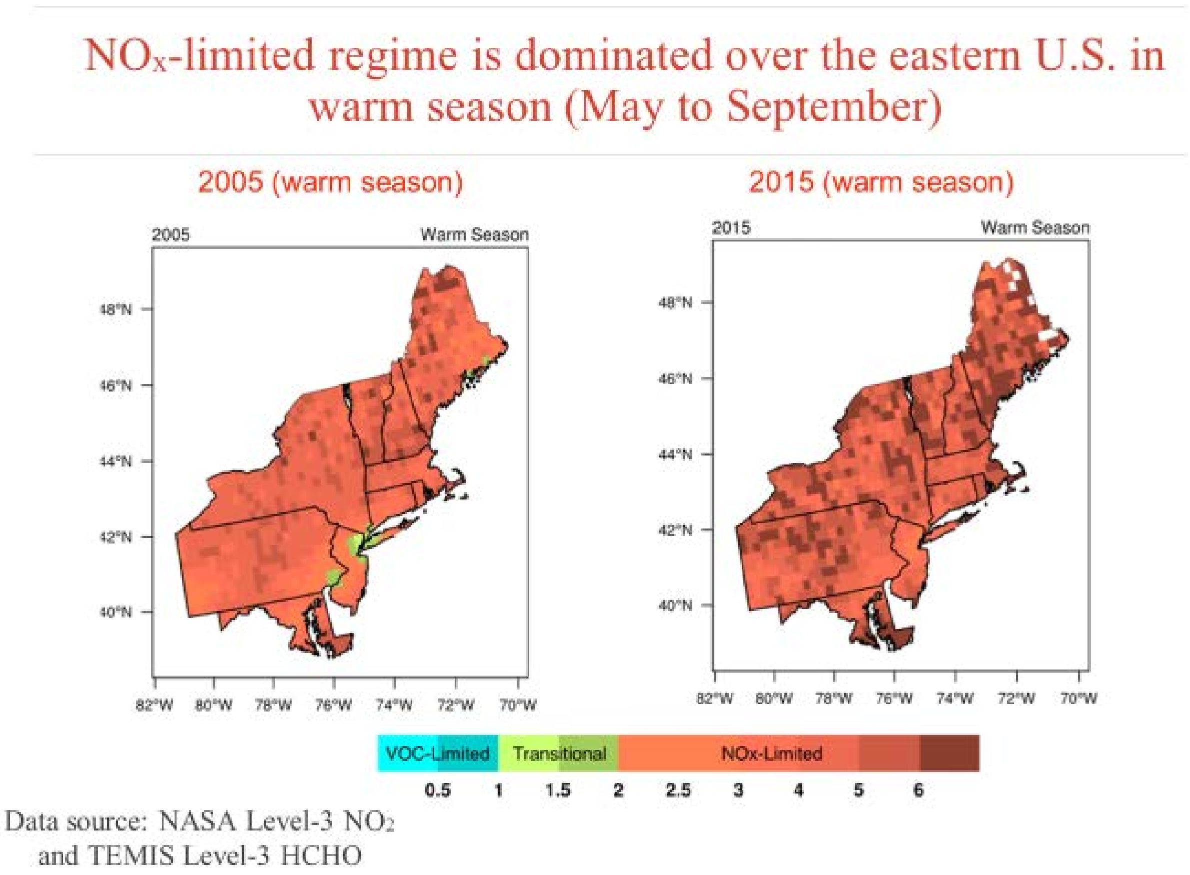


Ozone Chemistry

In addition to understanding the role that meteorological regimes and source emissions play in producing high ozone events, it is also important consider the relative balance of ozone precursors in the air shed. An air shed may be more limited in its ozone forming potential by either NOx or VOC. Chemical reactions are not one directional, there is an ebb and flow of production and destruction in any reaction depending on the availability of the various species involved in a reaction. In other words, control strategies implemented with a focus on a particular pollutant can have a more beneficial effect if ozone reactions in that air shed tend to be limited by that pollutant.

A study conducted by the Lamont-Doherty Earth Observatory at Columbia University[4] makes use of NASA data which measured air column NO_2 and formaldehyde (as a surrogate for VOC) by satellite and correlated the data to ozone episodes in the Northeast. As depicted in Figure 2-13 Jin *et al.'s* findings indicate that on a regional scale, ozone formation in the Northeast tends to be more NOx limited. Therefore, it is appropriate to favor NOx control strategies on a regional basis.

Figure 2-13. *Air column ratio of formaldehyde, as surrogate for VOC, to NO_2 indicate that ozone formation tends to be NOx limited in the northeast region of the United States. (Jin et al.)*



NO_x-limited regime is dominated over the eastern U.S. in warm season (May to September)

2005 (warm season)

2015 (warm season)

Data source: NASA Level-3 NO_2 and TEMIS Level-3 HCHO

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[4] Jin, Xiaomeng, and Arlene Fiore to Kurt Kebschull as Photochemical Modeling Presentation "Analyzing Surface Ozone Sensitivity to Nitrogen Oxide and Volatile Organic Compound Emissions: The View from Space", Department of Earth and Environmental Sciences, Lamont-Doherty Earth Observatory, Columbia University.

2.5 Conclusion

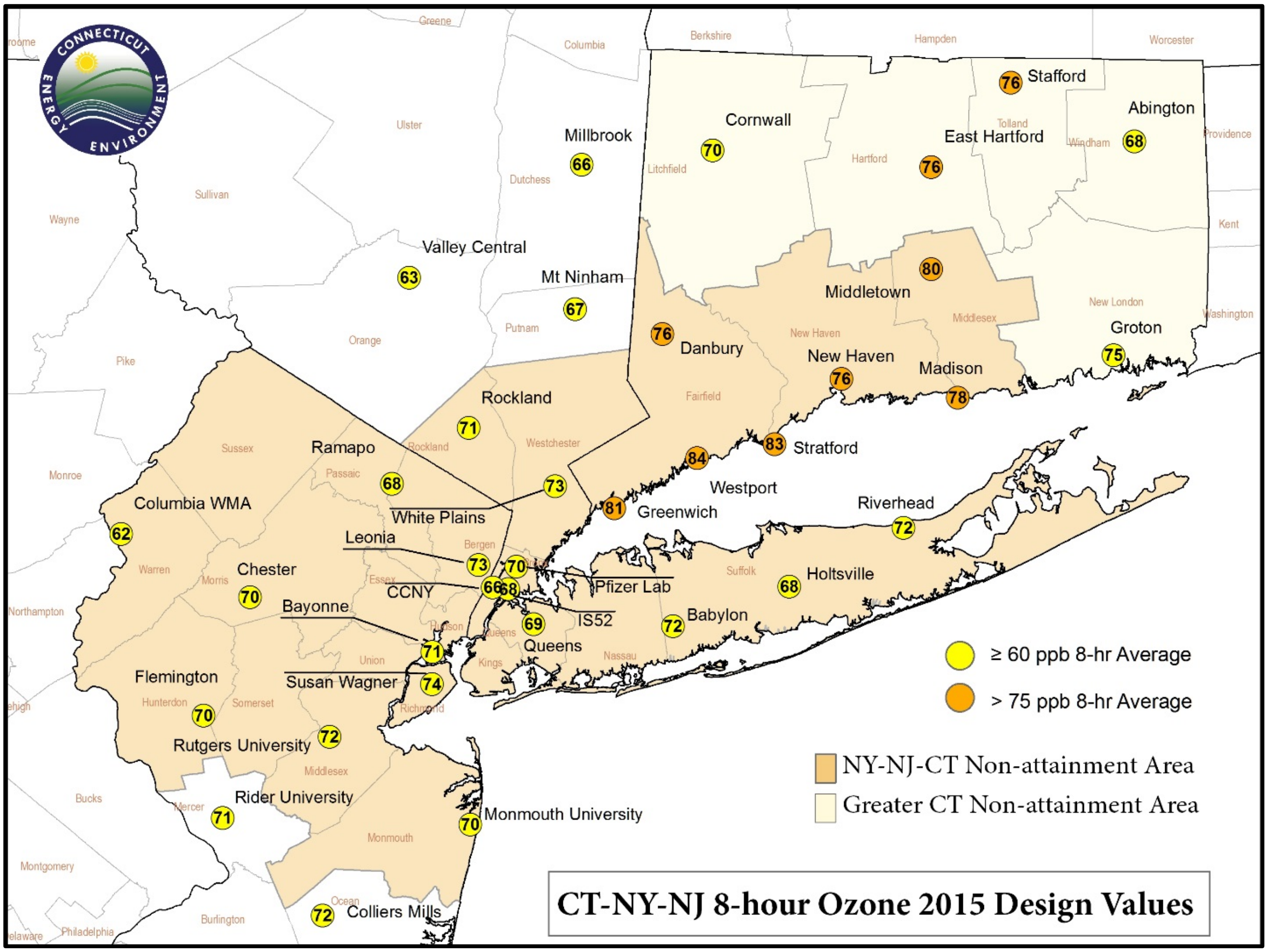
Larger synoptic scale weather patterns, and pollution patterns associated with them, support the need for NOx controls across the broader eastern United States. The presence of land, sea, mountain, and valley breezes indicate that there are unique aspects of pollution accumulation and transport that are area-specific. The smaller scale weather patterns that affect pollution accumulation and its transport underscore the importance of local controls for emissions of NOx and VOC. Studies and characterizations of nocturnal low level jets also support the need for local and regional controls on NOx and VOC sources, as locally generated and transported pollution can both be entrained in nocturnal low level jets formed during nighttime hours.

3. Ozone Air Quality Levels in Connecticut and Recent Trends

The CT DEEP has been monitoring ambient ozone levels throughout the state since the early 1970s. The current network consists of the twelve sites. In addition to ozone monitoring, Connecticut has operated up to four Photochemical Assessment Monitoring Stations (PAMS) since 1994 to collect ambient concentrations of VOCs, carbon monoxide (CO) and NOx.

The form of the 8-hour ozone standard is the three-year average of the fourth highest 8-hour ozone levels for each year. Compliance with the standard is achieved when this “design value” is less than 0.076 parts per million (76 parts per billion). Figure 3-1 shows the 2015 design values and 8-hour ozone nonattainment area boundaries in Connecticut, New York and New Jersey. Many locations throughout Connecticut exceed the level of the standard and therefore continue to be considered nonattainment with respect to the 8-hour ozone NAAQS. Note that 2015 design values in the Greater Connecticut area are all 76 ppb or lower, so that area is very close to measuring NAAQS compliance as of the 2015 ozone season.

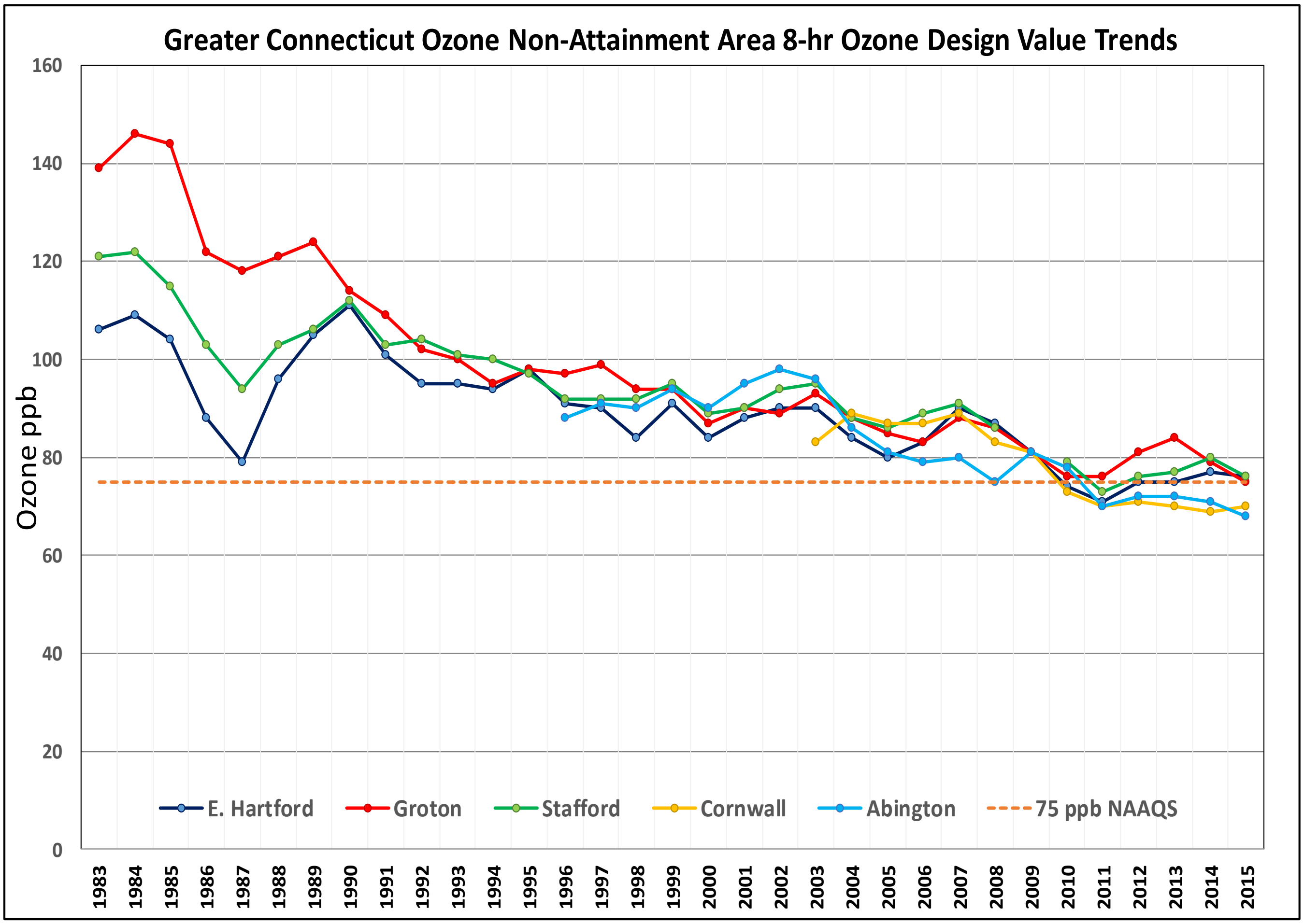
__Figure 3-1.__ 8-hour Ozone Nonattainment Areas in Connecticut, New York and New Jersey with Associated 2015 Design Values



3.1 Trends in Design Values

The trends in design values for each site in the Greater Connecticut nonattainment area are plotted in Figure 3-2**.** The maximum design values in Greater Connecticut area have decreased by approximately 45% since the mid-1980s, from over 140 ppb in 1983 to 76 ppb in 2015, just above the 75 ppb NAAQS level[5].

Figure 3-2. *Greater Connecticut 8-hour Ozone Design Value Trends*



3.2 Trends in Exceedance Days

An exceedance day for the 8-hour ozone NAAQS is defined as a day, measured from midnight to midnight, on which any one or more monitors in the state record a forward 8-hour ozone concentration greater than or equal to 76 ppb. The total number of annual exceedance days measured in Connecticut from 1974 through 2015 is shown in Figure 3-3. The number of Connecticut exceedance days has decreased dramatically from a high of 103 in 1980 to a low of six in 2009, with 21 exceedances days in 2015. Although the long-term trend has been downward, it appears to have leveled off in recent years. Note that, if exceedance day trends were analyzed for just the Greater Connecticut area, the number of days each year would be less than the statewide totals shown in Figure 3-3, but the long-term trend slope would be similar. In 2015, there were 11 days when at least one Greater Connecticut area monitor exceeded the standard. The largest number of exceedance days in 2015 at any single monitor in the Greater Connecticut area was 6, at the Groton site located near the coastline.

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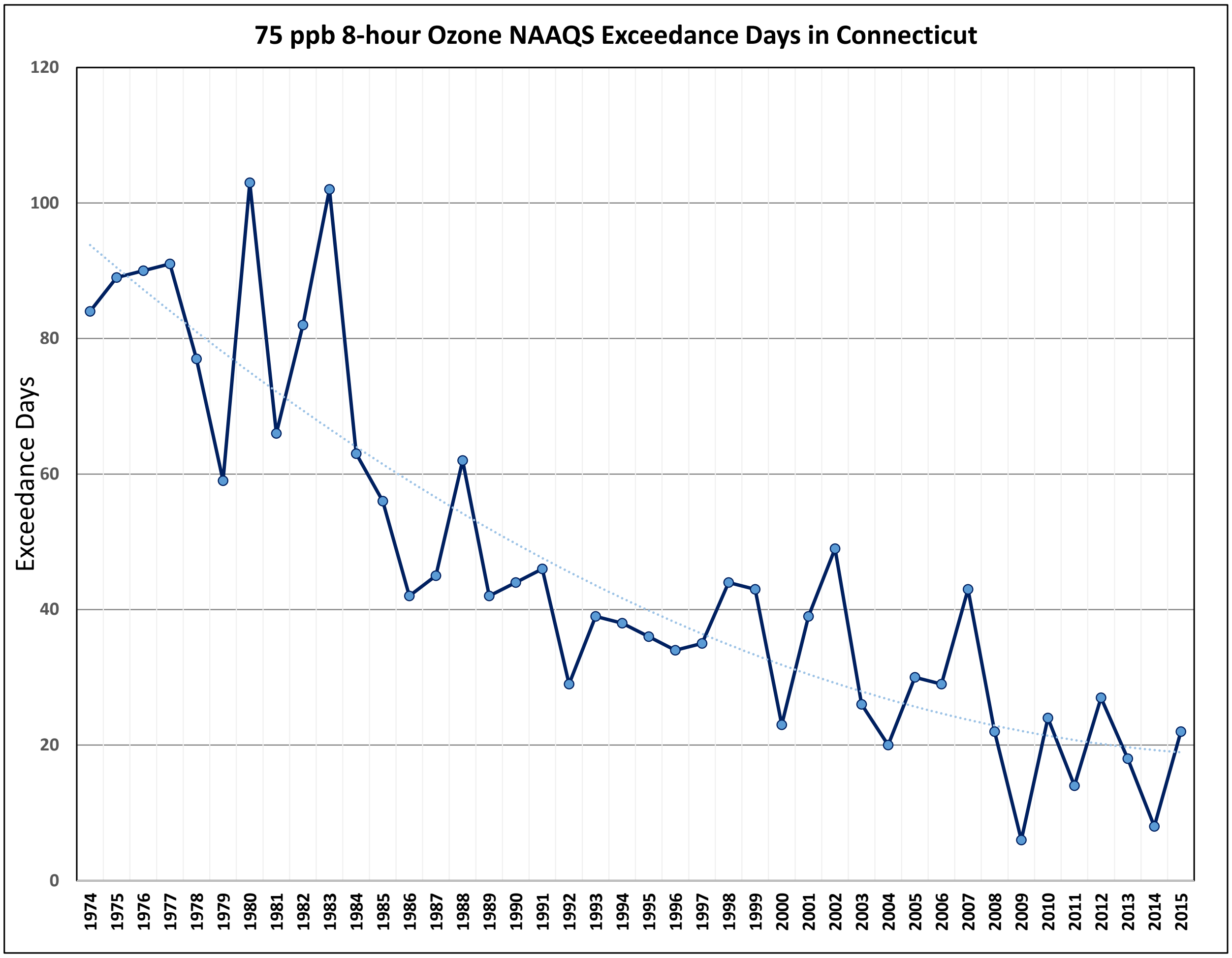
[5] Preliminary design values for 2016 indicate that all monitors in Greater Connecticut are in compliance with the 2008 ozone NAAQS.

Figure 3-3. *Connecticut Statewide 8-hour Ozone Annual Exceedance Day Trends*



3.3 Trends in 8-hour Ozone Percentiles

The trends addressed previously focused on the very highest ozone concentrations measured at Connecticut monitors. Another way of looking at long-term trends is to plot the full distribution of concentrations including the lowest to the highest percentiles measured during the ozone-monitoring season. Figure 3-4 displays distributions since 2006 for the four Greater Connecticut sites (excluding Abington). It shows that the greatest downward trends are for the 98th and 90th percentiles from 2007 to 2015, however there are no clear trends over the last few years. The 50th percentile trend values have shown the least (if any) decline.

Figure 3-4. *Greater CT 8-hour Ozone Percentile Trends*


E Hartford Ozone Percentile Trend 2007-2015

Stafford Ozone Percentile Trend 2007-2015

Groton Ozone Percentile Trend 2007-2015

Cornwall Ozone Percentile Trend 2007-2015

3.4 Meteorological Influences on Ozone Levels

Ozone is not emitted directly into the atmosphere, but is formed by photochemical reactions between VOCs and NOx in the presence of sunlight. The highest ozone concentrations in Connecticut typically occur on hot summer days, with surface winds from the southwest and winds aloft from the west. The photochemical reactions that produce ozone are enhanced by long summer days and elevated temperatures (which also lead to increased levels of evaporative VOC emissions). In addition, transported ozone and precursor species are enhanced by winds coming from areas with high emissions of stationary and mobile sources along the Interstate-95 corridor at the surface and from Electrical Generation Unit (EGU) power plants from upwind states at elevated levels. Hot summers can result in several extended periods of elevated ozone production, while cooler summers are typically characterized by fewer days of elevated ozone levels.

Meteorological data from Bradley International Airport (Windsor Locks, CT) were used to examine the year-to-year relationship between the frequencies of high ozone and high temperature days in Connecticut. Figure 3-5 shows the trend from 1997 through 2015 of average of statewide daily maximum 8-hour ozone levels binned by daily maximum temperature. It shows that, the highest ozone levels occur on the hottest days (days with maximum temperatures above 90 degrees Fahrenheit) and the trend of high ozone on the hottest days is downward. The trend of ozone on days with high temperatures below 82 degrees is fairly flat.

Figure 3-5. *Connecticut 8-hour Ozone Percentile Trends by Temperature Range*

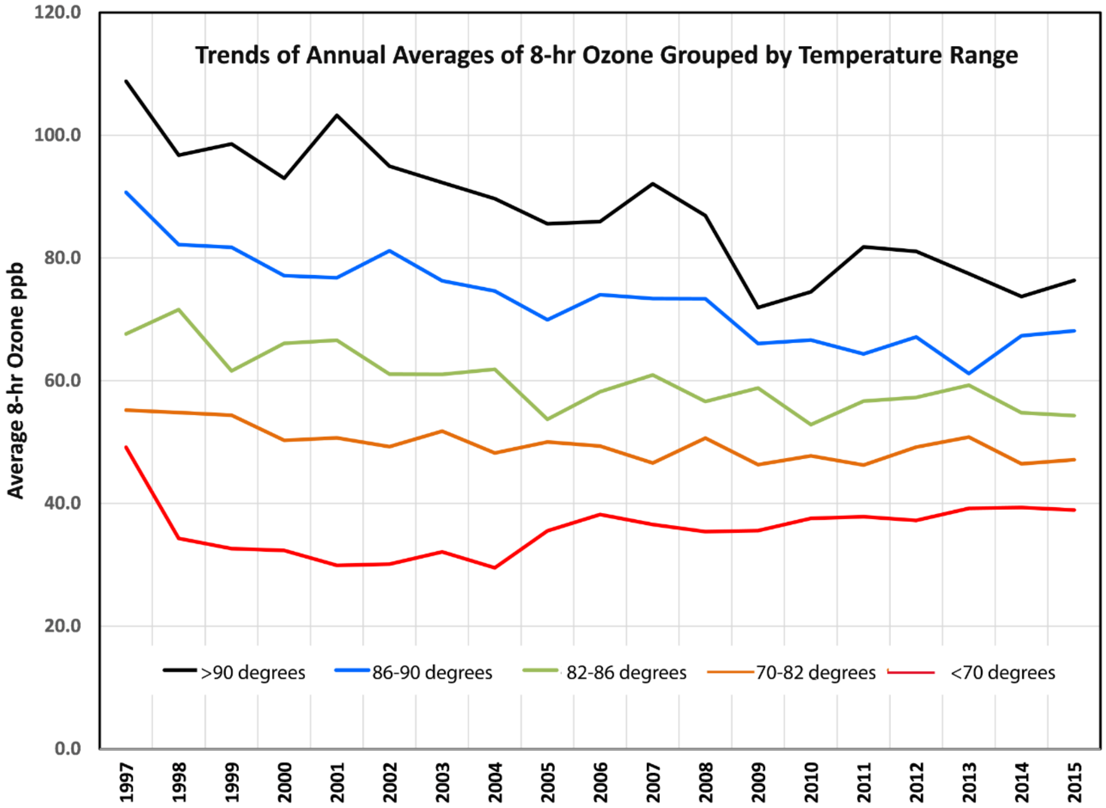


Figure 3-6 is a plot of the number of days with exceedances of the 2008 NAAQS in Connecticut for the period from 1981 through 2015, along with the number of "hot" days -- days with maximum temperatures of 90˚F or above at Bradley International Airport (BDL). Although the number of high ozone days tends to track with the number of hot days, the frequency of high ozone days has decreased over time, even for years with similar numbers of hot days. There was an average of 17 "hot" days over the 35-year period. The group of hottest years (i.e., 1983, 1988, 1991, 2002, 2005 and 2010, all with at least 30 days of ≥ 90˚F temperatures) show a steady improvement in the number of exceedance days (i.e., 102, 62, 46, 49, 30 and 24 exceedance days, respectively) for each of those hottest years.

The decline in ozone exceedances, after adjusting for temperature effects, is depicted in an alternate way in Figure 3-7, which plots the ratio of exceedance days ("unhealthy" days) to the number of "hot" days for each ozone season from 1981 through 2015. The ratios have improved over the period, from values generally near or greater than 3 during most of the 1980's, improving to values generally in the 2 to 4 range through the early 2000's. Since about 2010, the ratios have been hovering around a value of 1, signifying additional improvements in ozone levels when temperature influences are considered.

Figure 3-6. *Statewide Annual 8-hour Ozone Exceedance Days Compared to ≥ 90°F Days*

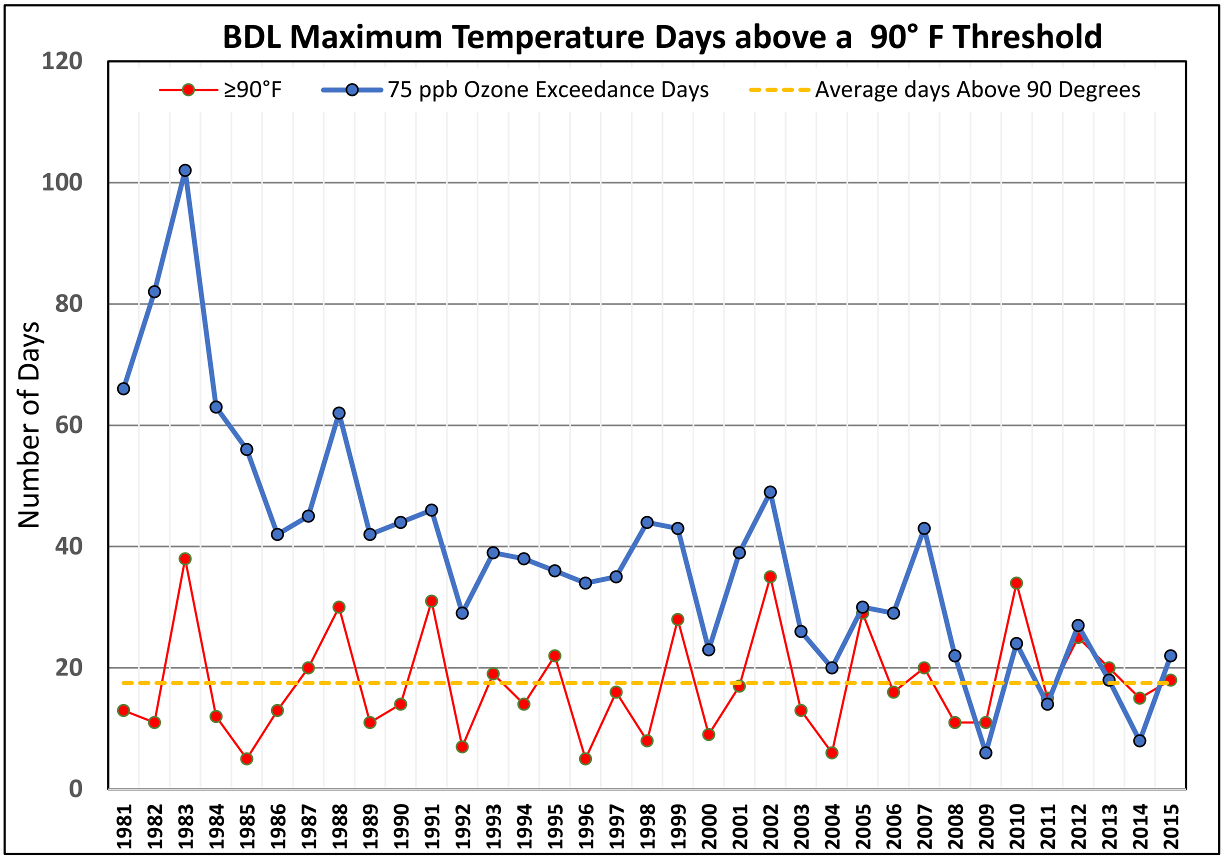
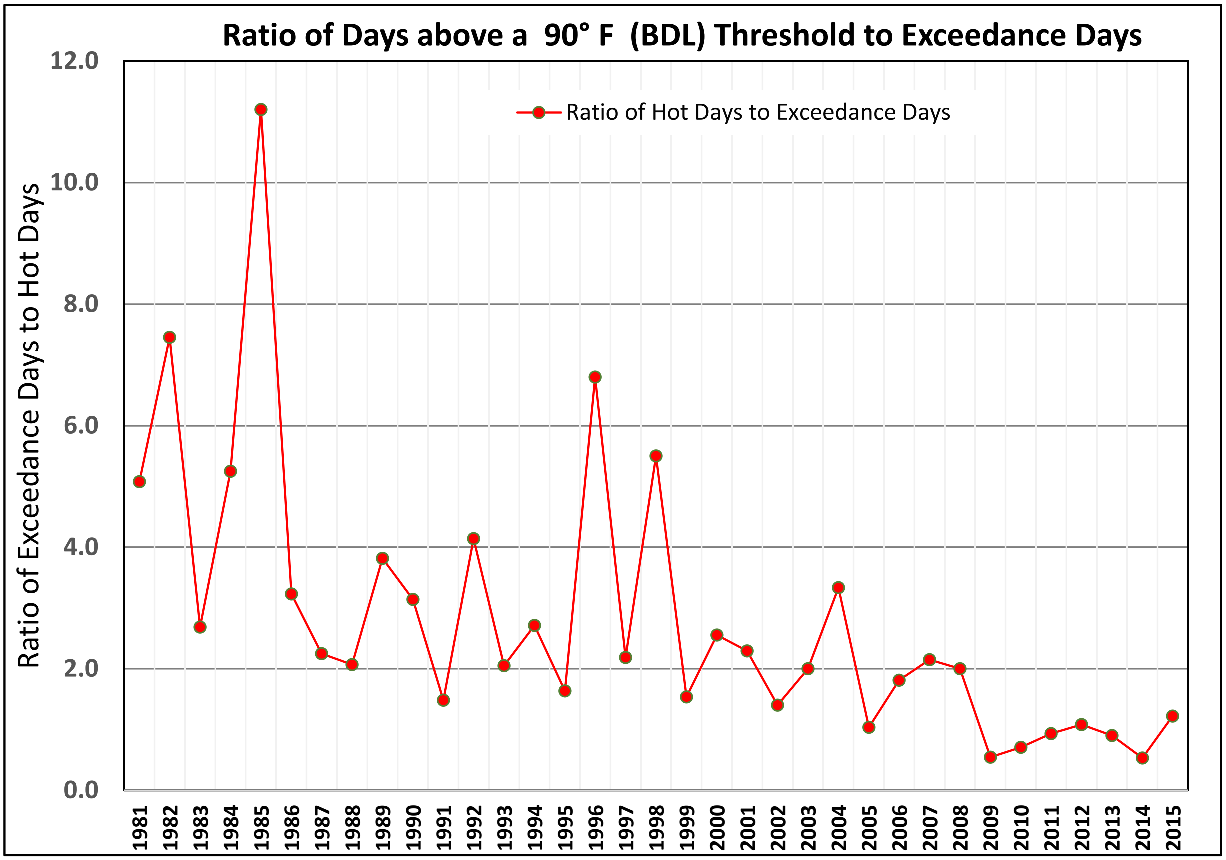


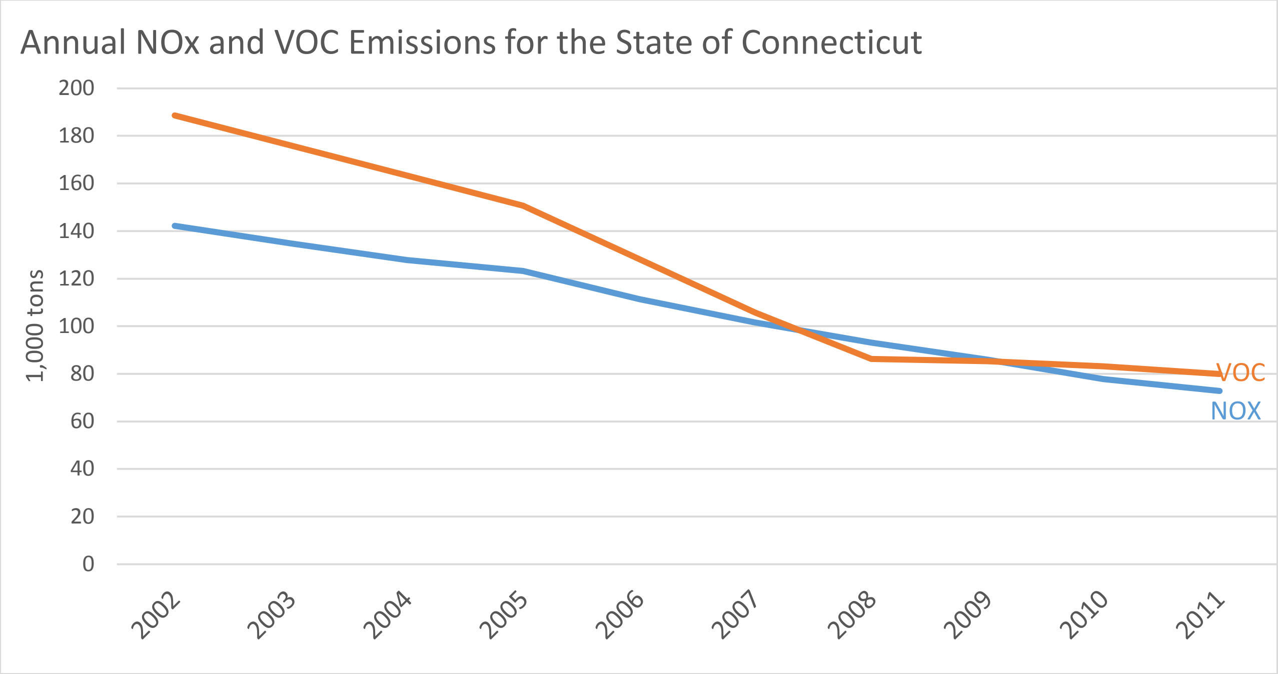
Figure 3-7*. Statewide Ratio of Annual 8-hour Ozone Exceedance Days to Number of ≥ 90°F Days*



3.5 VOC and NOx Trends

Emissions of ozone precursors in Connecticut have significantly declined over the years. Figure 3-8 displays trends in statewide anthropogenic NOx and VOC between 2002 and 2011. Emission reduction programs achieved 49% reduction in NOx and 58% reduction in VOCs over the period.

Figure 3-8. *Connecticut VOC and NOx Annual Emissions Trends*



Source:https:/www.epa.gov/air-emissions-inventories/air-pollutant-emissions-trends-data

Dozens of VOC species can be present in the atmosphere, influencing the ozone formation process. Section 182(c)(1) of the CAA directed EPA to promulgate rules (40 CFR 58) that would require states to establish Photochemical Assessment Monitoring Stations (PAMS) as part of their monitoring networks in serious, severe or extreme ozone nonattainment areas. CT DEEP established three PAMS sites during the mid-1990s that are currently operating: Westport (Sherwood Island), New Haven and East Hartford (see Figure 3-1 for locations).

PAMS data collection policy was revised by EPA in 2013 and includes a target list split into two groups – 28 priority and 29 optional VOC compounds. Two of the species, ethane and ethylene could not be quality assured at some of the sites and thus are not included in calculations for total VOCs. See Table 3-1 for a complete list of VOC species used to calculate total VOCs. PAMS Stations must also measure O3, NOx, and surface meteorological parameters on an hourly basis.

The federal objectives of this program include providing a speciated ambient air database that is both representative and useful for ascertaining ambient profiles and distinguishing among various individual VOCs and characteristics of source emission impacts. In furtherance of these objectives, the Northeast States for Coordinated Air Use Management (NESCAUM) contracted with Sonoma Technology, Inc. in 2002 to collect, organize and validate data from 2000 for all the NESCAUM PAMS sites and evaluate control program effectiveness in the NESCAUM region.[6]

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[6] The results of this effort may be obtained at: http://www.nescaum.org/projects/pams/part2/index.html.

__Table 3-1__. Pollutants monitored at Photochemical Assessment Monitoring Stations (PAMS) Used for Calculating Total VOC Concentrations

Parameter Code	Parameter Description		Parameter Code	Parameter Description
43202*	Ethane		43250	2,2,4-Trimethylpentane
43203*	Ethylene		43280	1-Butene
43204	Propane		45109	m/p Xylene
43205	Propylene		45201	Benzene
43212	n-Butane		45202	Toluene
43214	Isobutane		45203	Ethylbenzene
43216	trans-2-Butene		45204	o-Xylene
43217	cis-2-Butene		45208	1,2,4-Trimethylbenzene
43220	n-Pentane		45211	o-Ethyltoluene
43221	Isopentane		45212	m-Ethyltoluene
43231	n-Hexane		45213	p-Ethyltoluene
43243	Isoprene		45220	Styrene
* Removed due to quality assurance issues			45225	1,2,3-Trimethylbenzene

Figures 3-9 through 3-11 are plots of the average monthly NOx concentrations from 1996 to 2015 for the East Hartford, Westport and New Haven sites in Connecticut (New Haven moved in 2004). NOx concentrations are at their highest levels in the winter months and lowest in the summer months. The trend in NOx concentrations during the ozone season (May to September) has been downward throughout the period at all sites. This can more readily be seen in Figures 3-12 through 3-14, which show trends for these sites just for the three summer months, when ozone production is at its highest levels.

__Figure 3-9.__ East Hartford Monthly NOx Trends from 1996-2015

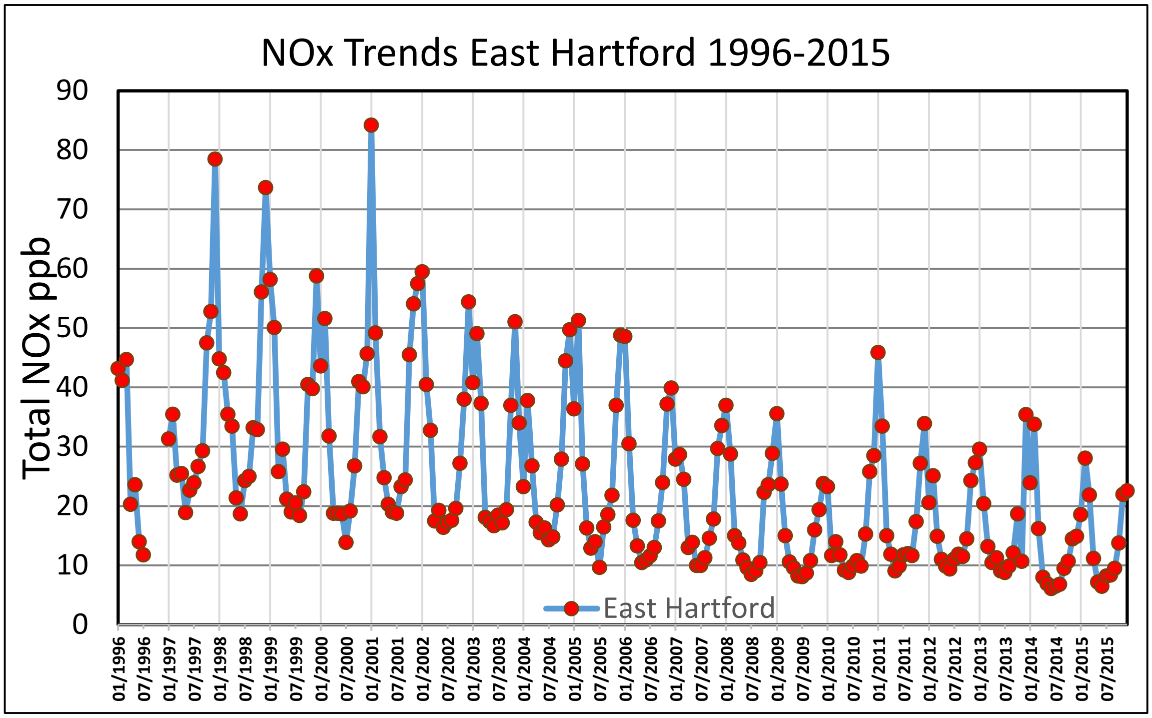


Figure 3-10. *Westport Monthly NOx Trends from 1996-2015*

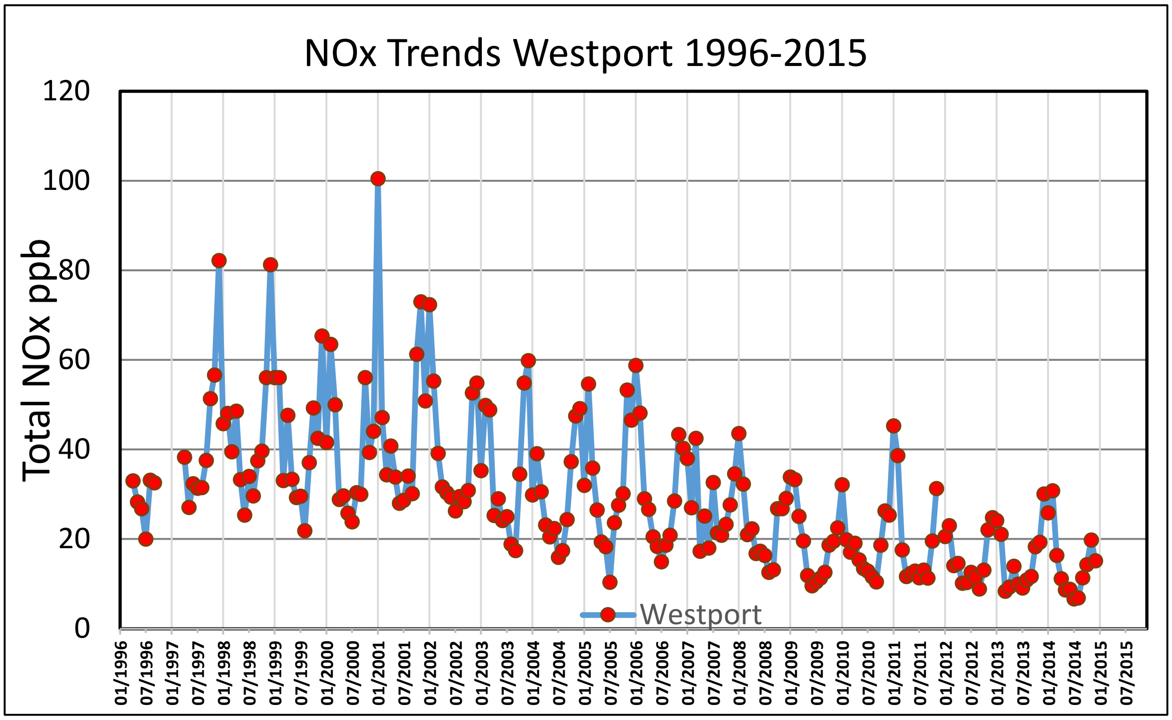


Figure 3-11. *New Haven Monthly NOx Trends from 1996-2015*

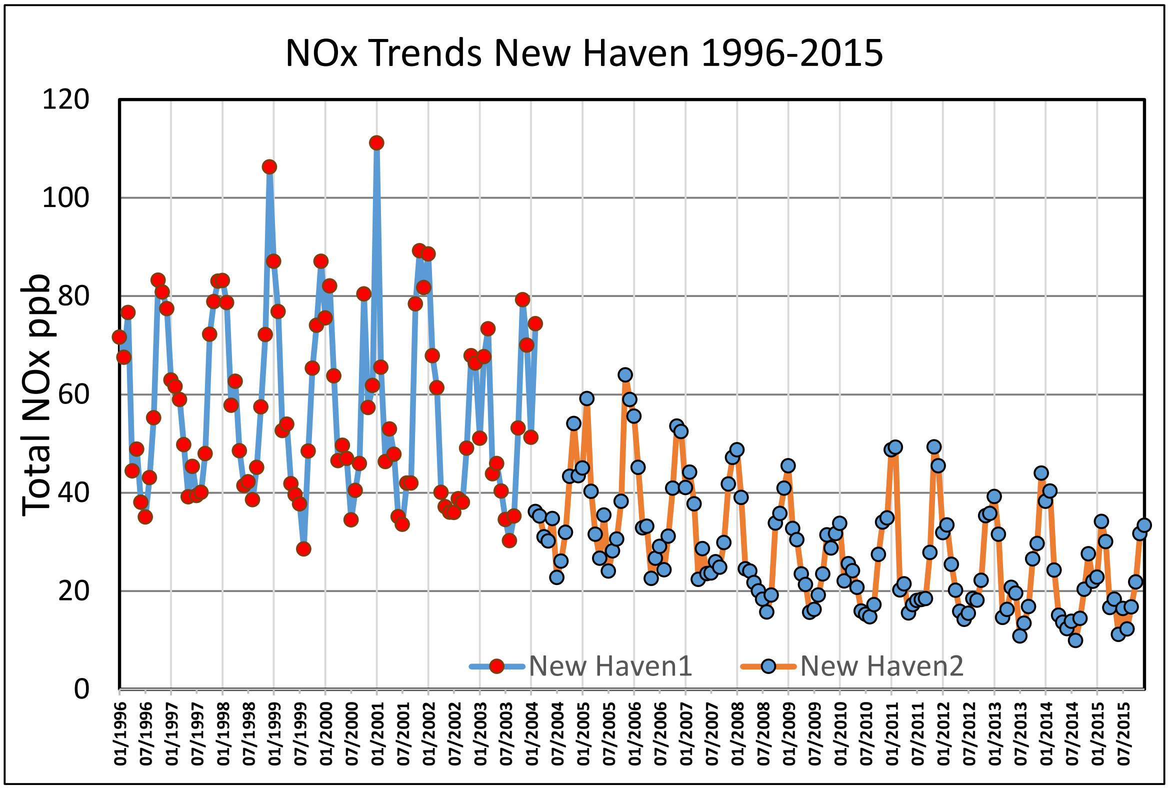


Figure 3-12. East Hartford Monthly Summer NOx Trends from 1996-2015

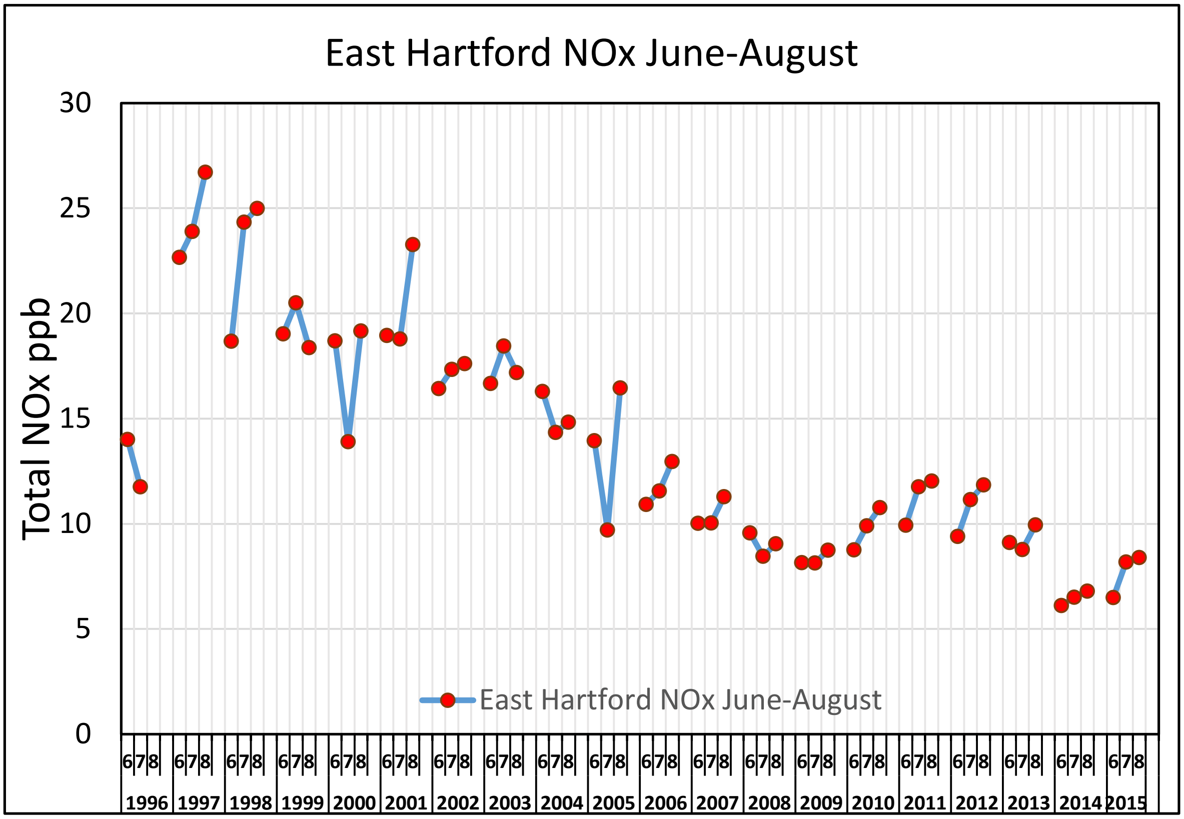


Figure 3-13. Westport Monthly Summer NOx Trends from 1996-2015

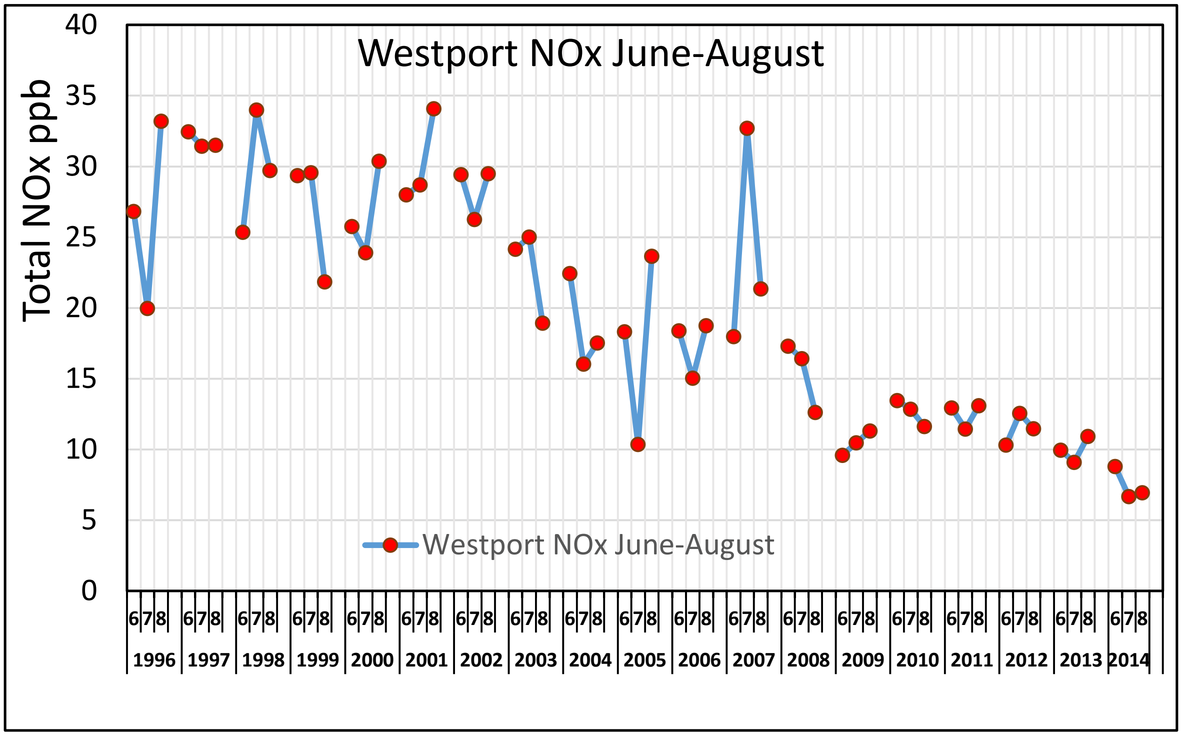
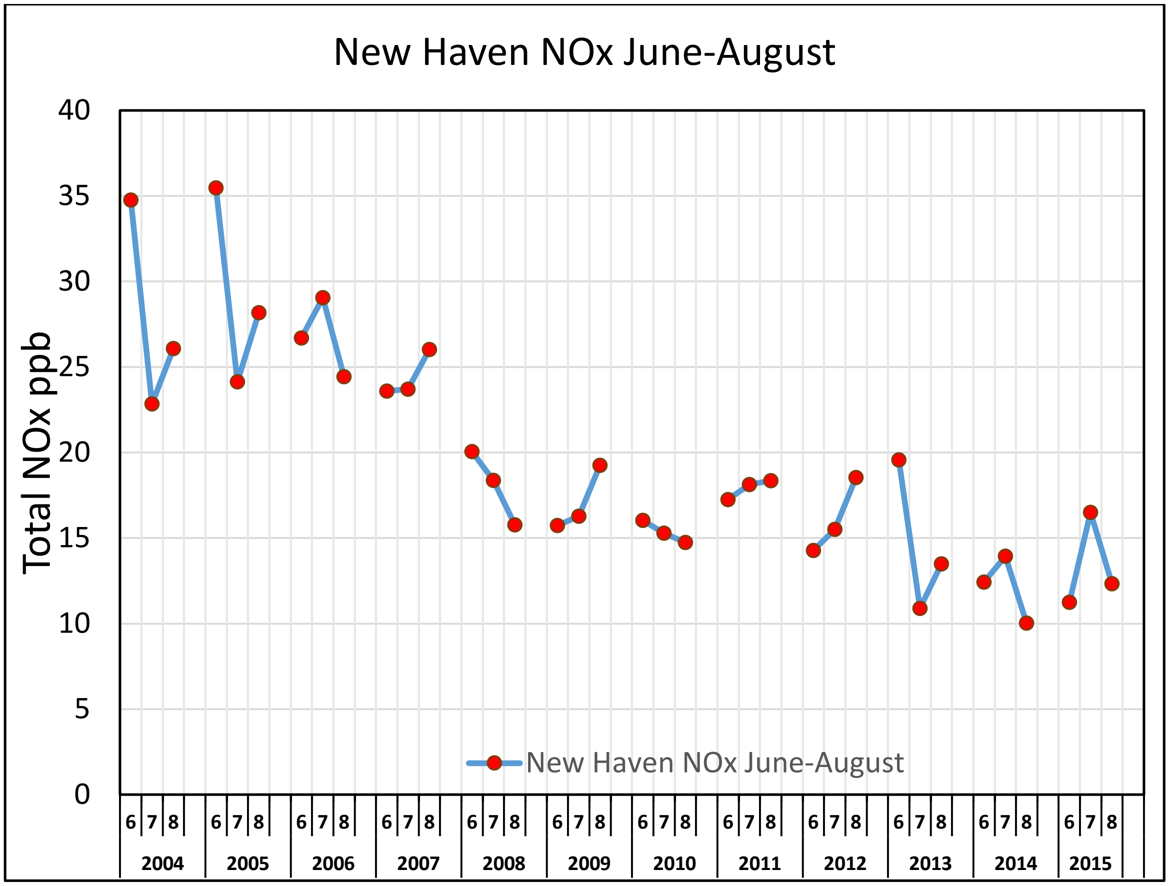


Figure 3-14. *New Haven Monthly Summer NOx Trends from 2004-2015*



Figures 3-15 through 3-17 display the trends in total VOCs measured at three PAMS sites. Over the period of data collection at each site, total VOC concentrations have trended downward; however, the concentrations are variable during each summer period. It should be noted that the New Haven site has consistently measured elevated VOC levels compared to the other two sites, probably due to its proximity to fuel terminals. Figure 3-18 is a Google Earth image of the New Haven monitor that shows the proximity of the bulk gasoline terminals. The facilities are labeled with the 2011 EPA National Emission Inventory (NEI 2011) VOCs that were reported to be emitted. The image indicates why the proximity of the New Haven PAMs site could lead it to have the high monitored VOC levels compared to the other two sites.

Figure 3-15. East Hartford Total VOC Concentrations Summer Trends

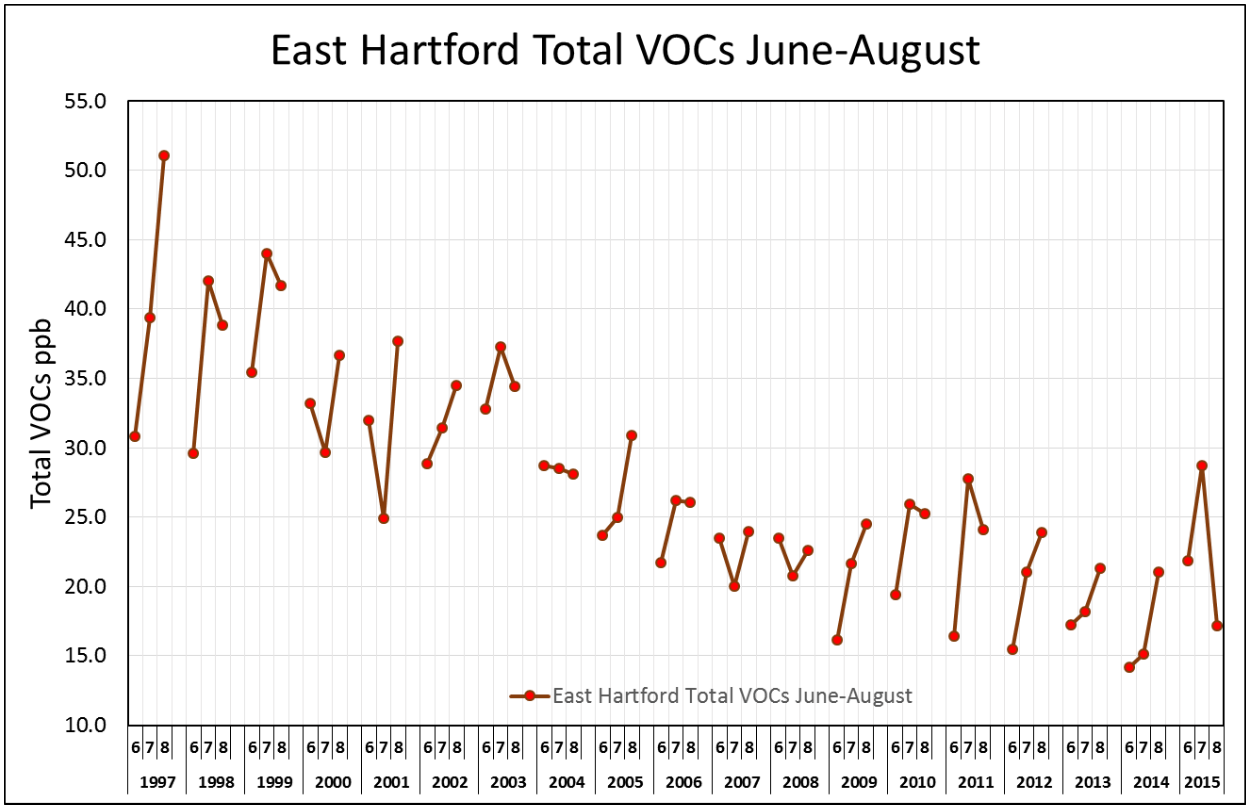


Figure 3-16. Westport Total VOC Concentrations Summer Trends

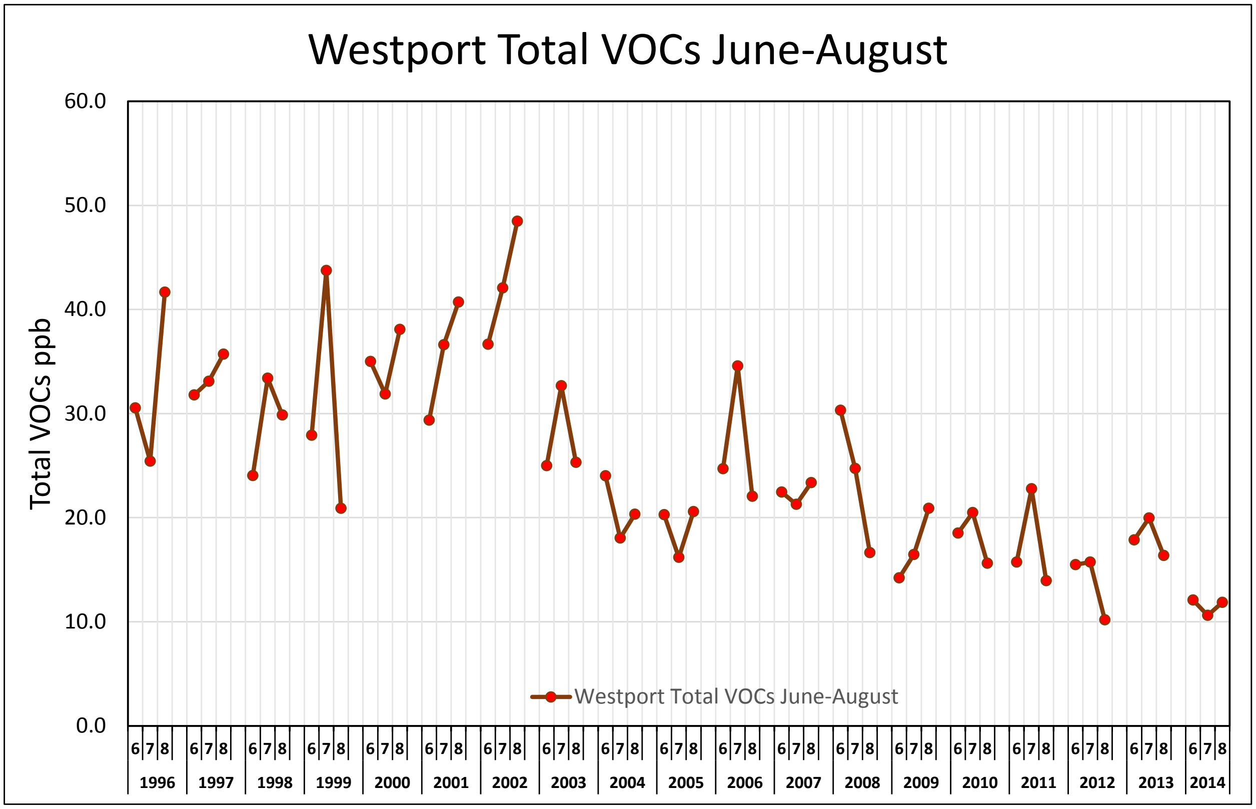


Figure 3-17. *New Haven Total VOC Concentrations Summer Trends*

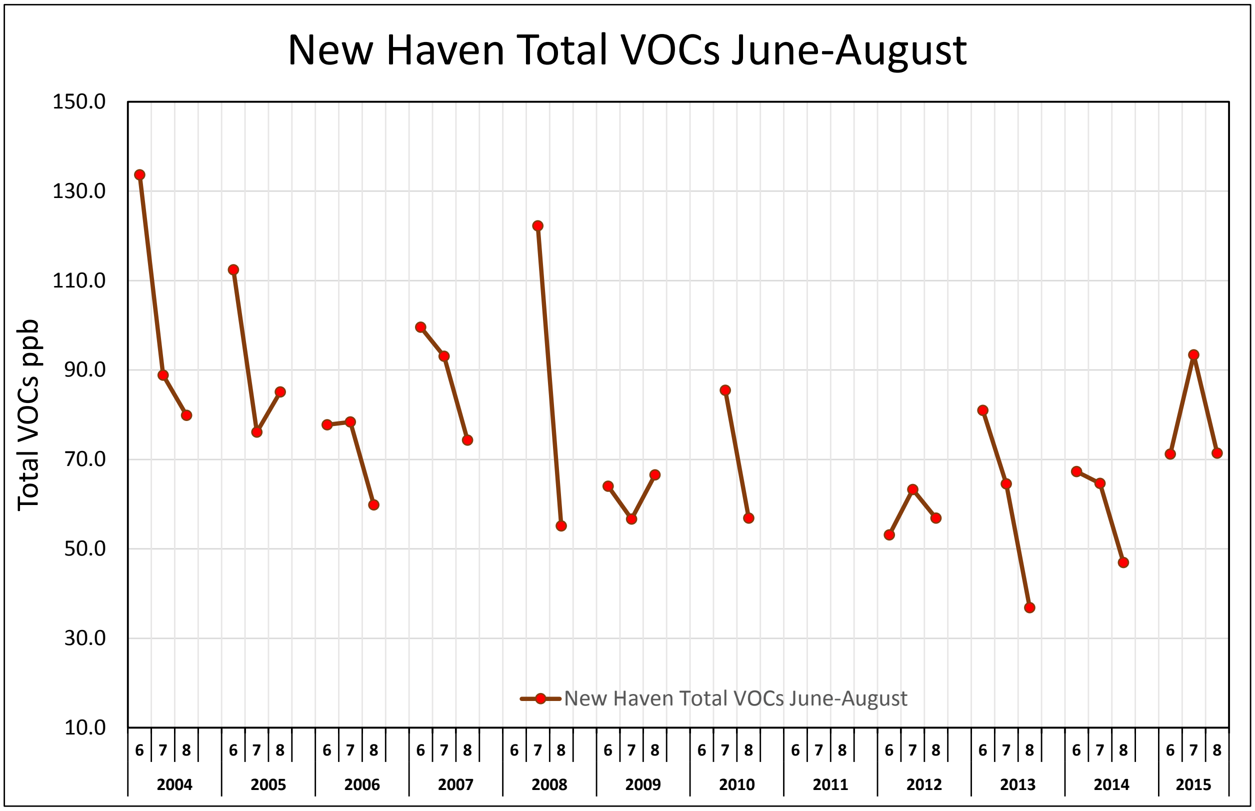


Figure 3-18*.* *Aerial Photograph of the New Haven Connecticut Monitoring Site*

3.6 Pollutant Wind Roses

Summer season wind rose plots for total VOC, NOx, and ozone were prepared for the East Hartford and Westport sites for 1997 and 2014 and for the New Haven site for 2004 and 2014 (see Figures 3-19 through 3-21 below). Wind rose plots are also provided for ozone, but are determined using just the 12 hour period of noon to midnight during the ozone season. This was done to accentuate the higher ozone concentration frequencies to make it easier to compare the two years. The length of the wind rose petals (colored bars) in each plot indicate the frequency that surface-level winds originated from specific directions and the color bands within each petal indicate the measured pollutant concentrations for that direction.

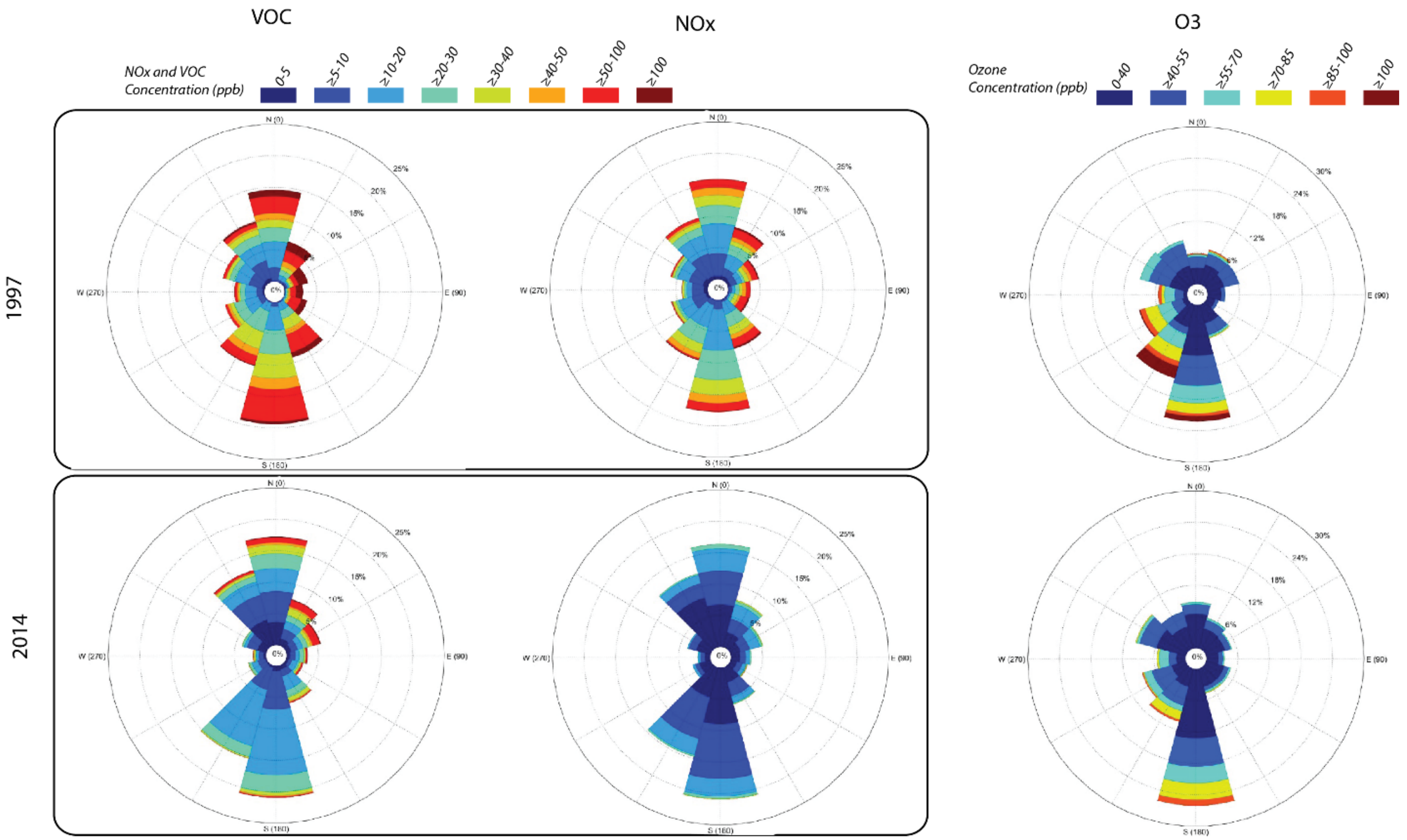
Wind direction patterns at each site are generally similar for the selected years, except that there is a greater frequency of southwest winds relative to south winds at Westport in 2014 than in 1997. Wind frequencies do shift to some extent at all sites around the 30-degree wind direction slices. The New Haven and East Hartford sites show predominant wind directions from the south and north because of the channeling effect of the Connecticut River Valley during the summer, while Westport show a higher frequency of summer season southwest winds, especially in 2014.

The plots indicate that the total VOC levels monitored in East Hartford and Westport are somewhat higher during periods of winds from the northerly direction, while the New Haven monitor shows higher concentrations from a southerly direction, which is not surprising due to the proximity of the bulk gasoline terminals to the south. These southerly VOC contributions at New Haven have decreased since 2004, but they are still larger than the other two sites. The 2014 figures at all sites do indicate a decrease in the highest VOC frequencies over the previous years, an indication that VOC emission control programs are working to reduce ambient concentrations of ozone precursors.

Wind rose plots of NOx concentrations at Westport show the influence of local mobile source NOx emissions, with the highest concentrations occurring when the winds are from the Northwest to Northeast carrying emissions from the area of Interstate 95 to the monitor. Plots for the East Hartford monitor (located further from high traffic areas than the other sites) show a less varying NOx concentration distribution. All three sites show a marked decrease in the highest NOx levels between 1997 (2004 for New Haven) and 2014. By 2014, the East Hartford monitor shows little, if any NOx occurring above 30 ppb for any direction at any hour, while the Westport monitor still shows a small contribution of NOx above 30 ppb from the north/northeast wind directions. New Haven shows a preponderance of high concentrations of NOx from the south during 2004 (likely originating from traffic on Interstate 95), which decreases by 2014. The overall decrease in NOx levels indicate the success of NOx control strategies in reducing ambient concentrations of that ozone precursor.

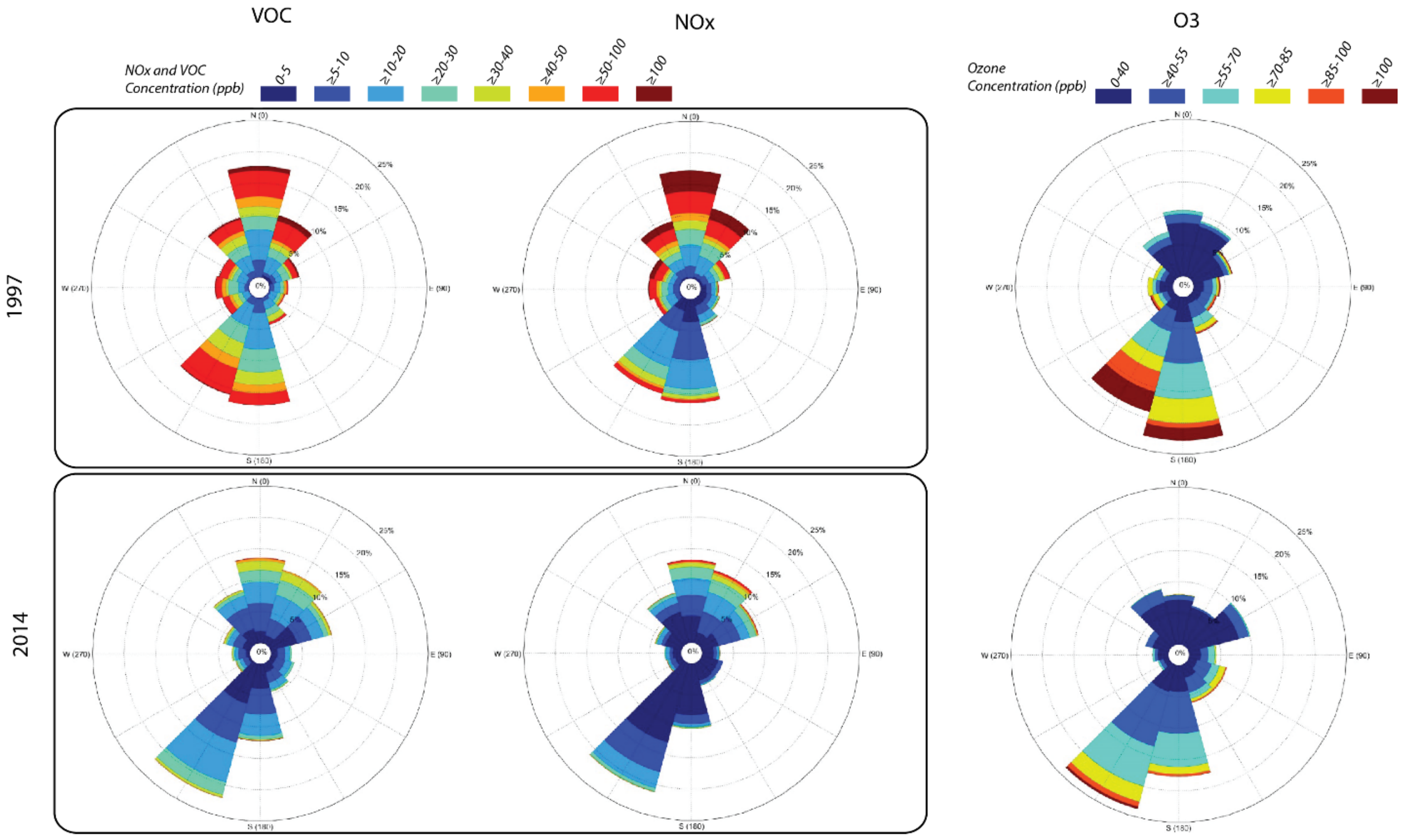
In general, the frequency of elevated ozone (>70ppb) has decreased at each site over the interval between the two years analyzed. In addition, high ozone levels predominately occur when surface winds at these sites are from the south and southwesterly directions. There are virtually no elevated ozone levels observed at any of the sites during periods when wind directions have a northerly component, even though high VOC and NOx concentrations can occur when winds are from a northerly direction. This demonstrates the important role that meteorology plays in producing high ozone events in Connecticut.

***Figure 3-19**. 1997 and 2014 Pollutant Wind Roses for East Hartford*



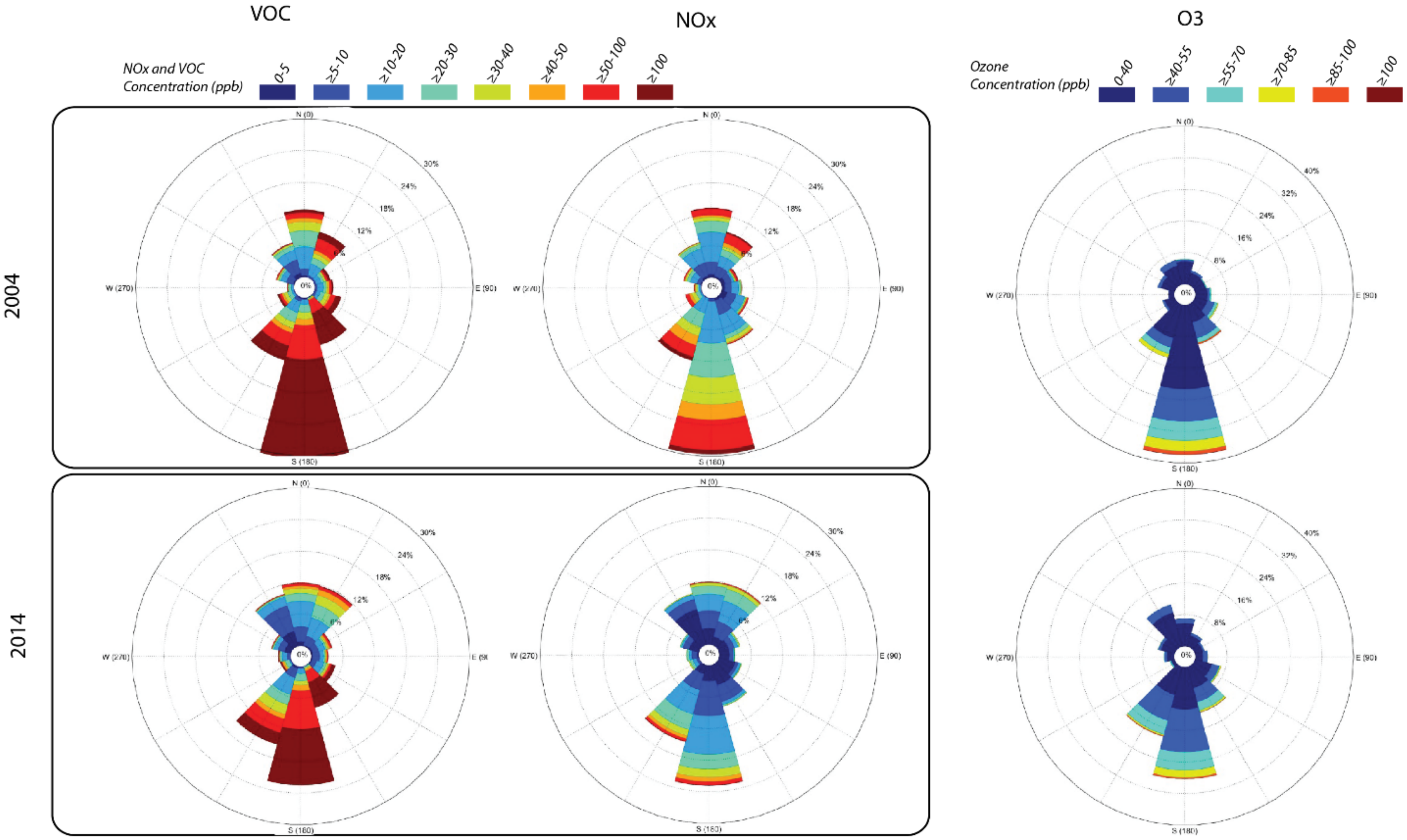
East Hartford CT. Frequency of concentrations and directions of hourly NOX and VOC concetrations through out tJune- August of the year denoted. Frequency of concentrations and direction of houlry ozone concentrations from noon to mid night through out the ozone season of the year denoted.

Figure 3-20. *1997 and 2014 Pollutant Wind Roses for Westport*



Westport, CT. Frequency of concentrations and directions of hourly NOX and VOC concetrations through out June- August of the year denoted. Frequency of concentrations and direction of houlry ozone concentrations from noon to mid night through out the ozone season of the year denoted.

***Figure 3-21**. 2004 and 2014 Pollutant Wind Roses for New Haven*



New Haven CT. Frequency of concentrations and directions of hourly NOX and VOC concetrations through out tJune- August of the year denoted. Frequency of concentrations and direction of houlry ozone concentrations from noon to mid night through out the ozone season of the year denoted.

4. Base Year and Future Year Emission Estimates

The CT DEEP has adopted, or is currently pursuing adoption of, multiple regulations to reduce in-state emissions of ozone precursors (i.e., VOC and NOx) in the post-2011 period. These in-state measures, along with EPA measures targeted nationally at on-road and non-road emission sources and regionally at electric generating units (EGUs), are projected to provide significant emission reductions through 2017 and beyond that should improve ozone air quality. This section documents the level of emissions in the Greater Connecticut nonattainment area in the baseline year of 2011, provides descriptions of post-2011 control measures, including those relied upon to meet CAA reasonable further progress (RFP) and attainment requirements, and provides estimates of projected 2017 emissions resulting from state and federal measures.

4.1 2011 Base Year Ozone Season Day Inventory

As described more fully in Section 5, the RFP demonstration establishes emission reduction targets that must be met in 2017 to satisfy the requirement that a 15% reduction in any combination of NOx and/or VOC emissions occur relative to the level of emissions in the 2011 base year inventory. CT DEEP developed the 2011 base year inventory using ozone summer day emissions estimates from Connecticut's 2011 periodic emissions inventory (PEI) as the starting point. Appropriate revisions were incorporated to reflect updated emission modeling procedures and inputs and to ensure the inventory is representative of ozone season meteorological conditions that led to the nonattainment designations for Connecticut, as recommended by EPA guidance.[7] Adjustments were also made to ensure that NOx emissions offsets tracked by CT DEEP's Administrative Enforcement group are properly represented in the 2011 Base Year Inventory. Details about these adjustments are provided below.

4.1.1 Connecticut's 2011 Periodic Emissions Inventory

Section 182(a)(3) of the CAA requires states with moderate or above ozone nonattainment areas to prepare periodic emission inventories every three years, starting in 1990, estimating actual emissions from all sources. In addition to being a mandated PEI year, EPA's implementation rule[8] for the 2008 ozone NAAQS also established 2011 as the preferred base year for determining future year RFP compliance and for performing photochemical grid modeling.

As required, CT DEEP has regularly prepared PEI updates since the original inventory submission for 1990. The most recent update, the 2011 PEI[9], was submitted in final form to EPA as a SIP revision on March 9, 2016, after completion of the required public review process. The 2011 PEI provides both annual and typical high ozone summer day estimates of actual VOC and NOx emissions for each county in Connecticut, with sources grouped into the following general categories:

- Stationary Point Sources: Industrial or commercial operations classified in 2011 as major sources of VOC or NOx are included by CT DEEP in the point source inventory. Examples include power plants (also referred to as electric generating units or EGUs), municipal waste combustors (MWC), factories, large industrial and commercial boilers and other fuel burning equipment.
- Stationary Area Sources: Emission sources too small to be inventoried individually as stationary point sources are classified as area sources. Examples include small industrial or commercial facilities such as gasoline stations, printing shops, dry cleaners, auto refinishing shops, as well as the use of consumer products.
- On-Road Mobile Sources: Also referred to as highway mobile sources, these include exhaust and evaporative emissions from cars, buses, motorcycles and trucks traveling on state and local roads.

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[7] For example, see 80 FR 12290.

[8] "Implementation of the 2008 National Ambient Air Quality Standards for Ozone: State Implementation Plan Requirements" (the Implementation Rule); 80 FR 12264; March 6, 2015.

[9] The 2011 PEI SIP submittal, with full documentation, is posted on the DEEP website at: http://www.ct.gov/deep/cwp/view.asp?a=2684&Q=432056&deepNav_GID=1619.

- Non-Road Mobile Sources: Also referred to as off-highway mobile sources, these include exhaust and evaporative emissions from mobile sources that are not generally traveling on state and local roads. Examples include construction equipment such as backhoes and graders, recreational equipment such as all-terrain vehicles and off-road motorcycles, commercial and residential lawn and garden equipment such as lawn mowers and leaf blowers, industrial equipment such as forklifts and sweepers, marine equipment such as commercial and recreational watercraft, aircraft and ground support vehicles, and rail locomotives.

The 2011 PEI contains full documentation of the procedures and data used to develop 2011 emissions estimates for all of Connecticut. Summaries of 2011 PEI ozone season day NOx and VOC emission estimates for the portion of the state which comprises the Greater Connecticut ozone nonattainment area[10] are provided in Table 4-1. The 2011 PEI, after incorporating the modifications described below in Section 4.1.2, will serve as the 2011 Base Year Inventory for determining compliance with ozone RFP obligations.

Table 4-1. *Summary of Greater Connecticut NOx and VOC Emissions from the 2011 Periodic Emissions Inventory**

Source Category	**Ozone Season Day NOx (tons/ozone season day)**	**Ozone Season Day VOC (tons/ozone season day)**
Stationary Point	10.0	1.3
Stationary Area	6.2	48.5
On-Road Mobile	55.8	30.3
Non-Road Mobile**	36.1	37.0
Total Anthropogenic	**108.1**	**117.1**
Biogenic	1.7	283.7
Total	**109.8**	**400.7**

*These estimates of actual 2011 emissions are reproduced directly from CT DEEP's 2011 periodic emissions inventory, which was submitted as a SIP revision to EPA on March 9, 2016. Note that the 2011 PEI refers to the On-Road sources as Highway sources and Non-Road sources as Off-Highway sources. See Section 4.1.2 below for a description of modifications made to the 2011 PEI estimates to ensure the 2011 Base Year Inventory (used for determining reasonable further progress) is based on the most recent emission estimation techniques. The resultant 2011 Base Year Inventory is presented below in Section 4.1.3 (and Table 4-2).

** Non-road mobile emission totals include estimates for the commercial marine, aircraft & airport support equipment, and rail locomotive sectors (MAR), which are summed with estimates determined using EPA's NONROAD model for all other non-road sectors.

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[10] The Greater Connecticut nonattainment area includes the following Connecticut counties: Litchfield, Hartford, Tolland, Windham and New London. The remaining Connecticut counties (Fairfield, New Haven and Middlesex) comprise the Southwest Connecticut portion of the NY-NJ-CT nonattainment area, which will be addressed in a separate SIP submission.

4.1.2 Modifications Made to the 2011 PEI Emissions to Establish 2011 Base Year Emissions

Subsequent to the preparation of the 2011 PEI, updated emission estimation techniques and data became available for the on-road and non-road mobile source sectors. Updates include EPA's release of a major revision to the Motor Vehicle Emissions Simulator (MOVES) model that now addresses emissions from both on-road vehicles and most non-road equipment, associated revisions to MOVES inputs that more accurately reflect Connecticut's motor vehicle emission inspection and maintenance (I&M) program, updated traffic data provided by the Connecticut Department of Transportation (CT DOT), and revised meteorological inputs that are more representative of the high ozone events that resulted in Connecticut's nonattainment designation for the 2008 ozone NAAQS. Prompted by these updates, CT DEEP developed improved on-road and non-road emission estimates for the 2011 Base Year Inventory to be used in the RFP demonstration.

In addition, revisions were made to emissions from aircraft and airport support equipment (part of the non-road mobile sector in the 2011 PEI) and to landfill emissions (part of the area source sector in the 2011 PEI) to correct for database summation errors included in the submitted PEI. Finally, CT DEEP elected to substitute EPA's estimates for rail locomotives to replace those contained in the 2011 PEI submittal. Descriptions of these updates is provided below. Documentation of emission estimation procedures for all other source sectors was previously provided to EPA as part of CT DEEP's submittal of the 2011 PEI (see footnote 6).

EPA's MOVES2014a Model

MOVES is a state-of-the-science emission modeling system developed by EPA[11] that allows users to estimate emissions for mobile sources at the national, county, and project level for criteria pollutants, greenhouse gases, and air toxics. Connecticut's 2011 PEI estimates were determined using EPA's MOVES2010b model (for on-road sources) and NONROAD2005 model (for most non-road source sources). In October 2014, EPA released[12] a major new revision to the MOVES modeling system (i.e., MOVES2014) with a subsequent recent minor revision, MOVES2014a, released in December 2015. Some of the primary changes included in MOVES2014a related to on-road emissions include incorporation of the effects of three new federal rules (Tier 3 vehicle emission and fuel standards; Phase 2 light-duty vehicle greenhouse gas emission & fuel economy standards; and Medium/Heavy duty vehicle greenhouse gas emission & fuel economy standards) improvements to evaporative emission calculations, new real world in-use emissions data for heavy-duty vehicles, and new data and updates for default populations and activity. The MOVES2014a model also incorporates EPA's most recent version of the NONROAD model, NONROAD2008, enabling the user to estimate emissions for all non-road categories, except for aircraft/airport support equipment, commercial marine equipment and rail locomotives

EPA requires[13] states to use the latest official version of the MOVES model in new SIPs, unless significant work has already been completed using the previous version of the model prior to the updated release. For that reason, the 2011 Base Year Inventory developed by CT DEEP for this SIP replaces the outdated on-road and non-road emission estimates contained in the 2011 PEI with revised estimates calculated using MOVES2014a and the updated inputs described below.

Minor Revisions to MOVES Inputs for Connecticut's Vehicle I&M Program

Emission estimates in the 2011 PEI, determined using MOVES2010b, did not account for the emission benefits achieved by Connecticut's I/M program for gasoline vehicles with weights between 8,500 and 10,000 pounds. A more complete I/M input data set was developed for use with the MOVES2014a model to better simulate I&M program benefits for the portion of vehicles in that weight class that are model year 1996 or newer.[14]

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[11] For a full description of the EPA MOVES model, and its history, see: https://www3.epa.gov/otaq/models/moves/#generalinfo-2014a.

[12] 79 FR 60343; October 7, 2014.

[13] See ''Policy Guidance on the Use of MOVES2014 for State Implementation Plan Development, Transportation Conformity, and Other Purposes'' (EPA–420–B–14–008, July 2014) and 79 FR 60343 (October 7, 2014).

[14] See Appendix B (MOVES2014a Input Summary) for more details regarding this revision, as well as descriptions of all other MOVES2014a inputs used in this analysis.

Updated CT DOT Traffic Data

The Connecticut DOT regularly revises estimates of current and projected vehicle miles traveled (VMT) and other data as part of its short and long-term planning requirements using their travel demand model. Each major update to VMT estimates is identified by a series number, with a letter added for subsequent minor revisions. At the time the 2011 PEI was being developed by CT DEEP, CTDOT supplied traffic data with a designation of Series 30B. CTDOT subsequently released a revised Series 31 data set, which was used for developing this SIP revision. For comparison purposes, the Series 30B estimate of 2011 statewide summer weekday VMT is 94.6 million miles, while the revised Series 31 estimate for 2011 is 93.7 million miles, a slightly lower value. The revised VMT estimates and related traffic data were used to develop other MOVES2014a inputs, such as speed distributions, vehicle type VMT fractions, and source type populations.[15]

Updated Meteorological Inputs

Ambient temperature is a key factor in estimating emission rates for mobile sources, with substantial effects on most pollutant processes. Relative humidity is also important for estimating NOx emissions from motor vehicles. The 2011 PEI emission estimates were generated with temperature and humidity data representative of high ozone events during the 2000 to 2002 period, associated with designations made by EPA for the 1997 ozone NAAQS. However, EPA's designations for the 2008 ozone NAAQS were based on high ozone days in the 2008 to 2010 period. Therefore, CT DEEP developed revised inputs for the MOVES2014a model using actual meteorological data measured during high ozone events occurring in the summers of 2008, 2009 and 2010. Separate sets of meteorological inputs were developed for the Greater Connecticut nonattainment area (using data from Bradley International Airport in Windsor Locks, CT) and the Connecticut portion of the NY-NJ-CT nonattainment area (using data from Sikorsky Airport in Bridgeport, CT).[16]

Revised Emission Estimates for Non-road Sources

EPA's MOVES2014a model incorporates EPA's most recent release of its NONROAD model, NONROAD2008. The model calculates emissions estimates for all non-road categories, except for commercial marine vessels, aircraft/airport support equipment, and rail locomotives (often collectively referred to as the MAR categories). CT DEEP used MOVES2014a, along with the revised meteorological input data described above, and EPA's improved default fuels data to develop revised emission estimates for the covered non-road categories.[17]

As mentioned above, while preparing this SIP TSD, CT DEEP discovered that a database summation script inadvertently resulted in a large overestimation of ozone summer day emissions from the aircraft/airport support equipment sector in the March 2016 submittal of the 2011 PEI. The CT DEEP has addressed those errors and corrected values are included in the 2011 Base Year Inventory. As documented in Appendix B, the corrections reduce 2011 aircraft/airport support equipment NOx emissions in the Greater Connecticut area from 13.4 tpd to 1.2 tpd and VOC emissions from 2.8 tpd to 0.3 tpd.

CT DEEP recently concluded that the rail locomotive emission estimates developed for EPA's 2011 National Emissions Inventory (NEIv2)[18] provide a better representation of emissions for Connecticut than those initially included in the 2011 PEI. The NEIv2 estimates for 2011 are somewhat higher than those developed for the PEI and are also consistent with those developed for other states and used in photochemical modeling performed by both OTC and EPA. Emissions for the other MAR sector (commercial marine vessels) were not changed from the values documented in Connecticut's 2011 PEI.

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[15] See Appendix B for more details regarding how traffic-related inputs were developed for MOVES2014a runs. Relevant descriptions of the CT DOT travel demand modeling and other related data are included in the documentation for Connecticut's 2011 PEI (Section 3.2).

[16] See Appendix B for details regarding these revisions.

[17] See Appendix B for additional information regarding inputs used to develop non-road emissions estimates using the MOVES2014a model.

[18] See EPA's 2011 National Emission Inventory, version 2: Technical Support Document (August 2015), available at: https://www.epa.gov/air-emissions-inventories/2011-nei-technical-support-document.

Inclusion of Landfill Area Source Emissions

In Section 4.14 of the 2011 PEI, CT DEEP includes calculations of landfill area source emissions, but does not carry those calculations forward into summary tables elsewhere in the document. Those emissions (about 0.5 tons/summer day in Greater Connecticut) are properly reflected in the 2011 base year estimates presented below.

Inclusion of Stationary Source NOx Emission Offsets

CT DEEP's Administrative Enforcement group evaluates, certifies and tracks requests from sources that desire to retain rights to emission reductions resulting from source shutdowns or enforceable emission reductions that go beyond regulatory requirements. Certified reductions are "banked" and are potentially available for future use as emission offsets by newly permitted sources. CT DEEP has included certified 2011 offsets of 0.7 tons/ozone season day (255 annual tons) for the Greater Connecticut area in the 2011 base year inventory to be used for the RFP demonstration. Although not actually emitted to the atmosphere in 2011, addition of these banked offsets to the 2011 inventory conservatively results in a slightly greater level of required emission reductions in order to meet the 15% RFP reduction target required to be achieved in 2017.

4.1.3 Resulting 2011 Base Year Inventory Used for Reasonable Further Progress Calculations

The adjustments described above were made to the 2011 PEI emission estimates to ensure that the 2011 emissions used for the RFP demonstration reflect the most recent and best available emission estimation methods and inputs. The resulting 2011 Base Year Inventory for NOx and VOC are summarized in Table 4-2. Note that only anthropogenic emissions are included in the 2011 Base Year Inventories because the RFP demonstration process does not consider biogenic emissions. Nevertheless, biogenic emissions dominate the VOC category, contributing 283.7 tons per ozone season day compared to total anthropogenic emissions of 106.1 tons per ozone season day in the Greater Connecticut area. In contrast, biogenic NOx emissions are small compared to anthropogenic NOx emissions, amounting to only 1.7 tons per ozone season day compared to total anthropogenic emissions of 91.9 tons per summer ozone day in the Greater Connecticut area.

Figures 4-1 and 4-2 graphically depict the 2011 base year emission estimates for NOx and VOC emissions, respectively. The largest contributing sectors to anthropogenic NOx emissions are on-road and non-road sources (see Figure 4-1) contributing 55% and 26%, respectively. Stationary point (11%) and area sources (7%) are lesser contributors. For anthropogenic VOC emissions (see Figure 4-2), the largest contributing sectors are stationary area sources (46%), non-road mobile sources (27%) and on-road mobile sources (26%), with stationary point sources contributing only 1%. A more complete source category breakdown of 2011 base year emissions is included in Appendix C.

Table 4-2. Greater Connecticut 2011 Base Year Emissions Inventory for NOx and VOC *

Source Category	**Ozone Season Day NOx (tons/ozone season day)**	**Ozone Season Day VOC (tons/ozone season day)**
Stationary Point	10.0	1.3
Stationary Area	6.2	48.9
On-Road Mobile	50.5	27.8
Non-Road Mobile**	24.5	28.1
2011 Emission Offset Bank	0.7	0.0
Total Anthropogenic	**91.9**	**106.1**

*As described in the text, the 2011 Base Year Inventory is an updated version of Connecticut's 2011 periodic emissions inventory, which was submitted to EPA in March 2016. Updates include incorporation of emission estimates from EPA's most recent version of the MOVES model (MOVES2014a, including the NONROAD model), associated input updates, more recent traffic information provided by CT DOT, modifications to rail locomotive emissions, corrections to aircraft/support equipment and landfill emission summations, and the inclusion of 2011 NOx emission offsets. The resultant 2011 Base Year Inventory is used in the Reasonable Further Progress demonstration described in Section 5.

** Non-Road Mobile emissions include estimates for the commercial marine, aircraft & airport support equipment, and rail locomotive sectors, which are summed with estimates determined using EPA's NONROAD model (as embedded in MOVES2014a) for all other non-road sectors.

Figure 4-1. *2011 Base Year NOx Inventory for Greater Connecticut Area*

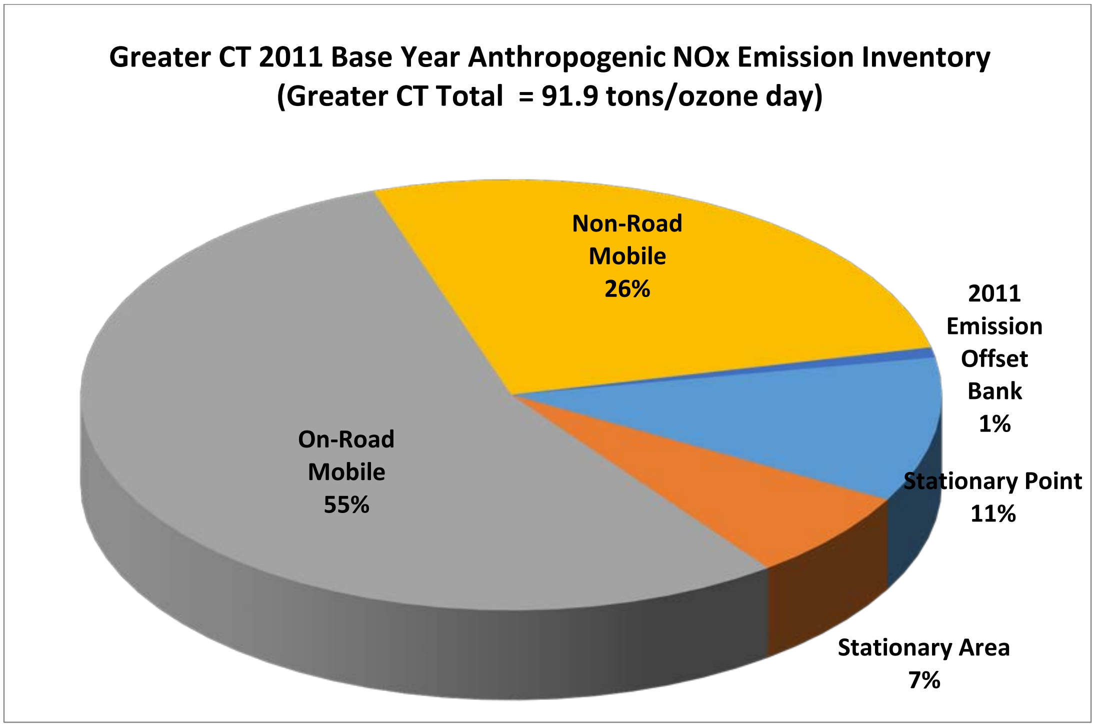
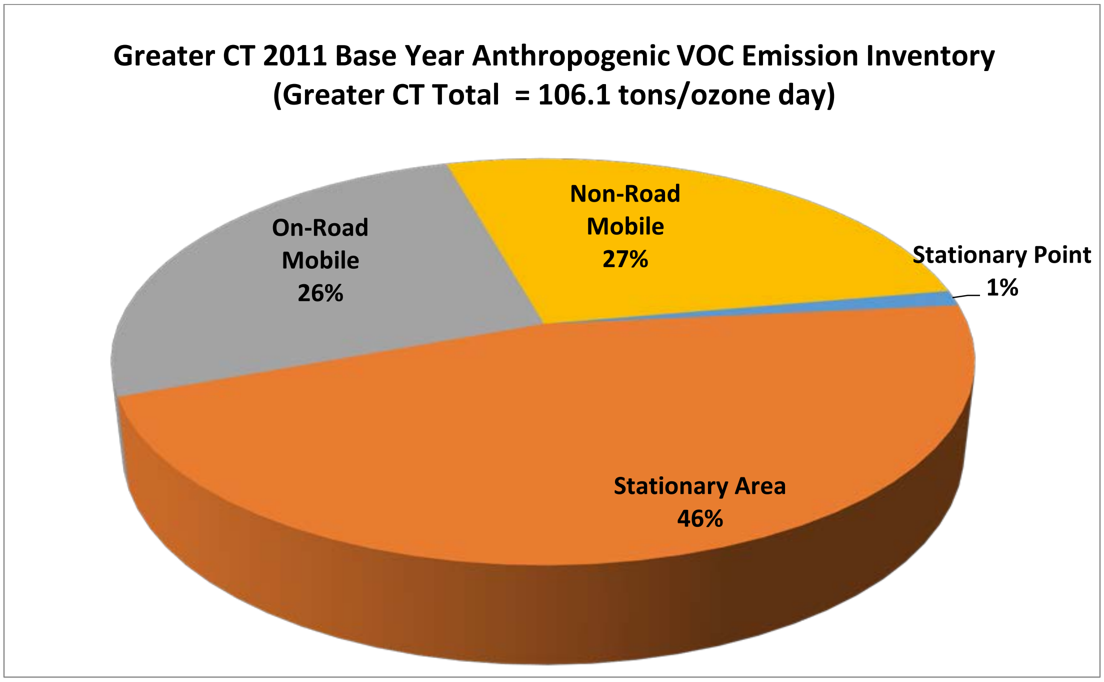


Figure 4-2. *2011 Base Year VOC Inventory for Greater Connecticut Area*



4.2 Control Measures Included in Future Year Projections

CT DEEP has implemented all emission control programs mandated by the 1990 CAA, as well as other measures necessary to meet RFP and RACT/RACM requirements and to demonstrate attainment of the 2008 ozone NAAQS, as expeditiously as practicable, by the July 20, 2018 moderate attainment deadline for the Greater Connecticut area. Unless otherwise noted, measures identified in this section create emissions reductions after the 2011 baseline emissions inventory year and, therefore, are creditable towards RFP and attainment efforts for the 2008 NAAQS. This section identifies the date on which each measure became or is anticipated to become effective in the state, as well as the compliance date on which the measure will begin to create emissions reductions. See Section 4.3 for a summary of projected 2017 emission levels that result from the post-2011 control measures.

4.2.1 Mobile Source and Fuels Control Programs

Numerous federal and state control programs have been implemented over the last four decades to reduce ozone precursor emissions from mobile sources. These programs have established increasingly more stringent emission standards for new on-road vehicles and non-road engines and equipment, with associated changes required to fuel composition, as well as implementation of emission inspection programs to ensure continued compliance by in-use motor vehicles. The gradual replacement of older on-road vehicles and non-road equipment due to purchases of newer models, when coupled with increasingly stringent emission standards, has resulted in continuing reductions in ozone precursor emissions over time. On-road and non-road mobile source control programs are described below, highlighting those yielding emission reductions since the 2011 base year.

Table 4-3 provides a summary of major ozone precursor emission control programs implemented statewide in Connecticut for on-road vehicles that have occurred since the enactment of the 1990 Clean Air Act Amendments. Pre-2011 programs[19] are included in the table because they continue to contribute to post-2011 emission reductions in cases where owners replace older vehicles with more recent model year vehicles subject to tighter emission standards.

Pre-2011 federal programs establishing NOx and VOC emission standards[20] for new cars and light/medium duty trucks include the Tier 1 (phased-in between 1994 and 1996), National Low Emission Vehicle (NLEV, starting in 1998 in Connecticut), and Tier 2 (phased-in between 2004 and 2009) programs. Motorcycle emission standards[21] were phased-in between 2006 and 2010. EPA also promulgated rules establishing heavy duty truck emission standards[22] that began in 2004 and 2007, with phase-in completed in 2010.

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[19] A more complete description of control programs implemented between 1990 and 2010 is provided in DEEP's "8-Hour Ozone Attainment Demonstration (for the 1997 NAAQS)", submitted to EPA on 2/1/2008.

[20] 56 FR 25724 & 65 FR 6698. See https://www.epa.gov/emission-standards-reference-guide/light-duty-vehicles-and-trucks-emission-standards and https://www3.epa.gov/otaq/regs/ld-hwy/tier-2/index.htm.

[21] 69 FR 2398. See https://www.epa.gov/sites/production/files/2016-03/documents/420b16016.pdf.

[22] 65 FR 59895 & 66 FR 5001. See https://www.epa.gov/emission-standards-reference-guide/heavy-duty-highway-engines-and-vehicles-emission-standards.

Table 4-3. On-Road Mobile Sources Control Strategies[1]

Control Strategy	Pollutant		Federal Program	State Program	Rule Approval Date[2]	Initial Year of Implementation[3]
	VOC	NOx				
Tier 1 Vehicle Standards	●	●	●		6/5/1991[4]	1994-1996
Reformulated Gasoline – Phases I & II	●	●	●		2/16/1994[5]	1995 & 2000
On-board Refueling Vapor Recovery	●		●		4/6/1994[6]	1997-2005
National Low Emission Vehicle (NLEV) Program	●	●	●		1/7/1998[7]	1998-2003 (in CT)
Tier 2 Motor Vehicle Controls/30ppm Sulfur Gasoline	●	●	●		2/10/2000[8]	2004-2009
Heavy-Duty Diesel Vehicle Controls and Fuels	●	●	●		10/6/2000[9]	2004-2005
CT OBD-II Enhanced I/M Program	●	●		●	12/5/2008[10]	2004
2007 Highway Rule/15ppm Sulfur Diesel Fuel	●	●	●		1/18/2001[11]	2006-2010
Highway Motorcycle Exhaust Emission Standards	●	●	●		1/15/2004[12]	2006-2010
CT Low Emission Vehicle Phase 2 (CT LEV2)	●	●	●	●	3/17/2015[13]	2007
CT Low Emission Vehicle Phase 3 (CT LEV3)	●	●		●	8/1/2013[14]	2015-2025
Tier 3 Vehicle Standards/10ppm Sulfur Gasoline	●	●	●		4/28/2014[15]	2017-2025

[1] All strategies (except RFG & OBD-II Enhanced I/M) result in emission reductions after 2011 due to gradual fleet turnover.

[2] Unless otherwise noted, this is the Federal Register date of either a final federal rule or EPA's approval of a state SIP submittal.

[3] A range of implementation years is listed for some strategies due to phase-in of standards.

[4] 56 FR 25724 6/5/1991.

[5] 59 FR 7716.

[6] 59 FR 16262.

[7] 63 FR 926.

[8] 65 FR 6698.

[9] 65 FR 59896.

[10] 73 FR 74019.

[11] 66 FR 5002.

[12] 69 FR 2398.

[13] 80 FR 13768.

[14] RCSA 22a-174-36c was adopted by CT DEEP on 8/1/2013; submitted to EPA for SIP approval on December 14, 2015.

[15] 81 FR 23414.

Pre-2011 federally-required fuel programs for on-road vehicles include lower volatility reformulated gasoline[23] (Phase 1 RFG in 1995 and Phase 2 RFG in 2000), low sulfur gasoline[24] (30 ppm limit, phased-in starting 2004 as part of the Tier 2 program), and ultra-low sulfur diesel[25]fuel (15 ppm limit, phased-in starting 2006 to coincide with the 2007 new truck standards). The lower sulfur limits were necessary to minimize contamination of catalysts used to achieve greater tailpipe NOx emission reductions. In addition, federal rules required new cars and light/medium duty trucks to be equipped with on-board refueling vapor recovery (ORVR) systems[26] to control refueling emissions. The requirement was phased-in for new vehicles between 1997 and 2006. EPA also established rules[27] in 2000 that require heavy-duty vehicles (HDVs), up to 10,000 lbs GVWR, be equipped with ORVR systems. The ORVR systems for HDVs began to be equipped on model year 2004 vehicles and were fully phased in on HDVs by model year 2006.

In addition to these federal programs, Connecticut implemented several in-state programs during the pre-2011 period. After playing a major role in prompting EPA to promulgate the NLEV program in the late 1990's, Connecticut has continued to require new vehicles sold in the state to meet California's Low Emission Vehicle (LEV) standards, which are more stringent than federal requirements. In December 2004, CT DEEP adopted Regulations of Connecticut State Agencies (RCSA) section 22a-174-36b, which mirrors California's LEV II regulations and includes zero emission vehicle requirements. [28] The Connecticut LEV II regulation applies to model year 2008 through 2014 passenger car and light-duty trucks and model year 2009 through 2014 medium-duty vehicles. The LEV II standards also include a zero emission vehicle (ZEV) provision, as well as greenhouse gas (GHG) emission standards for 2009 through 2016 model year passenger cars, light-duty trucks and medium duty passenger vehicles. The CT LEV II program was approved as a SIP revision by EPA in March 2015. [29]

Connecticut has required in-use vehicles to undergo periodic emission inspection and maintenance since 1983. The program has been modified over the years to meet CAA-required enhancements and to accommodate technological advancements in new vehicles such as on-board diagnostics (OBD). EPA approved Connecticut's OBD-II enhanced I/M program SIP revision in December 2008. Implementation of the revised program began in 2004. [30]

In the post-2011 period, both Connecticut and EPA have further tightened new passenger vehicle emission standards to secure additional mobile source reductions, as described below.

Connecticut's LEV III New Vehicle Emission Standards

Sections 209(a) and (b) of the Clean Air Act prohibits states from adopting motor vehicle emission standards for new vehicles, but also provides a waiver provision allowing the State of California to adopt standards more stringent than federal standards under certain conditions. Notwithstanding the section 209(a) prohibition, CAA section 177 allows other states to adopt vehicle standards that are identical to California standards which have received the section 209(b) waiver.

As noted earlier, Connecticut has long been committed to reducing motor vehicle emissions beyond federal requirements through the state's LEV program. Connecticut General Statutes (CGS) section 22a-174g requires CT DEEP to adopt regulations to remain consistent with California LEV standards, to ensure consistency with

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[23] 40 CFR Subpart D. See https://www.epa.gov/gasoline-standards/reformulated-gasoline.

[24] 40 CFR Subpart H. See https://www.epa.gov/sites/production/files/2016-03/documents/420b16004.pdf.

[25] 40 CFR Subpart I. See https://www.epa.gov/sites/production/files/2016-03/documents/420b16005.pdf.

[26] See https://www3.epa.gov/otaq/regs/ld-hwy/onboard/orvrfact.txt. On May 16, 2012, EPA completed a finding (77 FR 28772) that ORVR technology was in widespread use, thereby enabling EPA to waive the requirement for affected states to implement Stage II refueling programs at gasoline stations due to the duplicative nature of the two programs. DEEP subsequently repealed its Stage II program on 7/8/2015.

[27] 65 FR 59895.

[28] DEEP also submitted revisions to the LEV II program on 12/22/2005 and 8/4/2009.

[29] 80 FR 13768.

[30] 73 FR 74019.

CAA section 177. In August 2012, the California Air Resources Board (CARB) finalized major new revisions to the California program[31] and EPA issued the required CAA section 209(b) waiver in December 2012. The CA LEV III revisions include more stringent exhaust and evaporative emission standards for both criteria pollutants and greenhouse gases for new passenger cars, light duty trucks and medium-duty vehicles. CARB estimates the changes will reduce ozone precursor emissions by about 75 percent from 2015 levels when fully implemented in 2025.[32] California, stakeholder states (including Connecticut) and the regulated community worked with EPA during California's rulemaking process to harmonize the standards with federal Tier III requirements and make it easier for the regulated community to meet a national standard.

Subsequent to the updates to the California program, CT DEEP proposed amendments to Connecticut's regulations, officially adopting RCSA 22-174-36c (CT LEV III) on September 1, 2013 to be consistent with the standards specified in the CA LEV III program. RCSA 22-174-36c replaced a temporary emergency regulation that was established in December 2012 to ensure the two-year lead time required by CAA section 177 was satisfied so that the more stringent standards could be in place for 2015 model year vehicles. Connecticut is one of only 12 states that have adopted the California LEV III requirements.

The CT LEV III program establishes more stringent non-methane organic gases (NMOG), NOx, particulate matter (PM) and evaporative emission standards for passenger cars, light duty trucks and medium-duty passenger vehicles beginning with model year 2015. The regulation also includes revised ZEV mandates beginning with model year 2018 and revised greenhouse gas standards beginning with model year 2017. In addition, through incorporation by reference to the California regulations, RCSA 22-174-36c extends full useful life durability requirements from 120,000 miles to 150,000 miles.

Adoption of the California LEV III standards in Connecticut extends vehicle standards out to 2025. The CT LEV III standards provide additional criteria pollutant reduction beyond EPA's Tier 2 and Tier 3 vehicle standards.

Federal Tier 3 Emission Standards and Gasoline Sulfur Requirements

On April 28, 2014, EPA published the final rule establishing the federal Tier 3 vehicle emission and fuel standards.[33] As with the Tier 2 program, Tier 3 was designed considering the vehicle and its fuel as an integrated system. The vehicle standards will reduce both tailpipe and evaporative emissions from passenger cars, light-duty trucks, medium-duty passenger vehicles, and some heavy duty vehicles, resulting in significant reductions in pollutants such as ozone, particulate matter, and air toxics across the country. The Tier 3 standards are intended to harmonize with California's LEV program, thus creating a federal vehicle emissions program that will allow automakers to sell the same vehicles in all 50 states. The standards will be implemented over the same timeframe as the federal greenhouse gas/fuel efficiency standards for light-duty vehicles (promulgated by EPA and the National Highway Safety Administration in 2012), as part of a comprehensive approach toward regulating emissions from motor vehicles.

The Tier 3 standards include new light- and heavy-duty vehicle emission standards for exhaust emissions of NMOG+NOx, PM and evaporative emissions, to be phased in between model years 2017 (2018 for heavier vehicles) through 2025. The final standards are in most cases identical to those of California's LEVIII program. The rule also requires the reduction of gasoline sulfur content from the current 30 parts per million (ppm) average down to a 10 ppm average beginning in 2017. As mentioned earlier, vehicle catalytic converters become significantly less efficient at reducing pollutant emissions when exposed to sulfur. The reduction in average sulfur content of gasoline from the current Tier 2 level of 30 ppm to the Tier 3 level of 10 ppm will optimize catalyst performance with two beneficial effects: 1) Vehicles designed to the Tier 3 tailpipe exhaust standards will be able to meet those standards in-use for the duration of their useful life, and 2) Immediate emission reductions will be realized from all the gasoline-fueled vehicles on the road at the time the new lower sulfur limits are implemented in 2017.

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[31] See the CARB webpage: http://www.arb.ca.gov/msprog/levprog/levprog.htm#background.

[32] See the CARB webpage: http://www.arb.ca.gov/msprog/consumer_info/advanced_clean_cars/consumer_acc.htm.

[33] 79 FR 23414. See: https://www.gpo.gov/fdsys/pkg/FR-2014-04-28/pdf/2014-06954.pdf

In the Tier 3 rule, EPA cited research studies that examined the effect of various gasoline sulfur levels on Tier 2 vehicles. The results indicated that reducing sulfur levels in gasoline from 30 ppm to10 ppm could result in NOx reductions from Tier 2 vehicles of 12-27% and hydrocarbon reductions of 11-13%. EPA also evaluated the national impact of the Tier 3 program using the MOVES model, finding a 10% reduction in national on-road NOx emissions in 2018 due to the program, with a 35% reduction in 2030. VOC emission reductions were estimated to be 3% in 2018 and 16% in 2030 for the national on-road inventory due to the Tier 3 requirements.

Elsewhere in the Tier 3 rule, EPA estimates that the final phased-in (i.e., 2025 model year) standards for light-duty vehicle, light-duty truck, and medium-duty passenger vehicle tailpipe emissions are an 80 percent reduction in fleet average NMOG+NOx compared to current standards for new vehicles. The fully phased-in Tier 3 heavy-duty vehicle tailpipe emissions standards for NMOG+NOx and PM are on the order of 60 percent lower than current standards for new vehicles. In addition, the fully phased-in evaporative emissions standards represent a 50 percent reduction from current standards. When considered across the in-use fleet, in 2030 when Tier 3 vehicles will make up the majority of the fleet as well as vehicle miles traveled, EPA estimates that NOx and VOC emissions from on-road vehicles will be reduced by about 21 percent compared to the current in-use fleet.

Non-road engines are used in a variety of applications such as construction equipment, outdoor power equipment, farm equipment, lawn and garden equipment, marine vessels, locomotives, and aircraft. Prior to the mid-1990's, emissions from these engines were largely unregulated. EPA has since issued several rules regulating emissions from new and, in some cases, remanufactured non-road engines.[34] Major non-road emission control measures and fuel programs are summarized in Table 4-4 and accounted for in the emissions inventories used for this attainment demonstration. Pre-2011 programs are included in the table because they continue to contribute to post-2011 emission reductions through fleet turnover as owners replace older equipment with more recent model year equipment subject to tighter emission standards.

Non-Road Compression Ignition (Diesel) Engines

EPA rules have established four tiers of emission standards for new non-road diesel engines. EPA's first non-road regulations were finalized in 1994,[35] when (Tier 1) emission standards were issued for most large, greater than 50 horsepower (hp), land-based non-road compression-ignition (CI, or diesel) engines used in applications such as agricultural and construction equipment, which were phased in between 1996 and 2000.

In 1998, EPA promulgated Tier 1 standards for smaller (< 50 hp) diesel engines, including marine propulsion and auxiliary engines, which required phase-in between 1999 and 2000.[36] At the same time, EPA issued more stringent Tier 2 emission standards for all non-road diesel engine sizes to be phased in from 2001 to 2006 and Tier 3 standards requiring additional reductions from new diesel engines between 50 and 750 hp to be phased in from 2006 to 2008.

EPA finalized Tier 4 rules for non-road diesel in 2004. The rule integrated new diesel engine emission standards with fuel requirements. The emission standards applied to most construction, agricultural, industrial, and airport equipment, and were phased in between 2008 and 2015. The Tier 4 emission standards do not apply to diesel engines used in locomotives and marine vessels.

The rule also established a two phase reduction in diesel fuel sulfur levels, limiting concentrations to 500 ppm in 2007 and 15 ppm in 2010 (2012 for locomotives and marine vessels). The lower diesel sulfur levels minimize damage to emission-control systems used to meet the Tier 4 engine exhaust standards.

Non-Road Spark Ignition (e.g., Gasoline) Engines

EPA rules regulate small (less than 25 hp) non-road spark-ignition (SI) engines (except marine and recreational

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[34] See EPA's non-road engine webpage: https://www3.epa.gov/nonroad/. Tables of emission standards by engine type are also posted by EPA at: https://www.epa.gov/emission-standards-reference-guide/nonroad-engines-and-vehicles-emission-standards.

[35] 59 FR 31306.

[36] 63 FR 56968.

engines) in two phases. EPA's Phase 1 standards for new small SI engines were issued in 1995.[37] These engines, which usually burn gasoline, are used primarily in lawn and garden equipment. The standards apply to model year 1997 and newer engines.

EPA subsequently issued more stringent Phase 2 emission standards for both small non-handheld engines (e.g., lawn mowers, generator sets, air compressors) and small handheld engines (e.g., leaf blowers, chain saws, augers) in 1999[38] and 2000,[39] respectively. Phase 2 standards were phased-in from 2001 to 2007 for non-handheld engines and from 2002 to 2007 for handheld engines.

EPA finalized emission standards for new gasoline spark-ignition marine engines in 1996[40] to be phased-in between 1998 and 2006. These engines, typically based on simple two-stroke technology, are used for outboard engines, personal watercraft, and jet boats.

EPA's 2002 rulemaking also included exhaust emission standards for non-road recreational spark-ignition engines and vehicles.[41] These recreational land-based engines are found in snowmobiles, off-highway motorcycles, and all-terrain-vehicles (ATVs). The standards were phased-in between 2006 and 2007, except for snowmobiles, which had until 2009 to comply. In addition, snowmobiles were subject to more stringent standards that became effective in 2010 and 2012. Plastic fuel tanks and rubber hoses available on recreational vehicles are also regulated for permeation, to minimize the fuel lost through the component walls. The permeation standards for fuel tanks and fuel hoses on recreational vehicles were effective in 2008.

Marine Diesel Engines

Marine diesel engines include small auxiliary and propulsion engines, medium-sized propulsion engines on coastal and harbor vessels, and very large propulsion engines on ocean-going vessels. EPA published a final rule in 2002 that included new engine emission standards for recreational marine diesel engines.[42] These are marine diesel engines rated over 37 kW, or >50 hp, which are used in yachts, cruisers, and other types of pleasure craft. The standards were phased-in, beginning in 2006, depending on the size of the engine. By 2009, emission standards were in effect for all recreational, marine diesel engines.

On February 28, 2003, EPA finalized emission standards for exhaust emission from U.S.-flagged vessels with new marine diesel engines rated over 37 kW with displacements over 30 liters per cylinder (also known as Category 3 Marine Diesel Engines).[43] This marks the first time that emissions from very large marine diesel engines have been regulated. These diesel engines are used primarily for propulsion power on ocean-going vessels such as container ships, tankers, bulk carriers, and cruise ships. Most Category 3 marine diesel engines are used for propulsion on vessels engaged in international trade.

Both new and modified marine diesel engines rated above 175 hp must adhere to international standards (i.e., MARPOL convention) if vessel construction or engine modification commences on or after January 1, 2000. U.S.-flagged commercial vessels with new marine diesel engines rated over 37 kW (or >50 hp, with displacements up to 30 liters per cylinder) produced after 2003 (after 2006 for very large engines) were required to comply with EPA standards issued in 1999.[44] In October 2008, the member states of the International Maritime Organization agreed to amend MARPOL Annex VI, adopting new tiers of NOx and fuel sulfur

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[37] 60 FR 34582.
[38] 64 FR 15208.
[39] 65 FR 24268.
[40] 61 FR 52088.
[41] Ibid.
[42] 67 FR 68242.
[43] 68 FR 9746.
[44] 64 FR 73300.

Table 4-4. *Non-Road Mobile Sources Control Strategies*

Non-Road Engine Category	Date of Final Rule	Implementation Phase-In (MY)
Compression Ignition (diesel) Engines		
Tier 1: Land-Based Diesel Engines > 50 hp	06/17/1994 (59 FR 31306)	1996-2000
Tier 1: Small Diesel Engines < 50 hp	10/23/1998 (63 FR 56968)	1999-2000
Tier 2: Diesel Engines (all sizes)		2001-2006
Tier 3: Diesel Engines 50 - 750 hp		2006-2008
Tier 4: All Diesel Engines (Except locomotive and marine vessels)	06/29/2004 (69 FR 38958)	2008-2015
Spark-Ignition (e.g., gasoline) Engines		
Phase 1: SI Engines < 25 hp (except marine & recreational)	07/03/1995 (60 FR 34582)	1997
Phase 2: Non-Handheld SI Engines < 25 hp	03/30/1999 (64 FR 15208)	2001-2007
Phase 2: Handheld SI < 25 hp	04/25/2000 (65 FR 24268)	2002-2007
Gasoline SI Marine Engines (outboard & personal watercraft)	10/04/1996 (61 FR 52088)	1998-2006
Large Spark-Ignition Engines >19 kW (or >25 hp)	11/08/2002 (67 FR 68242)	2004 & 2007
Recreational Land-Based Spark-Ignition Engines		2006-2012
Marine Diesel Engines The Act to Prevent Pollution from Ships (APPS) implements the provisions of the International Convention for the Prevention of Pollution from Ships (MARPOL) Annex VI for the United States (33 U.S.C. 1901–1912)	Most recent: 2/19/2015 (80 FR 9078) More info: https://www3.epa.gov/otaq/oceanvessels.htm#engine-fuel	US Emission Control Areas in effect: 2012 Aftertreatment NOx controls: 2016
Commercial Marine Diesel Engines[1] (US-flagged vessels)	12/29/1999 (64 FR 73300)	2004-2007
Recreational Marine Diesel Engines >37 kW (or >50 hp)	11/08/2002 (67 FR 68242)	2006-2009
Marine Diesel Engines (US-flagged vessels) >30 liters/cylinder	02/28/2003 (68 FR 9746)	2004
Spark-Ignition Engines/Equipment (marine & land engines)	10/08/2008 (73 FR 59034)	2010-2012
Locomotives New & Remanufactured Locomotives and Locomotive Engines[2]	04/16/1998 (63 FR 18978)	Tier 0: 1973-2001 Tier 1: 2002-2004 Tier 2: 2005 +
Locomotive & Marine Diesel Rule (new & remanufactured)	06/30/2008 (73 FR 37096)	2009-2015
Non-Road Diesel Fuel	06/29/2004 (69 FR 38958)	Phase 1: 2007 Phase 2: 2010 (2012 for Marine & Locomotive)
Aircraft Control of Air Pollution From Aircraft and Aircraft Engines 1 Control of Air Pollution From Aircraft and Aircraft Engines 2 Control of Air Pollution From Aircraft and Aircraft Engines 3	05/08/1997 (62 FR 25356) 11/17/2005 (70 FR 69664) 6/8/2012 (77 FR 36342)	1997 2005 2012 & 2014

[1] Only applies to commercial marine diesel engines with displacements under 30 liters per cylinder.

[2] EPA has established three sets of locomotive standards, applied based on the date the locomotive was first manufactured (i.e. during the Tier 0, Tier 1, or Tier 2 periods). The applicable standards take effect when the locomotive or locomotive engine is first manufactured and continue to apply at each periodic remanufacture.

controls. The most stringent of these new emission standards apply to ships operating in designated ECAs, including the newly-designated North American Emission Control Area (ECA), which was officially recognized in 2012. The Tier III standards for NOx, which become effective in 2016 along the US East Coast, are 80 percent lower than Tier I standards.

In 2008, EPA finalized the Marine Diesel Rule creating exhaust emission standards for marine spark-ignition engines (more stringent than those finalized on October 4, 1996[45]) and small land-based non-road spark-ignition engines.[46] The rule also included new evaporative emission standards for equipment and vessels using these engines. The marine spark-ignition engines and vessels affected by these standards, effective starting with the 2010 model year, include outboard engines and personal watercraft, as well as sterndrive and inboard engines. The small non-road spark-ignition engines and equipment affected by these standards, effective starting with the 2011 and 2012 model year, are those rated below 25 hp (19 kW) used in household and commercial applications, including lawn and garden equipment, utility vehicles, generators, and a variety of other construction, farm, and industrial equipment.

Locomotives

States are preempted from adopting standards to control emissions from locomotives. As such, Connecticut depends on EPA to establish standards. EPA established emission standards for new and remanufactured locomotives and locomotive engines in 1998.[47] At that time, three sets of standards were adopted, with applicability of the standards tied to the date a locomotive is first manufactured (i.e., 1973 through 2001, 2002 to 2004, and 2005 and later). In June 2008, EPA finalized additional standards to reduce emissions of PM and NOx from locomotives and marine vehicles.[48] The 2008 rule established short term Tier 3 standards and longer term Tier 4 standards for new locomotives as well as established idling restrictions.

The remanufacturing standards do not apply to the existing fleets of locomotives owned by very small railroads, such as those which comprise the bulk of the fleet in Connecticut. The second part established near term engine-out (Tier 3) emission standards for new locomotives and marine diesel engines, phased-in starting in 2009. The third part of the program entailed setting longer-term (Tier 4) emission standards for newly-built locomotives and marine diesel engines that reflect the application of high-efficiency emission control technology. The Tier 4 emission standards began to be phased-in starting in 2014 for marine diesel engines and 2015 for locomotives (these standards are enabled due to the availability of diesel fuel capped at 15 ppm sulfur content in 2012). All new marine diesel engines with displacements less than 30 liters per cylinder (Category 1 and Category 2 engines greater than 50 hp) vessels are covered in this rulemaking.

Aircraft

States are preempted from adopting standards to control emissions from aircraft. As such, Connecticut depends on EPA to establish standards. Control of air pollution from aircraft and aircraft engines was first regulated by EPA in a 1997 rulemaking.[49] That rule adopted the international aircraft emissions standards of the United Nations International Civil Aviation Organization (ICAO), which had been in place since 1986 and amended in 1993. The rule brought U.S. aircraft standards into alignment with international standards and applied to newly manufactured and newly certified commercial aircraft gas turbine engines with rated thrust greater than 26.7 kilonewtons. ICAO adopted revised standards in 1999 for implementation beginning in 2004. In November of 2005, EPA finalized the adoption of the revised ICAO standards, to once again bring U.S. aircraft standards into alignment with international standards.[50]

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[45] 61 FR 52088.

[46] 73 FR 59034.

[47] 63 FR 18978.

[48] 73 FR 37096.

[49] 62 FR 25356.

[50] 70 FR 69664.

In June 2012, EPA adopted additional measures to establish Tier 6 and Tier 8 aircraft standards, both designed to further reduce NOx emissions.[51] The Tier 6 standards applied to engines until December 31, 2013, and the Tier 8 standards apply to engines being manufactured since January 1, 2014.

4.2.2 Stationary and Area Source Control Measures

Several existing and proposed federal and state rules will help to reduce ozone precursor emissions from stationary and area sources in Connecticut (and upwind states) in the post-2011 period. These measures will provide assistance with demonstrating RFP and achieving attainment of the 2008 ozone NAAQS in Greater Connecticut by 2017 and/or maintaining attainment in subsequent years.

Table 4-5 summarizes federal stationary and area source measures, along with the effective date of the final rules (or the date of the proposed rule) and the initial date when emission reductions are required. The table also indicates which federal measures are included in Connecticut 2017 emission estimates presented in this TSD.

Some of the federal rules, such as the Cross-State Air Pollution Rule (CSAPR) and the final CSAPR Update, directly limit emissions of NOx during the ozone season in states located upwind of Connecticut. Other rules, such as the Reciprocating Internal Combustion Engine (RICE) National Emission Standards for Hazardous Air Pollutants (NESHAP) rule, the Industrial/Commercial/Institutional (ICI) Boiler Maximum Achievable Control Technology (MACT) rule, and the Mercury and Air Toxics (MATS) rule, may not specifically require limitations on ozone precursor emissions, but are projected by EPA[52] to indirectly reduce ozone precursor emissions in Connecticut and upwind states. Small, indirect reductions are anticipated to occur as a co-benefit of regulation of another pollutant (e.g., by motivating changes in equipment or fuels used, work practices, or increased use of renewable generating capacity).

Table 4-5 also refers to the requirement for a full transport remedy to address the obligations of upwind states that contribute to nonattainment and maintenance issues in Connecticut and other impacted states for the 2008 ozone NAAQS. EPA acknowledges in the CSAPR Update that the proposed rule is only a partial remedy towards fulfilling the responsibilities of upwind states under CAA section 110(a)(2)(D)(i)(I). The upwind states and EPA share the responsibility to fully address the CAA's transport obligations for the 2008 NAAQS, which were statutorily required to be met by March 2011.

CT DEEP recognizes that, despite the overwhelming contribution of interstate pollutant transport to Connecticut's highest monitored ozone levels, emissions from Connecticut sources do contribute to in-state ozone levels[53]. CT DEEP continues to evaluate and adopt control measures that reduce NOx and VOC emissions from Connecticut sources to reduce in-state impacts and to minimize impacts on downwind areas in other states, some of which may include nonattainment areas for the 2015 ozone NAAQS. A description of recent and upcoming state-level stationary and area source control measures is provided below. Many of the measures described were identified and developed as part of Connecticut's RACT review[54] for the 2008 ozone NAAQS required by sections 182(a) and (b) and 184(b) of the Clean Air Act (CAA). Additional information regarding the process of identifying control measures suitable for 8-hour ozone NAAQS planning is included in the RACM discussion in Section 6.

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[51] 77 FR 36342

[52] See: "Technical Support Document (TSD) Preparation of Emissions Inventories for the Version 6.2, 2011 Emissions Modeling Platform"; EPA OAQPS; August 2015.

[53] EPA's July 2015 transport modeling for the proposed CSAPR Update rule indicates that Connecticut sources are responsible for 6% of high ozone levels at the Westport monitor, Connecticut's worst-case ozone monitor which is located along the state's upwind border in the Southwest Connecticut portion of the NY-NJ-CT nonattainment area. For monitors in the Greater Connecticut area, EPA's modeling for 2017 estimates that Connecticut sources contribute between 4% and 14% to high ozone levels.

[54] See CT DEEP's webpage for the latest update on CT's RACT program: http://www.ct.gov/deep/cwp/view.asp?a=2684&q=546804&deepNav_GID=1619

Table 4-5. Federal Stationary and Area Source Measures Expected to Provide Ozone Precursor Emission Reductions

Federal Control Measure	Affected Ozone Precursor Pollutant(s)	Date of Federal Rule Promulgation	Date when Emission Reductions Begin	Are Ozone Precursor Emission Reductions Included in CT 2017 Projections?
CSAPR*	NOx	7/6/2011 (76 FR 48208) & 12/15/2011 (76 FR 80760)	2015 (Phase 1) 2017 (Phase 2)	No, CT not in rule
Final CSAPR Update**	NOx	Finalized 09/07/2016 (Pre-published rule)	2017	No, CT not in proposed rule
Full Transport Remedy for the 2008 Ozone NAAQS***	NOx	Was due 3/12/2011. Joint responsibility of upwind states and EPA.	Yet to be determined	No, CT found to be non-contributing
RICE NESHAP	NOx, VOC	1/30/2013 (78 FR 6674) amendments to 8/20/2010 rule (75 FR 51570)	2013	Yes
ICI Boiler & Process Heater MACT & Amendments	VOC	11/5/2015 amendments to 3/21/2011 rules (76 FR 15608 and 76 FR 15554)	2014 & 2012+, respectively for the two March 2011 rules.	Yes
Mercury & Air Toxics Standards	NOx	4/25/2016 (81 FR 24420) latest amendment to original 2/16/2012 (77 FR 9304) rule	2015	Yes
Portable Fuel Container Rule (part of HAP rule)	VOC	EPA 2/26/2007 rule (72 FR 8428) enabled CT to revoke equivalent 2007 state rule (RCSA 22a-174-43)	2007-2017 (turnover period)	Yes

* The Cross-State Air Pollution Rule (CSAPR) was promulgated by EPA to address interstate transport for the 1997 and PM2.5 NAAQS and the 2006 PM2.5 NAAQS. Legal challenges delayed implementation of Phase 1 of the rule until 2015, with Phase 2 scheduled for 2017. Although targeted at the 1997 ozone NAAQS, CSAPR-required emission reductions provide progress towards meeting the 2008 ozone NAAQS. Connecticut was not cited by EPA as a significantly contributing state and is therefore not included in the CSAPR program; however, emission reductions required in upwind states were projected by EPA to provide small ozone air quality improvements (0.2 ppb or less) at Connecticut monitors.

** The final CSAPR Update addresses interstate transport from 22 states for the 2008 ozone NAAQS. Connecticut was not cited by EPA as a significantly contributing state and is therefore not included in the CSAPR Update program; however, emission reductions required in upwind states are projected by EPA to provide small ozone air quality improvements (much less than 1 ppb) at key Connecticut monitors. EPA notes that the rule's requirements are limited to achieving the transport-related emission reductions that the Agency judges are achievable by the 2017 ozone season.

*** EPA acknowledges in the proposed CSAPR Update (80 FR 75714 & 75715) that the rule is only a partial remedy towards fulfilling the responsibilities of upwind states under CAA section 110(a)(2)(D)(i)(I) for the 2008 ozone NAAQS. The upwind states and EPA share the responsibility to fully address transport obligations, which were required to be met by March 2011.

During the period from 2006 through 2008, EPA issued a large number of Control Techniques Guidelines (CTGs) and Alternate Control Technique (ACT) documents with recommendations on how to control VOC emissions from a variety of source categories. The CTG/ACTs are intended to assist states with the development of RACT regulations. CT DEEP has revised its regulations to be consistent with the recommendations of all of the CTG/ACTs issued by EPA that are applicable to sources found in Connecticut.

Regulatory revisions for 11 of the CTG/ACTs became effective in 2011 or later, as summarized in Table 4-6. Each of the control measures is listed, along with the date on which the requirement was adopted in Connecticut and the date on which compliance was required so that the control measure began to reduce VOC emissions. The CTG or ACT upon which each control measure is based (or that applies to the same source category as is regulated by the control measure) is also identified. All of the control measures listed in Table 4-6 have been submitted to EPA for approval into the State Implementation Plan (SIP), and all of the measures have been approved into the SIP with the exception of the control measure addressing VOC emissions from the transfer and dispensing of gasoline.

The first seven listed control measures in Table 4-6 were implemented at the beginning of 2011 (i.e., January 1, 2011 effective date). Therefore, associated emission reductions for these measures are reflected in both the 2011 base and 2017 projected inventories presented elsewhere in this section. The 2011 measures are included in this discussion for completeness, because they became effective midway through the 5-year monitoring period (i.e., 2009-2013) used to establish the baseline design values relied upon in the photochemical modeling described in Section 8. In addition, Connecticut implemented these measures prior to many other affected states and feels it is important to highlight that fact in this SIP submittal.

A brief description of the remaining four CTG/ACT measures implemented since 2011 is provided below:

Metal/Plastic Parts and Pleasure Craft Coatings

The VOC emissions from miscellaneous metal product and plastic part and pleasure craft surface coating result from the evaporation of the volatile components of the coatings and cleaning materials used in these operations. Essentially all the VOCs contained in a coating evaporate. Therefore, lowering the VOC content of coatings and improving coating efficiency directly lowers VOC emissions. EPA estimates that decreasing the allowable VOC content for coatings and cleaning materials will reduce VOC emissions from miscellaneous metal and plastic part (including pleasure craft) coatings by about 35%. In analyzing potential reductions, EPA assumed that all facilities will choose to utilize the low-VOC coating materials option because low-VOC coating materials are already widely available at a cost that is not significantly greater than the cost of coating materials with higher VOC contents. Also, the use of add-on controls to reduce emissions from typical spray coating operations is a more costly option.

CT DEEP examined historic in-state inventories and identified about 125 potentially affected facilities with total reported annual statewide VOC emissions of approximately 640 tons. Based on EPA’s 35% reduction estimate, the regulation revisions could result in statewide annual reductions as high as 223 tons (0.6 tons/day), with about half the decrease occurring in Greater Connecticut. However, many of the smaller sources are no longer required to report their emissions on a regular basis, so the historic inventory may not accurately quantify current emissions. Additionally, many of these small sources are not subject to the revised regulations because their emissions are below the applicability threshold. Given the uncertainties, CT DEEP elected not to account for any VOC reductions from this measure in the 2017 inventory.

Table 4-6. Connecticut's CTG/ACT-Based VOC Control Measures Enacted Since 2011 (Note: table is two pages)

Control Measure	Pollutant	Section of the Regulations of Connecticut State Agencies	Status of Regulation Adoption	Date Applies to Create Emissions Reductions*	CTG or ACT issued for the source category regulated by the control measure
Metal furniture coating	VOC	22a-174-20(p)	4/6/2010	1/1/2011	CTG for Metal Furniture Coatings (2007)
Paper, film and foil coating	VOC	22a-174-20(q)	4/6/2010	1/1/2011	CTG for Paper, Film and Foil Coatings (2007)
Flexible package printing	VOC	22a-174-20(ff)	4/6/2010	1/1/2011	CTG for Flexible Package Printing (2006)
Offset lithographic and letter press printing	VOC	22a-174-20(gg)	4/6/2010	1/1/2011	CTG for Offset Lithographic Printing and Letterpress Printing (2006)
Large appliance coatings	VOC	22a-174-20(hh)	4/6/2010	1/1/2011	CTG for Large Appliance Coatings (2007)
Industrial solvent cleaning	VOC	22a-174-20(ii)	4/6/2010	1/1/2011	CTG for Industrial Cleaning Solvents (2006)
Spray application equipment cleaning	VOC	22a-174-20(jj)	4/6/2010	1/1/2011	State-specific requirements. In the absence of RCSA section 22a-174-20(jj), spray gun cleaning would be addressed via the industrial solvent cleaning requirements (RCSA section 22a-174-20(ii)) adopted pursuant to the CTG for Industrial Cleaning Solvents (2006).
VOC emissions from miscellaneous metal and plastic parts coating	VOC	22a-174-20(s)	10/31/2012	1/1/2013	CTG for Miscellaneous Metal and Plastic Parts Coatings (2008)
VOC emissions from pleasure craft coating	VOC	22a-174-20(kk)	10/31/2012	1/1/2013	CTG for Miscellaneous Metal and Plastic Parts Coatings (2008)

Control Measure	Pollutant	Section of the Regulations of Connecticut State Agencies	Status of Regulation Adoption	Date Applies to Create Emissions Reductions*	CTG or ACT issued for the source category regulated by the control measure
Control of VOC emissions from above-ground storage tanks	VOC	22a-174-20(a)	3/7/2014	6/1/2014	Alternative Control Techniques Document – Volatile Organic Liquid Storage in Floating and Fixed Roof Tanks (1994) Control of Volatile Organic Emissions from Petroleum Liquid Storage in External Floating Roof Tanks (1978) Control of Volatile Organic Emissions from Storage of Petroleum Liquids in Fixed Roof Tanks (1977)
VOC emissions from transfer and dispensing of gasoline	VOC	22a-174-20(a), 22a-174-30a	7/8/2015	7/1/2015 -- CARB-approved P/V vent valves 7/8/2015 -- Annual pressure decay test	Design Criteria for Stage I Vapor Control Systems – Gasoline Service Stations (1975)

* The first seven listed control measures were implemented at the beginning of 2011 (i.e., January 1, 2011 effective date). Therefore, associated emission reductions for these measures are reflected in both the 2011 base and 2017 projected inventories presented elsewhere in this section. The 2011 measures are included in this discussion for completeness, because they became effective midway through the 5-year monitoring period (i.e., 2009-2013) used to establish the baseline design values relied upon in the photochemical modeling described in Section 8. In addition, Connecticut implemented these measures prior to many other affected states and wants to highlight that fact in this SIP submittal.

Control of VOC emissions from above-ground storage tanks

This control measure regulates aboveground VOC storage tanks to a level at least as stringent as described in the identified CTGs and ACT. However, the adopted measure is more stringent in some respects and applies more broadly because it is based on the 2010 OTC Model Rule for Large Aboveground VOC Storage Tanks and New Jersey's recently adopted large aboveground VOC storage tank requirements (N.J.A.C. 7:27-16.2). This measure has been approved into the SIP. Relatively few storage tanks in Connecticut are affected by this rule; therefore, expected emission reductions are small[55] and are not accounted for in 2017 emission estimates.

VOC emissions from transfer and dispensing of gasoline

This control measure was adopted consistent with EPA's guidance on widespread use of onboard refueling vehicle vapor recovery (ORVR) to discontinue Connecticut's Stage II vapor recovery controls in favor of ORVR while also enhancing Connecticut's Stage I vapor recovery requirements for gasoline dispensing stations. The measure also requires the installation of CARB-approved pressure/vacuum vent valves when existing valves are replaced. CARB P/V valves are of better quality, so failures are reduced, thereby providing greater assurance that intended VOC reductions occur. A full description of the regulatory changes made by Connecticut through this control measure is available at http://www.ct.gov/deep/lib/deep/air/regulations/sip/SIP-FinalSubmittal_GDF-VaporRecovery.pdf. CT DEEP considers these regulatory revisions to be a reinforcement of a requirement for P/V valves that was adopted in 2004, providing greater certainty that intended emission reductions are achieved. Therefore, no additional emission reductions are projected from the revised rule.

In addition to the CTG/ACT measures just described, CT DEEP has completed adoption of, or is in the process of adopting, six additional control measures that will further reduce NOx or VOC emissions from Connecticut stationary and area sources. Table 4-7 identifies the measures, the relevant statute or regulation, the adoption status, and the anticipated effective and compliance dates. Note that emission reductions resulting from these measures are not reflected in emission projections for 2017. Some measures (e.g., Phase 2 of the fuel oil sulfur limits and the proposed revisions to NOx limits in RCSA-22a-174-22e and f) will provide emission reductions in the post-2017 period. These are mentioned because they will help to ensure maintenance of the 2008 ozone NAAQS and continued improvements in ozone levels beyond the required attainment year of 2017.

As part of regional haze planning obligations, Connecticut and other northeast states recently revised state statutes and regulations to reduce the level of sulfur allowed in distillate and residual fuel oil to help reduce regional sulfate levels. Studies have found that lower levels of sulfur in distillate oil also result in reductions in NOx emissions from stationary combustion sources. As part of the MARAMA inventory effort[56], states examined the available literature and conservatively estimated that reducing distillate sulfur content from 3000 ppm to 500 ppm (Connecticut's Phase 1 limit starting in July 2014) would result in a 7% reduction in NOx emissions from boilers and process heaters. Reducing distillate sulfur content from 3000 ppm to 15ppm (Connecticut's Phase 2 limit starting in July 2018) was conservatively estimated to produce a 22% reduction in NOx emissions from 2011 levels. The further NOx reductions associated with Phase 2 of Connecticut's program, starting in 2018, will help to improve ozone air quality in 2018 and beyond. As mentioned above, the 2017 emission projections presented in this TSD do not include the NOx reductions expected from this control measure.

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[55] CT DEEP identified 45 tanks (all floating roof) subject to this rule, with estimated statewide total annual VOC emission reductions of less than 30tpy (< 0.1 tons/summer day). DEEP views the rule as regulatory maintenance, and has not included the minor emission reductions in 2017 projections.

[56] "Technical Support Document: Emission Inventory Development for 2011 and 2017 for the Northeastern U.S. (Beta Version)"; MARAMA; June 10 2016. See page 61 for a discussion of NOx emission reductions associated with low-sulfur fuel oil. The MARAMA TSD refers to a Technical Memorandum prepared by NYDEC dated April 15, 2016 for documentation on the level of NOx reductions.

*Table 4-7. Connecticut's Post-2011 Non-CTG Controls for Ozone Precursor Emissions from Stationary and Area Sources**

Control Measure	Pollutant	Section of the Regulations of Connecticut State Agencies or Connecticut General Statutes	Status of Regulation Adoption	Date Requirements Apply to Create Emissions Reductions
Fuel oil sulfur limits for #2 distillate/heating oil and #4/#6 residual oil that indirectly reduce NOx emissions	NOx	22a-174-19, 22a-17419a, 22a-174-19b, CGS 16a-21a	RCSA 22a-174-19, 19a & 19b: Revised 4/15/2014 and submitted as SIP revision 4/22/2014, with subsequent revisions submitted 6/8/2015 & 9/28/2015. CGS 16a-21a: Revised July 2013.	Phase 1: 7/1/2014 Phase 2: 7/1/2018
Reduction in emission limit for mass burn waterwall municipal waste combustors	NOx	22a-174-38	Regulation adoption completed on 8/2/2016.	Revised emission limits become effective 8/2/2017. SIP Revision submitted September 19, 2016.
Control of NOx emissions from fuel-burning emission units at major sources of NOx	NOx	22a-174-22e (one of two regulations proposed to replace current 22a-174-22)	Public hearing held June 8, 2016. Awaiting action by Legislative Regulations Review Committee. Anticipate final adoption by than December 31, 2016. Progress of adoption may be viewed on CT's eRegulations site .	Proposed Dates: Phase 1 emission limits: June 1, 2018. Phase 2 emission limits: June 1, 2022. End of compliance options and case-by-case RACT limits: May 1, 2028.
Limitations on daily NOx emissions from emission units at non-major sources of NOx	NOx	22a-174-22f (one of two regulations proposed to replace current 22a-174-22)	Public hearing held June 8, 2016. Awaiting action by Legislative Regulations Review Committee. Anticipate final adoption by December 31, 2016. Progress of adoption may be viewed on CT's eRegulations site .	Proposed Date: May 1, 2018.
Reduction in VOC content limits for consumer products	VOC	22a-174-40	Proposed revisions expected in 2016.	Goal: Sometime in 2017
Reduction in VOC content limits for architectural and industrial maintenance coatings	VOC	22a-174-41, 22a-174-41a	Proposed revisions expected in 2016.	Goal: Sometime in 2017

***** The 2017 emission projections presented in this TSD do not include emission reductions from any of the measures listed in this table.

Revisions to Connecticut's municipal waste combustor (MWC) regulation were recently finalized in August 2016, with the associated emission limits scheduled to take effect one year later in August 2017. The 2017 emission projections presented later in this section do not include the estimated statewide NOx emission reductions of 658 tons/year (with about 214 tons/year, or about 0.6 tons/summer day in the Greater Connecticut area) associated with the revised MWC rule. Those reductions will help to further improve ozone air quality in 2018 and beyond.

The other four measures identified in Table 4-7 have not been adopted, although CT DEEP is currently moving the two measures targeted at major (RCSA 22a-174-22e) and non-major (RCSA 22e-174-22f) NOx sources through the regulation adoption process. Based on the proposed implementation schedule, these NOx measures will not be effective prior to the 2017 ozone season. The two VOC measures, updates to Connecticut's regulations to further reduce emissions from consumer products (RCSA 22a-174-40) and architectural and industrial maintenance (AIM) coatings (RCSA 22a-174-41) have been prepared, but are not yet proposed for the public notice and comment portion of the regulation adoption process. Although it is possible that the updates for the two VOC measures may be in effect in time to produce reductions during the 2017 ozone season, the 2017 emission projections included later in this section do not account for any reductions. All of the outstanding measures will be submitted to EPA for approval after each measure has been adopted.

Many of the control measures mentioned above are identified and further described in the RACT SIP that CT DEEP submitted to EPA in July 2014 for the 2008 ozone NAAQS. Background information concerning the amendment of RCSA section 22a-174-38 concerning municipal waste combustors and the adoption of RCSA sections 22a-174-22e and 22a-174-22f is available on CT DEEP's RACT web page.

4.3 Future Year Emission Projections

EPA's Ozone Implementation Rule for the 2008 NAAQS requires moderate nonattainment areas to demonstrate reasonable further progress (RFP) towards attainment by achieving at least a 15% reduction in ozone precursor emissions between 2011 and 2017. The Implementation Rule requires that ozone season day emissions be used for the RFP demonstration and should represent the conditions that led to a nonattainment designation. CT DEEP has prepared a projected future year ozone season day inventory for 2017 to assess whether the 15% RFP requirement has been satisfied and to also meet the requirement to submit an inventory for the attainment year. Emissions projections were developed from the 2011 Base Year Inventory (see Section 4.1) by using appropriate methods to account for expected changes in activity (i.e., growth) and emission controls during the 2011 through 2017 period for each source category.

The following subsections describe the selection of growth factors for each source category, estimated reductions from the post-2011 controls described in Section 4.2, and the resulting future year emission projections for 2017.

4.3.1 Growth and Control Methodologies Used to Project 2017 Emissions

As described in Section 4.1, the 2011 Base Year Inventory to be used for the RFP demonstration was developed by CT DEEP using ozone season day emissions from Connecticut 2011 Periodic Emissions Inventory (PEI) for the point and area source categories. On-road and most non-road emission estimates for 2011 were updated from the PEI values by using EPA's most recent release of the MOVES emissions model (MOVES2014a), with updated input data. Corrections were also made to inadvertent summation errors found in PEI emissions estimates for aircraft/aircraft support equipment and for landfills. In addition, EPA NEIv2 estimates of rail locomotive emissions were substituted for estimates initially included in the 2011 PEI. See Section 4.1 for a more complete explanation.

Emission projections for 2017 were developed from the 2011 Base Year Inventory by accounting for changes in activity (i.e., growth) and post-2011 controls for the various anthropogenic source categories. Methodologies used for each source sector are described below.

Mobile Sources

The majority of anthropogenic NOx and VOC emissions from Connecticut sources are emitted by on-road and non-road mobile sources, and the greatest level of emissions reductions since 2011 occur from controls required for these sources. As was previously described in Section 4.1.2, CT DEEP used EPA's latest mobile source emissions model, MOVES2014a, to estimate ozone season day emissions for on-road motor vehicles and for most non-road equipment (all except for commercial marine, aircraft/airport support equipment and rail locomotives – also known as the MAR categories). The CT DEEP ran the MOVES2014a model to develop estimates for both 2011 and 2017.

For on-road estimates, the CT DOT provided county-level projections of various traffic data required by the MOVES2014a model for 2017. CT DOT's Series 31 data set projects that 2017 summer daily vehicle miles traveled (VMT) in the Greater Connecticut area will be 44.7 million miles, 0.3% greater than 2011 VMT levels provided by CT DOT. The MOVES2014a runs for 2017 also include appropriate inputs to reflect Connecticut's LEV III program and EPA's federal Tier 3 vehicle and fuel standards, in addition to all the control programs modeled to estimate 2011 emissions. See Section 4.2 (and Table 4-3) for a full description of modeled emission control programs for on-road vehicles. Model runs for 2017 used the same set of high ozone day meteorological inputs as were used in the runs conducted for 2011. See Appendix B for more details regarding on-road vehicle inputs for MOVES2014a.

CT DEEP also used EPA's MOVES2014a model to develop 2017 emission estimates for all non-road equipment, except for the MAR categories. As was described in Section 4.1.2, the MOVES2014a model incorporates EPA's most recent version of the NONROAD model, NONROAD2008, which includes all of the control programs that were described in Section 4.2 (and Table 4-4). With the exception of the recreational pleasure craft category[57], the model was run using the model's default set of equipment population growth projections, which are segregated by market sector and fuel type[58]. Model runs for 2017 used the same set of high ozone day meteorological inputs as were used in the runs conducted for 2011. See Appendix B for more details regarding non-road inputs for MOVES2014a.

For the MAR categories, CT DEEP used EPA's emission estimates for 2011 and 2017, consistent with those contained in EPA's 2011 emissions modeling platform.[59] Summer day emissions were calculated using EPA's July estimates for each year, assuming they are evenly distributed throughout the month. EPA's emissions estimates account for the marine, aircraft/support equipment and rail locomotive control programs summarized in Table 4-4.

Area and Non-EGU Point Sources

Growth and control factors needed to project 2017 emissions from the 2011 base year were developed as part of a regional effort coordinated by the Mid-Atlantic Regional Air Management Association (MARAMA). Connecticut and other MARAMA workgroup states provided local data, where applicable, to MARAMA to estimate growth and control expected to occur between 2011 and 2017. MARAMA's contractor compiled the information and used it to project 2017 annual emissions from 2011 levels on a county-level basis[60].

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[57] Along with other Northeast states, Connecticut modified the default pleasure craft equipment population estimates for 2011 and 2017, using data from the National Marine Manufacturers Association. See Appendix B for more information.

[58] EPA documentation for NONROAD2008 is located at: https://www3.epa.gov/otaq/nonrdmdl.htm#techrept. Further information on EPA's development of non-road equipment population growth can be found in the technical report "Nonroad Engine Growth Estimates"; EPA420—P-04-008; April 2004; NR-008c; See: http://www.epa.gov/omswww/models/nonrdmdl/nonrdmdl2004/420p04008.pdf.

[59] See EPA's Technical Support Document: Preparation of Emissions Inventories for the Version 6.2, 2011 Emissions Modeling Platform (August 2015), located at: https://www.epa.gov/sites/production/files/2015-10/documents/2011v6_2_2017_2025_emismod_tsd_aug2015.pdf.

[60] Comprehensive documentation and the TSD for MARAMA's 2011 & 2017 Beta inventories is available at: http://www.marama.org/technical-center/emissions-inventory/2011-2017-beta-regional-emissions-inventory.

MARAMA and most participating states (including Connecticut) also provided comments to EPA to assist that agency with the development of 2011 and 2017 modeling inventories used by EPA to prepare the proposed Cross-State Air Pollution Rule (CSAPR) Update. In general, EPA followed the comments by incorporating the growth and control factors developed by the MARAMA workgroup when performing photochemical modeling for the proposed rule. EPA's modeling results for 2017 are presented in Section 8 of this TSD for the Greater Connecticut area.

Growth factors used for the area and non-EGU point sectors were based on a variety of indicators as surrogates for future sector activity including economic, energy, vehicle miles traveled, and demographic parameters. While recognizing that these surrogates may not track exactly with emissions, they are considered to be the "best available" data for projecting emissions for area and non-EGU point sources. Growth indicators were mapped to specific source classification codes. The following paragraphs provide a brief summary for each growth indicator. More complete documentation is contained in Appendix C and in the MARAMA TSD for the 2011 and 2017 beta inventories.

New England region energy projections from the U.S. Energy Information Administration (EIA) 2015 Annual Energy Outlook (AEO)[61] were used as growth indicators for fuel burning sources in area source sectors, including the marketing and distribution of petroleum products. AEO2015 provides regional fuel-use forecasts for various fuel types (e.g., coal, residual oil, distillate oil, natural gas, renewables) by end use sector (e.g., residential, commercial, industrial, transportation, and electric power). For example, AEO projections for New England are summarized in Figures 4-3 and 4-4 for the industrial and commercial sectors, respectively. In one case, residual oil consumption by commercial facilities, AEO projections for positive growth between 2011 and 2017 were judged by CT DEEP and other MARAMA workgroup states to be unrealistic, and were replaced with a no-growth assumption. Note that there is very little use of residual oil by Connecticut commercial facilities, so the impact on emissions is minimal.

CT DEEP obtained 2010 to 2020 statewide employment projections from the Connecticut Department of Labor[62] for each 3- or 4-digit North American Industry Classification System (NAICS) code, representing a variety of industrial, commercial and other employment sectors. Linear interpolation was used to estimate 2017 employment levels. Overall, total employment in Connecticut is projected to increase by 5.8%, but employment in the manufacturing sector, typically among the most emissions intensive sectors, is projected to decline by 1.4% over the same time period.

CT DEEP instructed MARAMA's contractor to use employment projections as the growth surrogate for non-fuel burning area sources. Employment projections were also used as the growth indicator for non-EGU point sources, but a no-growth assumption was used for any sector for which forecasts projected shrinking employment levels between 2011 and 2017. This was done to support the potential use of emission reductions from facility shutdowns to meet new source review emission offset requirements. Known point source closures were included in a separate list of potential NOx offsets, and associated emissions (0.7 tons/day of NOx in Greater Connecticut) were carried forward with the 2011 and 2017 inventories for use in the RFP demonstration described in Section 5.

CT DEEP also instructed MARAMA's contractor to use a no-growth assumption for Connecticut's municipal waste combustor (MWC) units. The MWC units have been operating at, or close to, capacity for a number of years. In addition, Connecticut's Solid Waste Management Plan[63] and Comprehensive Materials Management Strategy call for achieving 60 percent diversion of solid waste from disposal by 2024 through reduced waste production, increased recycling and increased waste conversion technologies. Therefore, an assumption of no-growth is likely conservative in regards to future MWC throughput.

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[61] US Energy Information Administration Annual Energy Outlook 2015. See: http://www.eia.gov/forecasts/archive/aeo15/. Appendix K to MARAMA's Beta Inventory TSD summarizes the AEO2015 data for New England.

[62] Appendix M to MARAMA's Beta Inventory TSD includes a summary employment file for CT.

[63] Connecticut's 2006 Solid Waste Management Plan is currently being updated, with the latest proposed revision dated 2014. For details, see: http://www.ct.gov/deep/cwp/view.asp?a=2718&q=325482&deepNav_GID=1646%20.

Figure 4-3. *AEO 2015 Industrial Energy Consumption Projections for New England*

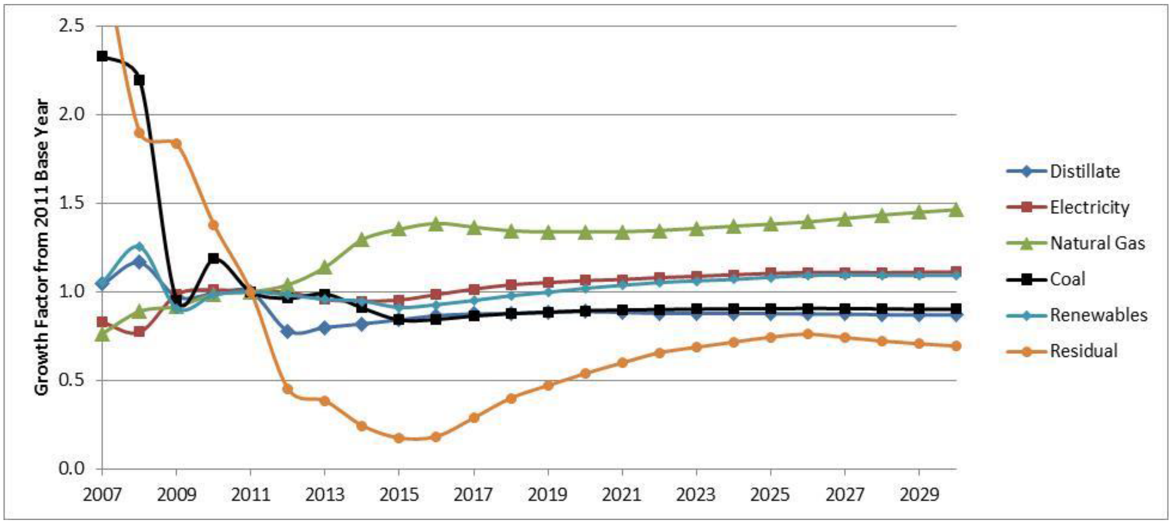
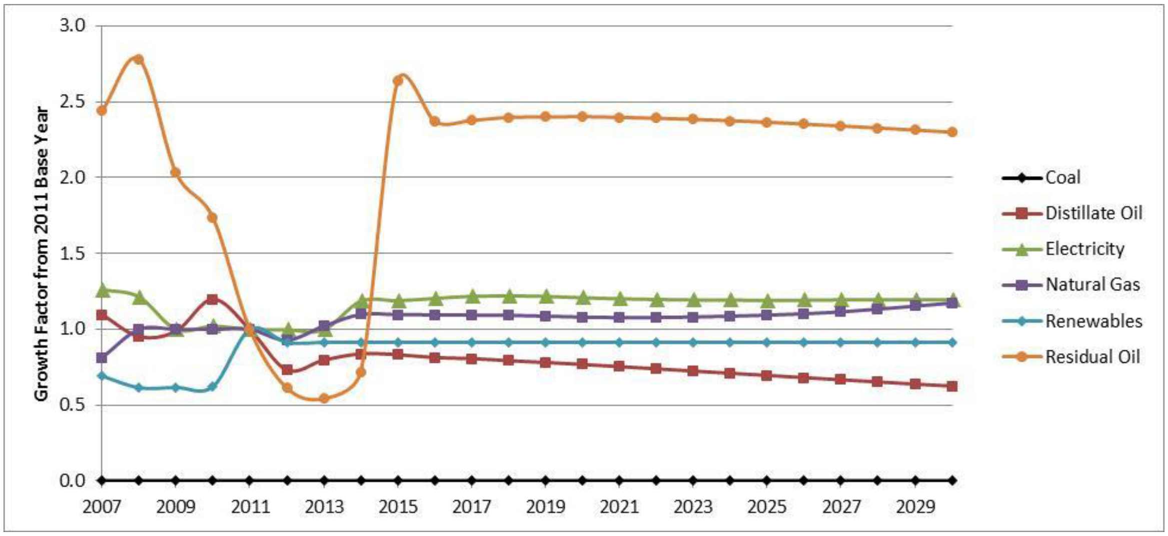


Figure 4-4. *AEO 2015 Commercial Energy Consumption Projections for New England*



Note: These figures are from the MARAMA TSD for the 2011 and 2017 Beta inventories. As noted in the text, AEO projections for positive growth between 2011 and 2017 for residual oil consumption by commercial facilities was judged by CT DEEP and other MARAMA workgroup states to be unrealistic. Growth for that sector was replaced with a no-growth assumption. There is very little use of residual oil in Connecticut by commercial facilities, so the impact on emissions is minimal. See the MARAMA TSD for complete documentation of all growth and control factors used for the point and area source sectors: http://www.marama.org/images/stories/documents/2011-2017_BETA_REI/TSD%20BETA%20Northeast%20Emission%20Inventory%20for%202011%202017%2020160701.pdf

CT DEEP obtained county-level historical population estimates from the US Census Bureau[64] and 2015-2025 population projections from the Connecticut State Data Center.[65] Population in the Greater Connecticut nonattainment area is projected to grow by 2.2% between 2011 and 2017, from 1,636,040 to 1,671,830 people. The population growth surrogate is used to project future emissions from consumer-oriented area source categories such as the usage of consumer solvent products (e.g., hair sprays/gels, household cleaners).

The 2017 emission projections also use EPA procedures[66] to account for reductions resulting from several federal New Source Performance Standards (NSPS) for oil and gas sources, RICE, Natural Gas Turbines, and Process Heaters. Emission reductions were also incorporated for the federal boiler MACT, RICE MACT and known consent decrees (not applicable to any Connecticut sources).

As was described earlier in Section 4.2 (and Table 4-6), Connecticut implemented seven CTGs effective January 1, 2011. VOC emission reductions resulting from those measures are reflected in both the 2011 and 2017 inventories. Minor emission reductions are projected for the other four CTG/ACT categories described in Section 4.2 In addition, Connecticut has adopted, or is in the process of adopting several additional NOx and VOC measures (see Table 4-7 in Section 4.2), that will not provide enforceable emission reductions prior to the start of the 2017 ozone season. Therefore, those measures have not been incorporated into the 2017 emission projections.

EGU Point Sources

The 2017 MARAMA Beta inventory uses emission estimates for EGU point sources that were developed with the ERTACv2.5 EGU forecasting tool. Development of the tool was a collaborative effort of the Eastern Regional Technical Advisory Committee (ERTAC), made up of representatives from the Northeastern, Mid-Atlantic, Southeastern, and Lake Michigan area states; other member states; industry representatives; and multi-jurisdictional planning organization representatives. The methodology calculates future emissions of NOx and SO_2 based on projections of future generation, the 2011 base year emission rates, and known future year emission controls, fuel switches, retirements, and new units. The future year emissions for other pollutants (CO, NH_3, PM10, PM2.5, and VOC) are calculated using generation projections from the ERTAC tool and a file of emission factors for each unit.

The ERTAC tool uses base year EPA Clean Air Markets Division (CAMD) data and fuel specific growth rates developed primarily from Energy Information Agency (EIA) and National Energy Reliability Corporation (NERC) data to estimate future activity and emissions. The 2017 MARAMA Beta inventory uses EGU estimates calculated with ERTAC v2.5. A complete description of the ERTAC tool and its use for developing 2017 emission projections is included in the MARAMA TSD for the 2011 and 2107 beta inventories.

CT DEEP used the ERTACv2.5 results to develop unit level ratios of 2017 to 2011 ozone season emission estimates. Those ratios were then applied to the corresponding 2011 PEI unit level summer day emissions to calculate 2017 summer day emission estimates.

4.3.2 Emission Projections for 2017

Greater Connecticut emission estimates for 2011 and projections for 2017 are summarized in Table 4-8 and Figure 4-5 for VOC and Table 4-9 and Figure 4-6 for NOx. The 2017 projections include the effects of the control measures described earlier in Section 4, and summarized in Tables 4-3 through 4-6. The control

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[64] Historical data for 2000 to 2010 obtained from U.S. Census Bureau. Intercensal Estimates of the Resident Population by County: July 1, 2001 to July 1, 2010. Accessed on November 21, 2013. See: http://www.census.gov/popest/data/intercensal/county/CO-EST00INT-01.html.

[65] Connecticut State Data Center at the University of Connecticut; 2015-2025 Population Projections for Connecticut at State, County, Regional Planning Organization, and Town levels - November 1, 2012 edition. See: http://ctsdc.uconn.edu/2015_2025_projections/.

[66] As documented in Section 4.2.4 of the EPA's 2011 Modeling Platform Version 6.2 TSD (August 2015). See: https://www.epa.gov/sites/production/files/2015-10/documents/2011v6_2_2017_2025_emismod_tsd_aug2015.pdf

measures that were summarized in Table 4-7 are not reflected in the 2017 projections.

Both VOC and NOx emissions are projected to significantly decrease in Greater Connecticut over the 6-year period from 2011 to 2017. Anthropogenic VOC emissions are projected to decrease by 20%, after accounting for growth. Anthropogenic NOx emission reductions are projected to be even greater, with estimated reductions of 39% between 2011 and 2017, after accounting for growth. The largest reductions are expected in the on-road (43% for VOC and 56% for NOx) and non-road (31% for VOC and 29% for NOx) sectors, as older vehicles and equipment are replaced by newer models.

Table 4-8. 2011 and 2017 Estimated VOC Emissions for Greater Connecticut

Source Category	2011 Anthropogenic VOC Emissions (tons/ozone season day)	2017 Anthropogenic VOC Emissions (tons/ozone season day)
Stationary Point	1.3	0.9
Stationary Area	48.9	48.3
On-Road Mobile*	27.8	15.9
Non-Road Mobile**	28.1	19.5
Total Anthropogenic VOC	**106.1**	**84.6**

Table 4-9. 2011 and 2017 Estimated NOx Emissions for Greater Connecticut

Source Category	2011 Anthropogenic NOx Emissions (tons/ozone season day)	2017 Anthropogenic NOx Emissions (tons/ozone season day)
Stationary Point	10.0	9.8
Stationary Area	6.2	6.2
On-Road Mobile*	50.5	22.2
Non-Road Mobile**	24.5	17.5
Emission Offset Bank	0.7	0.7
Total Anthropogenic NOx	**91.9**	**56.4**

* On-Road Mobile emission projections for 2017 will be used as transportation conformity budgets for the Greater Connecticut nonattainment area. See Section 7 for a description of the transportation conformity process.
** Non-Road Mobile emissions include estimates for the commercial marine, aircraft & airport support equipment, and rail locomotive sectors, which are summed with estimates determined using EPA's NONROAD model (as embedded in MOVES2014a) for all other non-road sectors.

Figure 4-5. *Comparison of 2011 and 2017 VOC Emissions for Greater Connecticut*

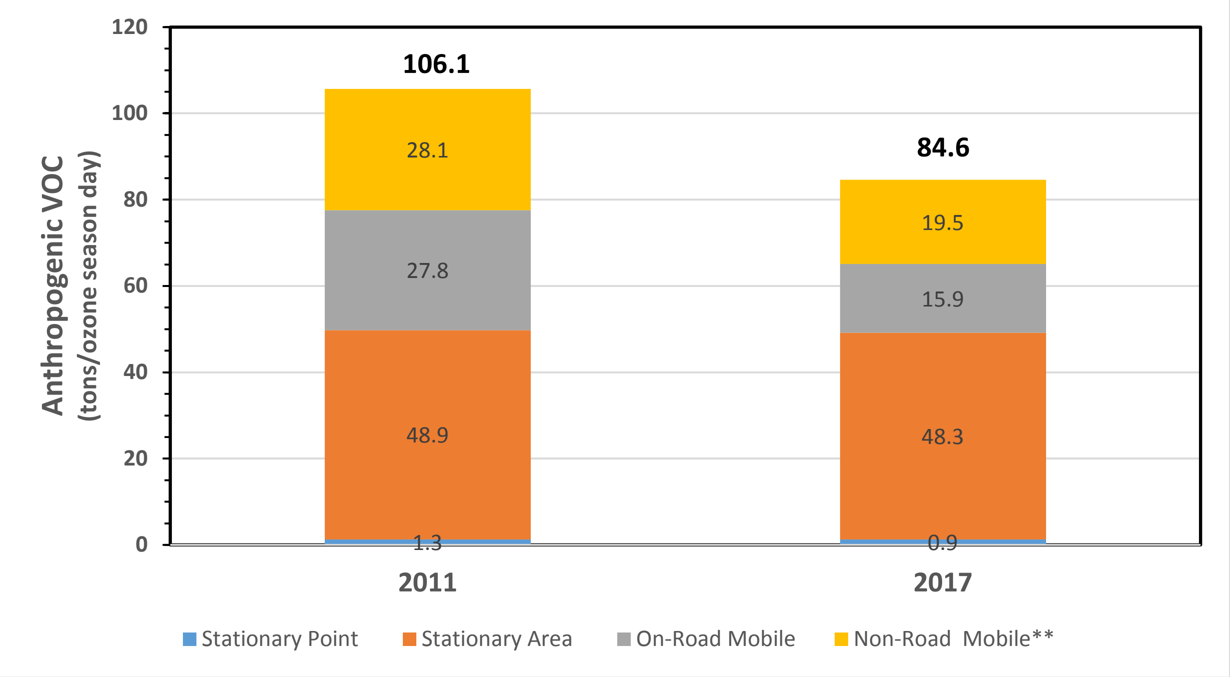
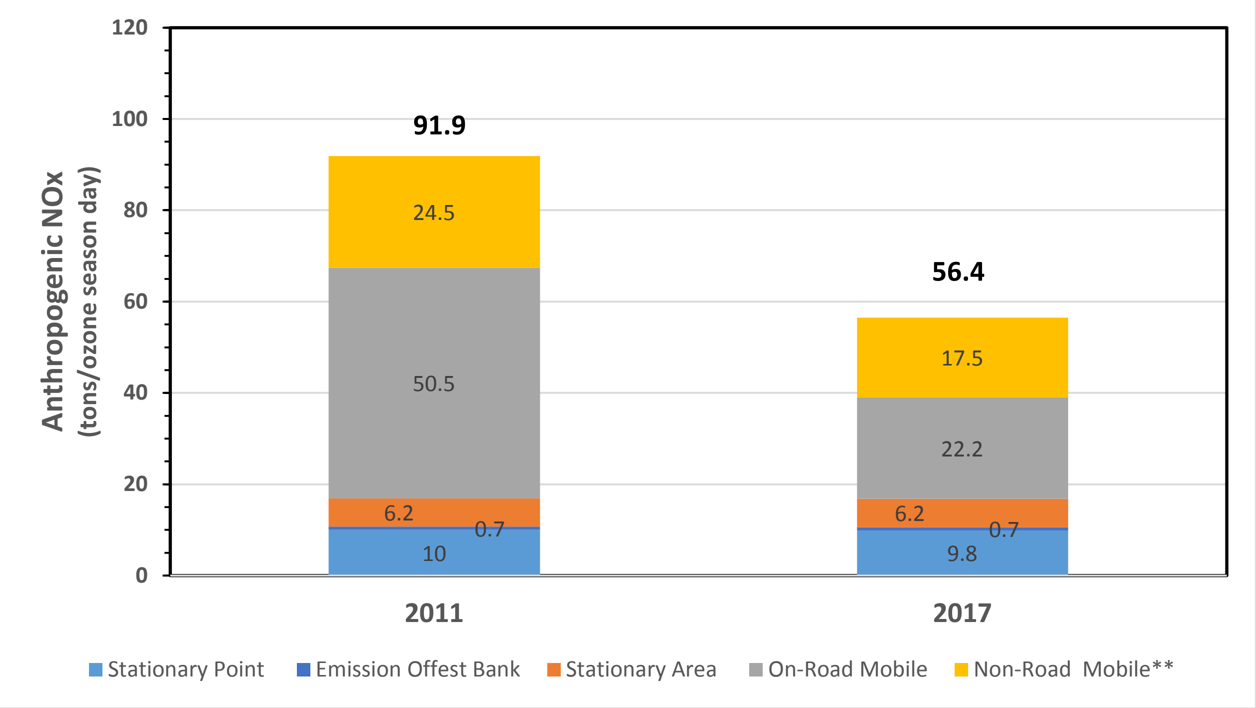


Figure 4-6. *Comparison of 2011 and 2017 NOx Emissions for Greater Connecticut*



5. Reasonable Further Progress

Sections 172(c)(2) and 182(b)(1) of the CAA require non-attainment areas to include a demonstration of Reasonable Further Progress (RFP). The implementation rule for the 2008 standard in 40 CFR 51.1110(a)(2) describes the RFP requirements applicable to the Greater Connecticut nonattainment area. Specifically, as a moderate nonattainment area, Greater Connecticut is required to obtain 15% reduction in ozone precursors within six years after the baseline year. Connecticut's baseline year is 2011, therefore the emission reductions must be achieved by 2017.

In order to demonstrate RFP, a nonattainment area must show that its projected emissions of NOx and VOC will be less than or equal to calculated target levels set for the end of the RFP period. This section describes the methodology and calculations used to establish the 2017 target emission levels for the Greater Connecticut nonattainment area. It also demonstrates that the area will meet RFP requirements because projected NOx and VOC emissions will be significantly less than the calculated target levels.

5.1 Base Year Inventory

The base year inventory for RFP is comprised of all anthropogenic sources of VOC and NOx for a typical high ozone day in 2011. This is identical to the 2011 base year summer day inventory presented in Section 4, which excludes biogenic emissions sources. Table 5-1 presents the high ozone (summer day) emissions for the anthropogenic portion of the Greater Connecticut inventory. This is the starting point for calculation of required target level emissions to show reasonable further progress.

Table 5-1. *Base year RFP Inventory for the Greater Connecticut Nonattainment Area*

Ozone Precursor Pollutant	***2011 Base RFP Inventory (TPD)***					
	Stationary Point	Stationary Area	On-Road Mobile	Non-Road Mobile	Emission Offset Bank	***Total***
NOx	10.0	6.2	50.5	24.5	0.7	***91.9***
VOC	1.3	48.9	27.8	28.1	NA	***106.1***

5.2 Calculation of Target Levels

EPA's RFP methodology specifies that the required 15% RFP emission reductions can come from any combination of VOC and NOx reductions occurring between the base year (2011) and six years later (2017) for a moderate area. Consistent with past practice, CT DEEP has elected to establish 2017 target levels comprised of 10% NOx reductions and 5% VOC reductions. While both pollutants contribute to ozone formation, the preference for NOx reductions recognizes that Connecticut's ozone problem is NOx limited. Table 5-2 shows the calculation of the Target Levels for the Greater Connecticut 2017 Summer Day Inventory.

Table 5-2. *Determination of 2017 Target Level Emissions to Demonstrate Reasonable Further Progress for the Greater Connecticut Nonattainment Area*

Greater Connecticut Target Level Emisson Calculation	NOx (tons/ozone season day)	VOC (tons/ozone season day)
1. Base Year (2011)	91.9	106.1
*2. RFP Reductions needed (Base*0.1) for NOx and (Base *0.05) For VOC*	9.2	5.3
3. 2017 Target Level (Base-RFP Reductions Needed)	**82.7**	**100.8**

5.3 Compliance with RFP Requirements

Compliance with the RFP requirements is met provided that the projected 2017 ozone season day emissions for the Greater Connecticut nonattainment area are less than or equal to the calculated RFP Target Levels.

Projected 2017 emissions were developed as described in Section 4. The process involved two steps: 1) revising 2011 summer day emissions estimates from CT DEEP's 2011 PEI to incorporate the most recent versions of EPA's mobile source models, update CT-specific mobile source inputs, include CT DEEP's bank of potential NOx emission offsets, and correct summation errors found in the 2011 PEI; and 2) projecting 2017 ozone season day emissions from the revised 2011 emissions by accounting for expected growth and adopted control programs in each source sector.

As described in Section 4, the growth and control factors used to develop the 2017 summer day inventory for Greater Connecticut are consistent with those developed by CT DEEP and other states as part of a MARAMA-led regional workgroup[67] responsible for creating the 2011 and 2017 OTC modeling inventories. EPA also decided to use essentially the same set of growth/control factors for its 2011eh modeling platform after soliciting comments and collaborating with the states. A prime difference between the MARAMA/OTC and EPA efforts is the use of the ERTAC and IPM models, respectively, to project EGU emissions. CT DEEP's 2017 summer day EGU emissions were calculated consistent with the ERTAC projections. The differences are minor for RFP purposes, since Connecticut EGU sources comprise only 2% of 2011 base year NOx emissions, and projected total 2017 emissions are well below the required RFP target levels.

Table 5-3 compares projected 2017 ozone season day emissions for Greater Connecticut to the required RFP target levels. Both NOx and VOC emission levels in 2017 are projected to be well below the target levels, thus meeting the RFP requirement. Projected NOx emissions in 2017 are 38% less than 2011 emission levels, while the RFP target requires a 10% emission reduction. Similarly, projected VOC emissions in 2017 are 20% less than 2011 emission levels, while the RFP target requires a 5% reduction. The excess emission reductions

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[67] As described in Section 4, CT DEEP performed new runs of EPA's MOVES2014a model to develop updated in-state summer day estimates of 2011 and 2017 emissions for on-road and non-road sources (except for MAR sources). Emission projections for 2017 for all other source categories were developed consistent with the growth and control factors identified by the MARAMA-led regional workgroup. EPA used essentially the same growth/control factors to develop the 2011/2017eh inventories used in their CAMx modeling, except that EPA used the IPM model to project 2017 EGU emissions, while the MARAMA/OTR states used the ERTAC model.

beyond the RFP requirement (28% excess for NOx and 15% excess for VOC) are available for use to meet CAA contingency measure requirements that are discussed in Section 10.

Table 5-3. *Comparison of 2017 Projected Emissions to the Required RFP Target Levels for Greater Connecticut*

Description	NOx (tons/ozone season day)	VOC (tons/ozone season day)
2017 RFP Emission Target Levels (portion of required 15% precursor reduction)	82.7 (10%)	100.8 (5%)
2017 Projected Emissions (% reduction projected from 2011- 2017)	56.4 (38%)	84.6 (20%)
Excess Reduction Beyond 15% RFP Requirement	28%	15%

6. Reasonably Available Control Measures (RACM) Analysis

As previously described in Section 4 of this document, and further analyzed in this section, sources in Connecticut are well-controlled as a result of numerous state and federal measures that have or will soon be implemented to reduce in-state emissions of ozone precursors. CT DEEP has historically pursued in-state emissions reductions and continues to do so in acknowledgement of the importance of actions in individual states in the larger region to better position the Connecticut nonattainment areas to attain both the 2008 and 2015 ozone NAAQS. The reasonably available control measures (RACM) analysis presented here identifies a number of reasonably available control technology (RACT) and other measures that have been adopted recently or are in the process of being adopted to satisfy the 2008 ozone NAAQS. CT DEEP is not aware of any additional candidate measures that can be identified as RACM for the 2008 NAAQS, as atmospheric transport from upwind areas on most high ozone days overwhelms the ability of CT DEEP to significantly advance Connecticut's attainment date solely with in-state control strategies. In addition, EPA's recently finalized bump-up process[68] provided insufficient time to adopt and implement additional RACM candidate measures prior to the 2016 ozone season, which would need to occur to advance the attainment date by one year.

6.1 RACM Requirements

The final rule "Implementation of the 2008 National Ambient Air Quality Standards for Ozone: State Implementation Plan Requirements" (the Implementation Rule)[69] describes how a state may satisfy the requirement of CAA section 172(c)(1) to implement all RACM that will assist the state to attain the ozone standard as expeditiously as possible. A RACM analysis traditionally includes point, area and mobile sources. The measures that are considered RACM are those readily implemented measures that are economically and technologically feasible and that advance the attainment date or are necessary for RFP for the area. RACM requires an area-specific analysis, in which the State considers the application of RACM for any source of VOCs or NOx within the state borders.

A subset of RACM are the NOx and VOC control measures that implement a RACT level of control on a source or source category. EPA has defined RACT as the lowest emission limitation that a particular source is capable of meeting by the application of control technology that is reasonably available considering technological and economic feasibility.[70] Unlike other RACM, RACT is limited to VOC sources for which EPA has developed Control Technique Guidelines (CTGs) and to major VOC and NOx non-CTG sources. As the analytical work for implementing the CTGs is readily available, and because the RACT sources are, *a priori*, a significant focus for implementing control strategies, EPA expects requirements limiting emissions from RACT sources to be addressed more immediately than the other control options. Connecticut submitted its RACT state implementation plan (SIP) for the 2008 ozone NAAQS to EPA on July 17, 2014. The 2014 RACT SIP included commitments to adopt additional control measures. Progress in addressing the RACT commitments is described in this section.

This section also provides an analysis of whether or not RACM exist for the point, area, off-road and on-road categories (including potential transportation control measures (TCM) for on-road mobile sources).

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[68] A RACM analysis is required for areas classified as moderate or higher nonattainment for ozone. The EPA Administrator signed the notice to reclassify the Greater Connecticut area from marginal to moderate nonattainment on April 11, 2016. The ruling was published on May 4, 2016 and effective on June 3, 2016. To be considered RACM, a measure or group of measures must advance the attainment date by at least one year. For moderate areas, that means achieving compliant design values during the 2016 ozone season; therefore, any additional RACM controls would need to be in place prior to the 2016 ozone season. The timing of the bump-up process makes that practically infeasible.

[69] 80 FR 12264; March 6, 2015.

[70] 44 FR 53762; September 17, 1979.

CT DEEP concludes this section indicating that the identified measures in this section satisfy the RACM obligation for the 2008 ozone NAAQS.

6.2 Summary of CT Reasonably Available Control Technology (RACT) Analysis

Section 182 of the CAA sets forth two separate RACT requirements for ozone non-attainment areas. The first requirement, the RACT "fix-up", calls for the state to correct RACT rules for which EPA identified deficiencies before the CAA was amended in 1990. Connecticut addressed this requirement as part of the attainment SIP submitted for the 1-hour ozone NAAQS, so there are no remaining deficiencies to correct. The second requirement calls for the state to evaluate, update and implement, as necessary, RACT controls on all major VOC and NOx emission sources and on all sources and source categories covered by an EPA-published CTG, the presumptive norm establishing RACT for the covered VOC sources. CT DEEP's RACT review for the 2008 ozone NAAQS was submitted to EPA as a SIP revision on July 17, 2014.[71] Sections II through IV of the July 17, 2014 RACT SIP describe the actions that CT DEEP has taken to address RACT for the 1-hour and 1997 ozone NAAQS, as well as completed and planned actions as a result of the 2008 ozone NAAQS RACT review.

The 2014 RACT SIP identified several source categories for which the RACT level of control required an update, including the NOx limitations for fuel burning sources and municipal waste combustors. This section describes CT DEEP's progress in fulfilling the commitments made to update NOx requirements in the July 17, 2014 RACT SIP. This section also describes the implemented VOC controls for major sources of VOC and CTG sources.

Major Sources of NOx

Major sources of NOx are identified in Table 5 of the July 17, 2014 RACT SIP. Each major source of NOx is subject to either RCSA section 22a-174-38 or RCSA section 22a-174-22. RCSA section 22a-174-38 applies to the state's municipal waste combustors (MWCs), of which there are six facilities, while RCSA section 22a-174-22 applies to every fuel-burning emission unit located in the state. As described in the RACT SIP, CT DEEP has determined that some of the NOx emissions limitations in RCSA sections 22a-174-38 and 22a-174-22 need to be reduced to require a current RACT level of control.

The MWC units at four of the six facilities are of the mass burn waterwall type, and CT DEEP has identified 150 ppmvd NOx as the emission limit resulting from a RACT level of control for this type of MWC unit. This emission limit is lower than the limits currently required of mass burn waterwall units through RCSA section 22a-174-38. CT DEEP adopted this emission limit as an amendment to RCSA section 22a-174-38. The amended regulation, which became effective on August 2, 2016, specifies that affected sources must meet the revised emission limit within one year of the rule's effective date (i.e., by August 2, 2017). CT DEEP estimates that the reduction in the emission limit for the mass burn waterwall MWC units will yield a NOx emission reduction of nearly 2 tons per day.

CT DEEP is also currently pursuing replacement of RCSA section 22a-174-22 with RCSA section 22a-174-22e to update the emissions limits for fuel-burning equipment located at major sources of NOx. The new RACT emission limits, when fully implemented, will be generally consistent with RACT-based emission limits now in place in New York and New Jersey. The new emission limits are phased-in to provide owners and operators with adequate time to plan, budget, hire contractors, and install new control technology or new emission units. Phase 1, as proposed, applies from June 1, 2018 through May 31, 2022, and Phase 2 applies June 1, 2022 forward. With the full implementation of more stringent emissions limits in Phase 2, CT DEEP also proposes to end the state's NOx emission trading program. New RCSA section 22a-174-22e was proposed on May 2, 2016 and the public hearing was held on June 8, 2016.[72] CT DEEP is moving the proposal towards adoption on a schedule to allow for an effective date no later than December 31, 2016, assuming timely approval is received

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[71] Available on the DEEP website: http://www.ct.gov/deep/cwp/view.asp?a=2684&q=546804&deepNav_GID=1619

[72] Current information on the adoption available on the Connecticut eRegulations site, PR2015- 193, https://eregulations.ct.gov/eRegsPortal/Search/RMRView/PR2015-193

from the Legislative Regulations Review Committee. Upon full implementation, CT DEEP estimates actual NOx emission reductions from the EGUs regulated by RCSA section 22a-174-22e to be about 395 tons per year.[73]

Although these regulatory revisions for NOx sources are considered to be RACT, the implementation of the revised emission limits will not occur in time to advance the attainment date; therefore, they are not identified as RACM measures for the 2008 ozone NAAQS.

Major VOC Sources and CTG Category Sources

Stationary sources of VOC are regulated by RCSA sections 22a-174-20 and 22a-174-32. RCSA section 22a-174-32 explicitly regulates major sources of VOC for the purpose of implementing RACT and allows CT DEEP to conduct individual RACT analyses for sources.

For sources for which a CTG has been published, RACT is considered met if a state imposes controls equivalent to the CTG for that source or source category. CT DEEP has addressed the majority of the CTG source categories and requirements through RCSA sections 22a-174-20 and 22a-174-32. The Stage I vapor recovery category was historically addressed via RCSA section 22a-174-30, which also included Stage II vapor recovery requirements. Following a legislative mandate to decommission the use of Stage II vapor recovery equipment and improve Stage I control compliance by July 2015,[74] CT DEEP repealed RCSA section 22a-174-30 and adopted new section 22a-174-30a with updated Stage I vapor recovery requirements consistent with the legislative mandate. A complete discussion of the programmatic revision and an analysis under CAA sections 110(l) and 184(b)(2) was submitted to EPA on September 14, 2015.[75]

Table 4 of the July 17, 2014 RACT SIP identifies every CTG and the regulatory requirement by which CT DEEP imposes control equivalent to each CTG. Table 5 of the July 17, 2014 RACT SIP includes all of the major sources of VOC in Connecticut. Through the regulations cited in Table 4 of the RACT SIP and CT DEEP's NSR permit program, all major sources of VOC and all CTG sources are regulated to at least a RACT level of control for VOC.

The CT DEEP concludes that the VOC RACT regulations described above collectively satisfy RACM requirements for major sources of VOC and CTG sources.

6.3 RACM Analysis for Other Stationary/Area Sources

The 1990 CAA amendments recognized the significant role of interstate transport of NOx and VOCs in influencing the ability of a downwind state to attain the ozone NAAQS. As part of that recognition, the United States Congress established the Ozone Transport Commission (OTC) to help coordinate control plans for reducing ground-level ozone in the Northeast and Mid-Atlantic states.

As a member of the OTC, Connecticut has worked jointly with the other eleven member states and the District of Columbia to assess the nature and magnitude of the ozone problem in the region, evaluate potential new control approaches and recommend regional control measures to ensure attainment and maintenance of the ozone NAAQS. This regional approach recognizes that all states benefit from coordinated attainment planning

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[73] The avoided tons of NOx for the EGU sector is estimated based on the weighted monthly averages of historical operations data during the months of January and July in 2010-2015. The reduction estimates reflect historical actual operations. Reductions in potential emissions would be much higher. Historical emissions show that actual NOx emissions have decreased since 2005. Potential emissions do not equal actuals for these units since actual operations have been erratic, particularly in recent years. For the regulated EGUs overall, actual NOx emissions have decreased since 2005, generally due to a reduction in hours of operation for many of the units with higher emission rates.

[74] CGS section 22a-174e was amended by Public Act 13-120 effective June 18, 2013.

[75] Available on the DEEP website: http://www.ct.gov/deep/lib/deep/air/regulations/sip/SIP-FinalSubmittal_GDF-VaporRecovery.pdf

efforts to reduce ozone precursors. Connecticut has been an active participant in this regional effort to assess potential attainment measures including RACM/RACT for the 8-hour ozone NAAQS.

To support the submission of attainment plans for the 1997 ozone NAAQS, OTC staff and member states formed several workgroups to identify and evaluate candidate control measures. Initially, the workgroups compiled and reviewed a list of over 1,000 candidate control measures. These control measures were identified through published sources such as EPA's Control Technique Guidelines, STAPPA/ALAPCO "Menu of Options" documents, the AirControlNET database, emission control initiatives in other states including California, state/regional consultations, and stakeholder input. The workgroups developed a preliminary list of approximately fifty candidate control measures to be considered for more detailed analysis with respect to the potential for emissions reductions, cost effectiveness, and ease of implementation. These measures were anticipated to have the potential to be the most effective in reducing ozone air quality levels in the Northeastern and Mid-Atlantic States. The 2007 OTC control measures Technical Support Document summarizes the process used to identify and evaluate candidate control measures and can be found on the OTC Website.[76]

Connecticut adopted a number of those candidate control measures prior to 2011 including:

- VOC content limits for consumer products;
- VOC content limits for architectural and industrial maintenance coatings;
- Restrictions on asphalt in paving operations;
- Pressure-vacuum vent valves; and
- Reduced vapor pressure limitation for solvent cleaning.

More information is available in the RACT SIP submitted for the 1997 ozone NAAQS.

In pursuing the adoption of these measures, Connecticut acknowledged that none of these measures, implemented by Connecticut alone, would be sufficient to advance attainment by one year or more for the 1997 ozone NAAQS. Connecticut chose to adopt these measures jointly with the OTC to develop effective controls on the regional level. In addition, such measures may serve to establish RACT for upwind states newly subject to RACT requirements for the 2008 or 2015 ozone NAAQS.

CT DEEP considers the RACM review developed in coordination with the OTC for the 1997 ozone NAAQS to largely satisfy the RACM requirement for the 2008 ozone NAAQS, given the relatively short passage of time between Connecticut's adoption of 1997 ozone NAAQS RACM prior to 2011 and the 2014 deadline for submission of the RACT SIP for the 2008 ozone NAAQS. In addition, CT DEEP performed a review in 2013-2014 to update the 1997 ozone NAAQS regional RACM review. In this focused review, CT DEEP examined a number of possible control measures including NOx limitations on asphalt production; VOC limits on lubricants used in metal rolling; VOC limits on polyethylene and polystyrene product manufacturing; and VOC emission limits for industrial laundry facilities. CT DEEP also considered updated OTC model rules for autobody refinishing, consumer products, architectural coatings, above ground storage tanks, and solvent degreasers.

CT DEEP determined it was appropriate to revise NOx emission limits for boilers and heaters used in asphalt production. Major asphalt sources of NOx will be addressed through the adoption of RCSA section 22a-174-22e (described earlier), while asphalt production facilities that are not major for NOx will be addressed through RCSA section 22a-174-22f. Note that RCSA section 22a-174-22f[77] will require the owner of equipment at all non-major sources of NOx to maintain fuel-burning emission units in proper operating condition and track daily emissions during the summer months, when NOx emissions are particularly harmful. If an emission unit exceeds a certain daily level of NOx emissions, the owner must reduce the emissions rate of the unit to the level required by RCSA section 22a-174-22e. These non-major source NOx requirements are being pursued for

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[76] See: http://www.otcair.org/document.asp?fview=Report, listed under work products completed in 2007.

[77] Information available as part of tracking number PR2015-193 at this location: https://eregulations.ct.gov/eRegsPortal/Search/RMRView/PR2015-193. DEEP is pursuing adoption of RCSA 22a-174-22f in concert with 22a-174-22e, with a targeted adoption date before the end of 2016.

adoption, but will not secure emission reductions in time to advance the attainment date, so CT DEEP concludes they are not RACM for the 2008 ozone NAAQS.

CT DEEP is also currently pursuing revisions to existing VOC rules for two model rules developed by the OTC: RCSA section 22a-174-40, updating VOC content limits for consumer products, and RCSA section 22a-174-41, updating VOC content limits for architectural, maintenance and industrial coatings. The amendments have not yet been proposed for public hearing and may not secure additional emission reductions prior to the 2017 ozone season; therefore, they are not considered to be RACM measures that could advance the attainment date. However, upon adoption, the amendments will produce additional VOC emission reductions compared with the current regulations and will assist with providing for attainment and maintenance of the 2008 ozone NAAQS and progress towards attaining the 2015 NAAQS.

As described in Table 3 of the July 17, 2014 RACT SIP[78], CT DEEP determined that the remaining OTC control measures for more restrictive limits on solvent degreasing and autobody refinishing would not be pursued in Connecticut at this time due to a limited number of sources, a low level of available emission reductions, and/or small business considerations. Furthermore, many of the sources in these categories are subject to NSR permitting. Since CT DEEP's minor source NSR program also requires the implementation of BACT, permitting of new or modified sources will result in a level of control that is RACT or higher.

In addition to the measures discussed above, NOx reductions are being achieved as an ancillary benefit to regional haze measures adopted in Connecticut to reduce the level of sulfur allowed in distillate and residual fuel oil used by stationary and area sources (including residential). As described in Section 4.2.2, revisions to CGS 16a-21a and RCSA 22a-174-19a and 19b establish more stringent sulfur limits as of July 1, 2014 (Phase 1) and July 1, 2018 (Phase 2). CT DEEP considers the Phase 1 limits to be RACM for the 2008 ozone NAAQS. While the Phase 2 limits are not RACM because they will not advance the attainment date for the 2008 NAAQS, they will help to further reduce ozone levels as SIP planning transitions to achieving compliance with the 2015 ozone NAAQS.

Table 6-1 provides a summary of RACM determinations for the stationary and area source measures adopted, or being pursued for adoption in Connecticut. As mentioned earlier, although CT DEEP intends to implement all these measures statewide, only those that could be implemented prior to the 2016 ozone season are considered to be RACM. Those implemented in 2017 or later are not considered as RACM because they will not advance the attainment date by one year or more.

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[78] Available at: http://www.ct.gov/deep/cwp/view.asp?a=2684&q=546804&deepNav_GID=1619.

***Table 6-1.** Summary of RACM Determinations for Stationary and Area Source Measures Adopted or Currently in Adoption Process in Connecticut*

Category	Regulation or Statute	Adoption Date	Implementation Date	Considered to be RACM?
Major & CTG Sources (VOC)	RCSA 22a-174-20 CGS 22a-174e RCSA 22a-174-30a RCSA 22a-174-32	4/6/2010, 10/31/2012, 3/7/2014 6/18/2013 (PA 13-120) 7/8/2015 7/8/2015	1/1/2011 & 1/1/2013 6/1/2014 6/18/2013 7/8/2015 7/8/2015	Yes: (11 CTG/AIM categories. See Section 4.2.2.1 and Table 4-5 for more information)
Low Sulfur Distillate & Residual Oil (NOx)	CGS 16a-21a RCSA 22a-174-19a RCSA 22a-174-19b	7/8/2013 (PA 13-298) 4/15/2014 4/15/2014	Phase 1: 7/1/2014 Phase 2: 7/1/2018	Phase 1: Yes Phase 2: No (based on implementation date)
Municipal Waste Combustor (NOx)	RCSA 22a-174-38	8/2/2016	8/2/2017	No (based on implementation date)
Asphalt Production	RCSA 22a-174-22e	Proposed: 5/2/2016 Proposed: 5/2/2016	Phase 1: 6/1/2018 Phase 2: 6/1/2022	No (based on implementation date)
Other Major NOx Sources	RCSA 22a-174-22e	Proposed: 5/2/2016	Phase 1: 6/1/2018 Phase 2: 6/1/2022	No (based on implementation date)
Minor NOx Sources	RCSA 22a-174-22f	Proposed: 5/2/2016	6/1/2018	No (based on implementation date)
Consumer Products	RCSA 22a-174-40	Revisions under development	Goal: CY 2017	No (based on implementation date)
Architectural and Industrial Maintenance Coatings	RCSA 22a-174-41	Revisions under development	Goal: CY 2017	No (based on implementation date)

6.4 RACM Analysis for Mobile Sources

This portion of the RACM analysis evaluates transportation control measures (TCMs) and their contribution to transportation and air quality planning in Connecticut. The statewide transportation planning process in Connecticut includes the identification, evaluation, selection, and implementation of appropriate TCMs. The Connecticut Department of Transportation (CTDOT) produces annual updates to the Statewide Transportation Improvement Program (STIP), documenting projects to be funded under federal transportation programs for a 3-year period.

One of the federal funding sources for the STIP is the Federal Highway Administration's Congestion Mitigation and Air Quality (FHWA CMAQ)[79] Program. Funds are used for projects that reduce emissions from vehicles and non-road equipment, improve traffic congestion, and/or generally reduce emissions to improve air quality. Some examples of projects eligible for FHWA CMAQ funding are:

- Programs for improved public transit;
- Restriction of certain roads or lanes to, or construction of such roads or lanes for use by, passenger buses or high-occupancy vehicles (HOV);
- Employer-based transportation management plans, including incentives;
- Traffic flow improvement programs that achieve emission reductions;
- Fringe and transportation corridor parking facilities serving multiple-occupancy vehicle programs or transit service;
- Programs for the provision of all forms of high-occupancy, shared-ride services;
- Programs to limit portions of road surfaces or certain sections of the metropolitan area to targeting use of non-motorized vehicles or pedestrian use, both as to time and place;
- Public Education and Outreach Activities;
- Idle Reduction;
- Freight/Intermodal;
- Alternative Fuels and Vehicles;
- Programs for secure bicycle storage facilities and other facilities, including bicycle lanes, for the convenience and protection of cyclists, in both public and private areas;
- Employer-sponsored programs to permit flexible work schedules; and
- Diesel retrofits and emission control technology on non-road diesel equipment or on-road diesel equipment operated on highway construction projects and port-related areas.

CTDOT produces annual FHWA CMAQ reports consisting of details of transportation projects and programs that are considered TCMs and will benefit air quality in Connecticut. The reports provide estimates of emission benefits resulting from the selected projects. Table 6-2 was compiled from CTDOT's annual reports from the period 2011 through 2015 for the most significant FHWA CMAQ projects and programs. A few included projects have construction completion dates in the near future beyond 2015.

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[79] For a current description of the FHWA CMAQ program, see: http://www.fhwa.dot.gov/fastact/factsheets/cmaqfs.cfm. In this document, the phrase FHWA CMAQ will be used distinguish it from EPA's photochemical dispersion model, CMAQ (Community Multi-scale Air Quality model), which is referenced elsewhere in this document.

***Table 6-2.** Emission Summary Compiled from CT DOT 2011-15 Annual FHWA CMAQ Reports*

State Project Number	**Project Description**	**Geographic Area**	**Total Emission Benefit (kg/day)**		
			VOC	**NOx**	**$PM_{2.5}$**
TRAFFIC FLOW IMPROVEMENTS					
0102-0326	FY11 So. Norwalk CBD Signal System (Phase 2)	NY-NJ-CT	0.31	0.29	n/a
0151-0307	FY11 IMS Breakout of 151-273 for I-84, Waterbury to Southington	NY-NJ-CT	2.80	1.37	n/a
0053-0181	CY13 Signal System-Putnam Blvd to Welles Street	Greater CT	0.30	0.30	n/a
0053-0187	F13 Intersection Improvement @ Harris and & House Streets Glastonbury	Greater CT	0.09	0.07	n/a
0056-0312	FY13 Traffic Signal Upgrade	NY-NJ-CT	1.00	0.65	0.00
0063-0690	FY13 Traffic Signal Upgrade @ 14 locations	Greater CT	0.41	0.29	n/a
0092-0666	FY13 Traffic Signal Upgrade @ 15 locations	NY-NJ-CT	0.27	0.18	0.00
0102-0347	FY13 Traffic Signal Upgrade @ 10 locations	NY-NJ-CT	0.25	0.19	0.00
0151-0325	FY13 Traffic Signal Upgrade @ 15 locations	Greater CT	0.18	0.30	n/a
0015-0365	FY 14 Traffic Signal System in five locations in Bridgeport	NY-NJ-CT	0.87	0.38	0.07
0084-0108	FY15 Construct Roundabout at CT111/110	NY-NJ-CT	0.08	0.03	0.00
EXPERIMENTAL PILOT PROGRAM					
0170-3069	FY11 CT Clean Fuels (NY-NJ-CT)	NY-NJ-CT	0.04	1.08	0.02
0170-0370	FY11 CT Clean Fuels (Greater CT)	Greater CT	0.02	0.45	n/a
0170-3100	FY13 CT Clean Fuels (NY-NJ-CT)	NY-NJ-CT	0.04	1.08	0.02
0170-0101	FY13 CT Clean Fuels (Greater CT)	Greater CT	0.02	0.45	n/a
0170-3109	FY14 CT Clean Fuels (NY-NJ-CT)	NY-NJ-CT	0.04	1.08	0.02
0170-3110	FY14 CT Clean Fuels (Greater CT)	Greater CT	0.02	0.45	n/a
0170-3118	FY15 CT Clean Fuels (NY-NJ-CT)	NY-NJ-CT	0.04	1.08	0.02
0170-3119	FY15 CT Clean Fuels (Greater CT)	Greater CT	0.02	0.45	n/a
DEMAND MANAGEMENT					
0170-3071					
0170-3072					
0170-3093	FY11 Statewide Trans. Demand Management (NY-NJ-CT)	NY-NJ-CT	25.36	44.14	2.36
0170-3094	FY11 Statewide Trans. Demand Management (Gtr CT)	Greater CT	25.36	44.14	n/a
0170-3102	FY12 Statewide Trans. Demand Management (NY-NJ-CT)	NY-NJ-CT	25.36	44.14	2.36
0170-3103	FY12 Statewide Trans. Demand Management (Gtr CT)	Greater CT	25.36	44.14	n/a
0170-3111	FY13 Statewide Trans. Demand Management (NY-NJ-CT)	NY-NJ-CT	25.36	44.14	2.36
0170-3112	FY13 Statewide Trans. Demand Management (Gtr CT)	Greater CT	25.36	44.14	n/a
0170-3120	FY14 Statewide Trans. Demand Management (NY-NJ-CT)	NY-NJ-CT	25.36	44.14	2.36
0170-3121	FY14 Statewide Trans. Demand Management (Gtr CT)	Greater CT	25.36	44.14	n/a

State Project Number	Project Description	Geographic Area	Total Emission Benefit (kg/day)		
			VOC	NOx	$PM_{2.5}$
	FY15 Statewide Trans. Demand Management (NY-NJ-CT)	NY-NJ-CT	25.36	44.14	2.36
	FY15 Statewide Trans. Demand Management (Gtr CT)	Greater CT	25.36	44.14	n/a
	DEMAND MANAGEMENT				
0170-3073	FY11 Telecommuting Partnership (Greater CT)	Greater CT	25.36	44.14	n/a
0170-3074	FY11 Telecommuting Partnership (NY-NJ-CT)	NY-NJ-CT	25.36	44.14	2.36
0170-3095	FY12 Telecommuting Partnership (NY-NJ-CT)	NY-NJ-CT	25.36	44.14	2.36
0170-3096	FY12 Telecommuting Partnership (Greater CT)	Greater CT	25.36	44.14	n/a
0170-3104	FY13 Telecommuting Partnership (NY-NJ-CT)	NY-NJ-CT	25.36	44.14	2.36
0170-3105	FY13 Telecommuting Partnership (Greater CT)	Greater CT	25.36	44.14	n/a
0170-3113	FY14 Telecommuting Partnership (NY-NJ-CT)	NY-NJ-CT	25.36	44.14	2.36
0170-3114	FY14 Telecommuting Partnership (Greater CT)	Greater CT	25.36	44.14	n/a
0170-3122	FY15 Telecommuting Partnership (NY-NJ-CT)	NY-NJ-CT	25.36	44.14	2.36
0170-3123	FY15 Telecommuting Partnership (Greater CT)	Greater CT	25.36	44.14	n/a
TRANSIT					
0171-0305	FY11 CMAQ Busway Transfer to FTA	Greater CT	9.40	19.90	n/a
0170-3108	FY13 Advanced Tech Buses	Greater CT	0.23	1.06	0.08
INCIDENT MANAGEMENT & OTHER TCM's					
0015-0345	FY13 Route 8 Area CCTV (PD)	NY-NJ-CT	7.01	3.43	0.00
0015-0344	FY15 Route 8 Area VMS	NY-NJ-CT	7.01	3.43	0.00
ALTERNATE VEHICLES					
0110-0135	FY13 Purchase 5 Hybrid Muni Vehicles	Greater CT	0.02	0.01	n/a
0103-0264	FY14 Construction of natural gas fueling station in Norwich	Greater CT	0.16	0.19	n/a
	Statewide Total for all projects (kg/day)		**536.96**	**920.58**	**23.83**
	Statewide Total (tons/day)		**0.59**	**1.02**	**0.026**
	Greater Connecticut Area Total (tons/day)		**0.29**	**0.51**	**0.013**

Total emission reductions from these projects are estimated to be 0.3 tons of VOC and 0.5 tons of NOx per ozone season day in the Greater Connecticut area. Approximately half of the emission benefits result from ongoing initiatives to promote increased telecommuting[80] and the recently completed CT*fastrak*[81], Connecticut's first bus rapid transit system. The system includes a dedicated bus-only roadway connecting New Britain and Hartford, with 10 stations along the primary route. Initial CTDOT data[82] indicate that ridership levels in the area served by the CT*fastrak* system doubled compared to levels prior to the March 2015 opening, well ahead of pre-project projections. Both the telecommuting initiatives and the CT*fastrak* system are reflected in the results of CTDOT's travel demand modeling, which is used to develop the transportation conformity emission budgets that are described in Section 7.

Although all of these measures will be implemented by 2017, the combined emission reductions are estimated to reduce overall 2017 ozone precursor emissions in the Greater Connecticut area by less than one percent, and are judged not be RACM because they are not large enough to advance the attainment date by at least one year. In addition to the projects quantified above, CTDOT continues to implement numerous other TCMs to improve traffic flow, manage travel demand, increase transit and commuter rail availability, manage traffic incidents, promote alternative fueled vehicles, encourage ride sharing/telecommuting and educate the public and businesses about available programs. See Appendix D for a full list of near-term TCM projects from CTDOT's most recent STIP.

Section 9 of this document includes descriptions of additional CT DEEP mobile source initiatives that result in ozone precursor emission reductions. Some of these programs, such as the Lawn Equipment Exchange Fund and engine replacements/retrofits using Diesel Emission Reduction Act funding, provide important reductions in localized emissions of NOx, VOC, PM2.5 and air toxics. Other programs such as Smartway® and EVConnecticut, are relatively new initiatives that promise to provide meaningful emission reductions as they are expanded and phased-in over time. CT DEEP has concluded that, collectively, these programs do not produce sufficient emission reductions before 2017 to advance the attainment date, and therefore are not considered to be RACM measures.

Looking beyond 2017, CT DOT plans to begin phasing in a major new commuter rail line in early 2018 along the Interstate-91 corridor, servicing the large urban areas of New Haven, Hartford and Springfield. This "Hartford" commuter line, a key component of the Let'sGoCT! Transportation initiative[83], is a partnership between Connecticut, Massachusetts, Amtrak and the Federal Railroad Administration to make rail travel in the corridor more attractive and competitive. The new service will connect with the existing Metro-North commuter rail and Amtrak Acela high-speed rail programs that serve the Northeast Corridor. As this new commuter line is phased-in, reductions in VMT and traffic-related emissions can be expected along the I-91 corridor, helping to maintain attainment of the 2008 ozone NAAQS and make progress towards attaining the 2015 ozone NAAQS.

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[80] See: http://www.hartfordbusiness.com/article/20140303/PRINTEDITION/302279941/ct-targets-commuters.

[81] For more information, see: http://ctfastrak.com/.

[82] See: http://www.courant.com/news/connecticut/hc-ctfastrak-ridership-hartford-0831-20160830-story.html and http://ctmirror.org/2016/08/30/for-malloy-and-transportation-the-campaign-never-ends/.

[83] CT DOT maintains a web-based dashboard to provide updates on progress implementing the Let'sGoCT! Initiative, including the Hartford line. See: http://www.letsgoct.com/RampUpDashboard.html.

7. Transportation Conformity Process and Motor Vehicle Emission Budgets

Transportation conformity serves as a bridge to connect air quality and transportation planning activities. Transportation conformity is required under section 176(c) of the CAA to ensure that highway and transit project activities receiving federal funds are consistent with (“conform to”) the purpose and goals of the SIP. Conformity to a SIP is achieved if transportation programs or transit project activities do not cause or contribute to any new air quality violations, do not increase the frequency or severity of violations, and do not delay timely attainment of the relevant NAAQS or any required interim milestone.

Transportation conformity currently applies to areas that are designated nonattainment for the following transportation-related criteria pollutants: ozone (O_3), particulate matter ($PM_{2.5}$ and PM_{10}), carbon monoxide (CO), and nitrogen dioxide (NO_2). Transportation conformity also applies to areas that have been re-designated to attainment after 1990, also known as “maintenance areas”.

Transportation conformity requires that certain precursor pollutants be addressed as well. These are pollutants that contribute to the formation of other, usually more harmful, pollutants. The precursor emissions for ozone are NOx and VOCs.

Transportation conformity addresses air pollution from on-road mobile sources such as cars, trucks, motorcycles, and buses. For this reason, transportation conformity budgets are often referred to as motor vehicle emission budgets (MVEB). There are also significant emissions from non-road mobile sources, area sources, and stationary sources that are not addressed by transportation conformity.

The State of Connecticut Department of Transportation (CTDOT) and the metropolitan planning organizations (MPOs) in Connecticut must demonstrate conformity for any transportation plans, transportation improvement programs (TIPs), or any federally supported highway and transit projects.

Conformity determinations are developed by CTDOT in consultation with CT DEEP and EPA. The Federal Transit Administration (FTA) and the Federal Highway Administration (FHWA), agencies of the United States Department of Transportation (US DOT), review the submittals from CTDOT and the Connecticut MPOs and make a conformity determination.

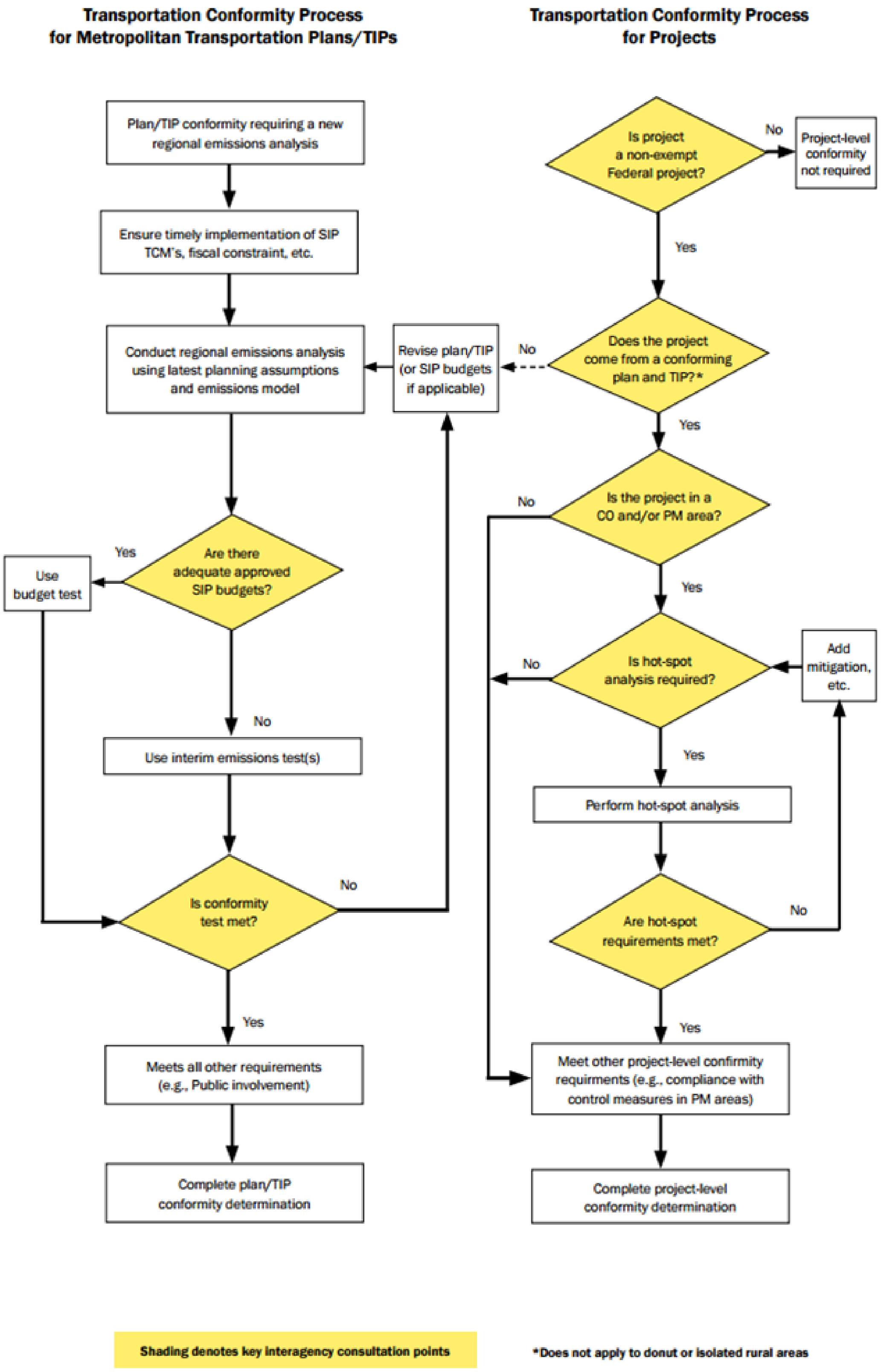
Conformity determinations consist of the following components:

- Regional emissions analysis;
- Transportation modeling requirements;
- Latest planning assumptions and emissions model;
- Timely implementation of transportation control measures (TCMs);
- Interagency consultation;
- Public participation (consistent with USDOT regulations); and
- Fiscal constraint (consistent with USDOT regulations).

The regional emissions analysis is the primary component, which incorporates either a “budget” test for areas or states with approved SIP budgets, or an interim emissions test for areas with no adequate or approved SIP budgets. Budgets are developed using various transportation and emissions models. Local modeling inputs are cooperatively developed by CTDOT and CT DEEP, using EPA recommended methods where applicable. Generally, CTDOT’s estimated air emissions from transportation plans and TIPs must not exceed an emissions limit, or budget, established by CT DEEP as part of an attainment or maintenance SIP.

A general flowchart depicting the transportation conformity process and how the elements of a conformity determination interact can be found in Figure 7-1.

Figure 7-1. General Flowchart of the Transportation Conformity Process



Shading denotes key interagency consultation points

***Does not apply to donut or isolated rural areas**

Source: [Transportation Conformity: A Basic Guide for State and Local Officials, Federal Highway Administration]

7.1 Transportation Conformity Regulatory History

The federal CAA and federal transportation reauthorization legislation passed in the 1990s established an interrelationship of clean air and transportation planning. In order to receive federal transportation funds, CTDOT and the MPOs in Connecticut must cooperatively work to develop and endorse an Air Quality Conformity Statement, which certifies to the federal government that the Statewide Transportation Improvement Program (STIP), which incorporates all TIPs, conforms to the requirements of the CAA amendments.

On August 15, 1997, the EPA published the Final Conformity Rule.[84] The full text of the rule, which has been updated multiple times since 1997 as various transportation funding bills have been passed, is contained in 40 CFR Part 93 – Determining Conformity of Federal Actions to State or Federal Implementation Plans[85].

The Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU)[86] revised the CAA conformity SIP requirements in 2005 in order to use state and local resources more efficiently. SAFETEA-LU guided surface transportation policy and funding up until it was due to expire in 2009. Congress extended the provisions nine times until it finally expired on June 30, 2012.

On July 6, 2012, Moving Ahead for Progress in the 21st Century (MAP-21)[87] was signed into law. MAP-21 reauthorized the transportation programs that were previously authorized by SAFETEA-LU. The programs under MAP-21 continued through September 30, 2014 and finally expired, after five short term extensions, on December 4, 2015.

On December 4, 2015, the Fixing America's Surface Transportation (FAST) Act[88] was signed in to law as the first long term transportation funding bill since SAFETEA-LU. The FAST Act authorizes federal highway, transit, safety and rail programs and funding certainty for five years - through September 30, 2020.

CTDOT produces a STIP in accordance with the terms and provisions of the FAST Act, the CAA amendments and all regulations issued pursuant thereto. As part of the STIP development, CTDOT conducts air quality assessments and prepares conformity reports. CT DEEP and EPA reviews the STIP and conformity reports.

7.2 Previous Motor Vehicle Emissions Budgets for the 2008 8-Hour Ozone Standard

On May 21 2012, EPA established designations and classifications[89] for the 2008 ozone NAAQS, which had been previously promulgated on March 12, 2008. EPA designated and classified two separate "marginal" nonattainment areas in the State of Connecticut for the 2008 NAAQS:

- Southwest Connecticut – Includes Fairfield, New Haven and Middlesex counties as part of the NY/NJ/CT non-attainment area; and
- Greater Connecticut – Includes Hartford, Litchfield, New London, Tolland and Windham counties.

The designations for the 2008 ozone NAAQS became effective on July 20, 2012. The previous 1997 eight-hour ozone standards were revoked effective April 6, 2015. A conformity determination for the new 2008 eight-hour ozone standard was required within one year from the effective date of the nonattainment area designations. The deadline to demonstrate conformity was July 20, 2013 and CT DOT's demonstration of conformity was approved by USDOT on July 10, 2013.

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[84] 62 FR 43780, August 15, 1997.

[85] 40 CFR Part 93.

[86] Public Law 109-59, August 10, 2005.

[87] Public Law 112-141, July 6, 2012.

[88] Public Law 114-94, December 4, 2015.

[89] 77 FR 30088, May 21, 2012.

The Motor Vehicle Emission Budgets (MVEBs) that were used in this initial conformity demonstration with the 2008 ozone NAAQS were budgets previously established and approved for the 1997 eight-hour ozone standard. The use of these existing MVEBs are allowed pursuant to transportation conformity rules in 40 CFR 93.109[90]. The rule states that a nonattainment area that has approved or adequate MVEBs in an applicable implementation plan or implementation plan submission for another NAAQS for the same pollutant, must use those existing MVEBs in transportation conformity determinations until MVEBs for the current NAAQS are submitted by the state and found adequate or are approved by the EPA.

The approved 1997 ozone standard MVEBs used for the initial conformity determination for both the Greater Connecticut and the Southwest Connecticut portion of the NY-NJ-CT marginal nonattainment areas under the 2008 ozone NAAQS are provided in Table 7.1.

Table 7-1. *Initial Ozone Nonattainment MVEBs for Each of CT's Nonattainment Areas for the 2008 Ozone NAAQS (As previously approved by EPA for the 1997 ozone NAAQS)*

Pollutant	Greater Connecticut MVEB (tons per summer day)		Southwest Connecticut MVEB (tons per summer day)	
	2008	2009	2008	2009
VOC	28.5	26.3	29.7	27.4
NOx	54.3	49.2	60.5	54.6

7.3 Final Motor Vehicle Emissions Budgets for the 2008 8-Hour Ozone Standard

On April 11, 2016, EPA signed[91] a rulemaking that, among other things, reclassified the two "marginal" nonattainment areas in Connecticut to "moderate" for the 2008 ozone NAAQS. The result is the requirement to submit a SIP revision that addresses the moderate nonattainment area requirements, including revised MVEBs that are consistent with the required attainment plan.

As was described in Section 4, this attainment plan includes numerous emission control programs designed to sufficiently reduce ozone precursor emissions in Greater Connecticut to meet CAA RFP requirements and achieve compliance with the 2008 ozone NAAQS by the July 20, 2018 attainment deadline established for moderate areas. Emission control strategies are targeted at all types of emission sources, including on-road sources such as cars and diesel trucks. Projected 2017 emission levels are consistent with achieving RFP and attainment requirements in the Greater Connecticut area.

The on-road portion of the 2017 emission estimates will, upon approval by EPA, become the sole governing MVEBs for the Greater Connecticut area. Table 7-2 displays the 2017 emission budgets for the Greater Connecticut area. Note that, as with previous attainment and maintenance SIPs approved by EPA for Connecticut, the on-road vehicle emission estimates for 2017 include an additional 2% contingency factor to account for uncertainties in future transportation planning, such as changes to modeling procedures that could affect future year emission estimates that must be compared to budgets established with previous model versions. The resulting final budgets are much more stringent than the current budget for the Greater Connecticut nonattainment area.

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[90] 40 CFR 93.109(c)(2)(ii)

[91] The rule was subsequently published in the Federal Register on May 4, 2016, with an effective date of June 3, 2016. See: 81 FR 26697.

Table 7-2. Final Greater Connecticut Nonattainment Area MVEBs for the 2008 Ozone NAAQS

Pollutant	2017 MVEB (tons per ozone season day)
VOC	15.9
NOx	22.2

As noted previously in this plan, a separate attainment plan is being prepared for the Southwest Connecticut portion of the NY-NJ-CT area. However, CT DEEP is proposing to establish revised 2017 emission budgets for the Southwest Connecticut area as a part of this submittal in an effort to streamline the transportation planning process for CT DOT and the local MPOs and to more quickly establish tighter emission budgets for Southwest Connecticut until the full attainment plan for that area can be completed. Gaining approval of 2017 budgets for both areas will enable CTDOT and the MPOs to use a single set of consistent MOVES2014a inputs for both areas and avoid confusion during the public review process. More importantly, the proposed 2017 budgets for Southwest Connecticut are much more stringent than those currently in place. Gaining quicker approval of the revised budgets will ensure continued progress towards attainment in Southwest Connecticut and help to provide for maintenance of the 2008 NAAQS in Greater Connecticut, which is situated downwind of the Southwest Connecticut counties.

The proposed budgets for Southwest Connecticut, summarized in Table 7-3, were calculated using the same MOVES2014a procedures and inputs documented in Section 4 for Greater Connecticut. Based on the RFP calculations presented in Section 5, CT DEEP expects that these budgets levels will be more than adequate to meet RFP requirements for Southwest Connecticut. Additional revisions to the budgets will be made, as necessary, to be consistent with the attainment plan that is required for Southwest Connecticut.

Table 7-3. Revised Southwest Connecticut Nonattainment Area MVEBs for the 2008 Ozone NAAQS

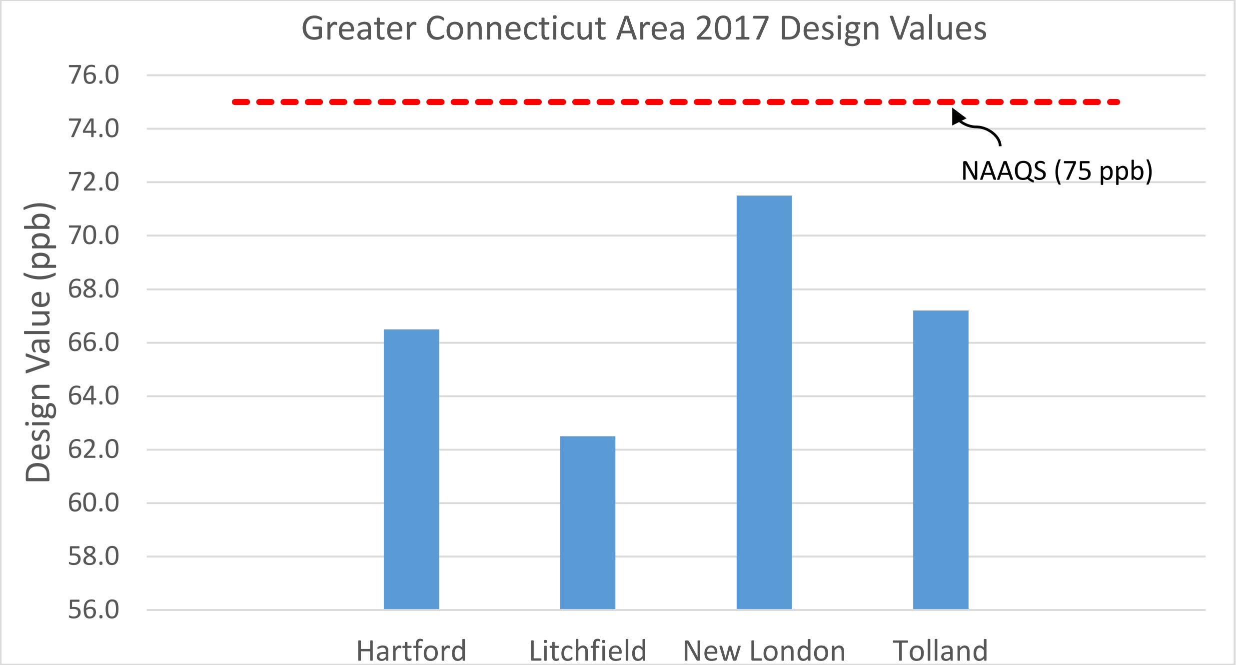
Pollutant	2017 MVEB (tons per ozone season day)
VOC	17.6
NOx	24.6

8. Attainment Demonstration

The objective of the photochemical modeling study is to enable the CT DEEP to analyze the efficacy of various control strategies, and to demonstrate that the measures adopted as part of the implementation plan will result in attainment of the 8-hour ozone standard by the end of the 2017 ozone season. EPA recommends the use of photochemical grid models for evaluating ozone control strategies. These models are complex and require significant time and resources to develop the regional scale inventories and meteorological data that are necessary for the selected episodes and scenarios modeled. Therefore, this attainment demonstration relies primarily upon EPA's July 2015 contribution modeling study used in support of the proposed update to the Cross-State Air Pollution Rule[92]. The study is described in *Air Quality Modeling Technical Support Document for the 2008 Ozone NAAQS Cross-State Air Pollution Rule Proposal* [EPA OAQPS, November 2015[93]].

The study and supporting documentation can be found at EPA's website: https://www.epa.gov/airmarkets/proposed-cross-state-air-pollution-update-rule. The relevant elements of the modeling are discussed below. The results of the study indicate design values at all monitors in the Greater Connecticut area will be in compliance with the 2008 ozone NAAQS of 75 ppb standard by 2017 (see Figure 8-1). Additional modeling further supports this conclusion and is presented in Section 8.3.

Figure 8-1. *EPA's July 2015 Transport Modeling: Projected 2017 Design Values for the Greater Connecticut Area Monitors*



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[92] At the time this proposed attainment plan was drafted, EPA's modeling for the proposed CSAPR Update rule was the only available modeling for 2017 that was fully documented. On September 7, 2016, EPA released the final CSAPR Update rule, along with updated modeling results for 2017. The OTC is currently in the process of completing 2017 modeling and documentation. Although this proposed plan relies on EPA's modeling for the proposed CSAPR modeling, both the final CSAPR Update modeling and the preliminary OTC modeling results project that 2017 design values for Greater Connecticut will be in compliance with the 2008 NAAQS.

[93] See: https://www.epa.gov/sites/production/files/2015-11/documents/air_quality_modeling_tsd_proposed_rule.pdf.

8.1 Description of Modeling Platform and Configuration

Following the recommendations outlined in EPA's *Modeling Guidance for Demonstrating Attainment of Air Quality Goals for Ozone, PM$_{2.5}$, and Regional Haze* [DRAFT, Dec. 2014], the model platform and configuration for the regional modeling conducted by EPA are described as they relate to the Greater Connecticut area.

Air Quality Model Selection

The selected model for the study was the Comprehensive Air Quality Model with Extensions (CAMx version 6.11). CAMx is a photochemical grid model capable simulating the transport and fate of ozone and its precursors on a regional scale.

Episode/Period Selection

EPA used 2011 for the base year. In selecting this period, EPA completed an extensive analysis of meteorological conditions to assure the modeling exercise simulates a variety of conditions that are generally associated with elevated ozone levels. The EPA concluded that the 2011 summer was overall warmer than normal and typical of ozone-conducive meteorological conditions for the northeast region of the country. In addition to EPA's assessment, the OTC performed an assessment which concluded that the 2011 ozone season was the best candidate for future and current modeling exercises.[94]

Modeling Domain and Grid Resolution

The modeling domain consisted of a rectangular region covering the 48 contiguous states to include portions of Canada and Mexico (see Figure 8-2). The domain was partitioned into 12 kilometer squares each with 25 vertical layers to a total height of up to approximately 17.5 kilometers. Each layer above each square grid contained appropriate hourly meteorology and emissions data. Connecticut's location is this domain is ideally situated to minimize boundary conditions and fully account for transport of ozone and precursors into the state.

Figure 8-2. *Modeling Domain in EPA's Transport Modeling*

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[94] *Future Year Modeling Base Year Analysis, Appendix I, Appendix J, OTC, 2013*

Initial and Boundary Conditions

The objective of a photochemical grid model is to estimate the air quality given a set of meteorological and emissions conditions. The winds move pollutants into, out of, and within the domain. The model handles the movement of pollutants within the domain and out of the domain. An estimate of the quantity of pollutants moving into the domain is needed. These are called boundary conditions. Similarly each grid cell throughout the domain needs initial concentration fields.

EPA used GEOS-Chem, a three-dimensional global atmospheric chemistry model, to determine boundary conditions and initial pollutant concentrations for CAMx. The CAMx model was run to simulate an additional ten days for late April to minimize the influence of the initial and boundary conditions on the model results for the period of interest, May 1 through September 30, 2011.

Meteorological Model Selection and Configuration

The meteorological data for air quality modeling of 2011 were derived from running Version 3.4 of the Weather Research Forecasting Model (WRF). The 35 vertical layers output from WRF were collapsed into the 25 vertical layers used in CAMx while maintaining thinner layers near the surface.

Emissions Inventories

EPA developed the base and future year inventories through a collaboration with the regions and states. The National Emissions Inventory (NEI) for 2011 was used for the base year and then grown and/or controlled for 2017 based on known population growth, projected industry demand, economic models, and known control strategies to be implemented by 2017.[95] CAMx requires detailed emissions inventories containing temporally allocated (i.e., hourly) emissions for each grid-cell in the modeling domain for a large number of chemical species that act as primary pollutants and precursors to secondary pollutants. Annual emission inventories for 2011 and 2017 were preprocessed into CAMx-ready, hourly gridded emission inputs using the Sparse Matrix Operator Kernel Emissions (SMOKE) modeling system. The 2011 and 2017 emissions, and associated control strategies, used by EPA in the CAMx modeling are essentially consistent with those described in Section 4 of this document.

Model Performance Evaluation

EPA evaluated model performance by comparing the observed 2011 monitored data with the model predictions. EPA concluded that the overall predictions correlated well with the observations. Data for the northeast indicate a slight over-prediction of maximum daily average 8-hour ozone concentration (MDA8) by the model (see Figure 8-3). The model performance for the Greater Connecticut area averaged over all stations performs well. The greatest bias occurs at the Fort Griswold, Groton receptor in New London county (see Figure 8-4 and Table 8-1), however still adequate and acceptable at 13%.

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[95] Preparation of Emissions Inventories for the Version 6.2, 2011 Emissions Modeling Platform (US EPA, 2015a) and 2011 National Emissions Inventory, version 2 (US EPA, 2015b).

Figure 8-3: *Density Scatter Plot of Observed vs. Modeled Maximum Daily Average 8-Hour (MDA8) Ozone Concentrations for the Northeast Portion of the Modeling Domain.*

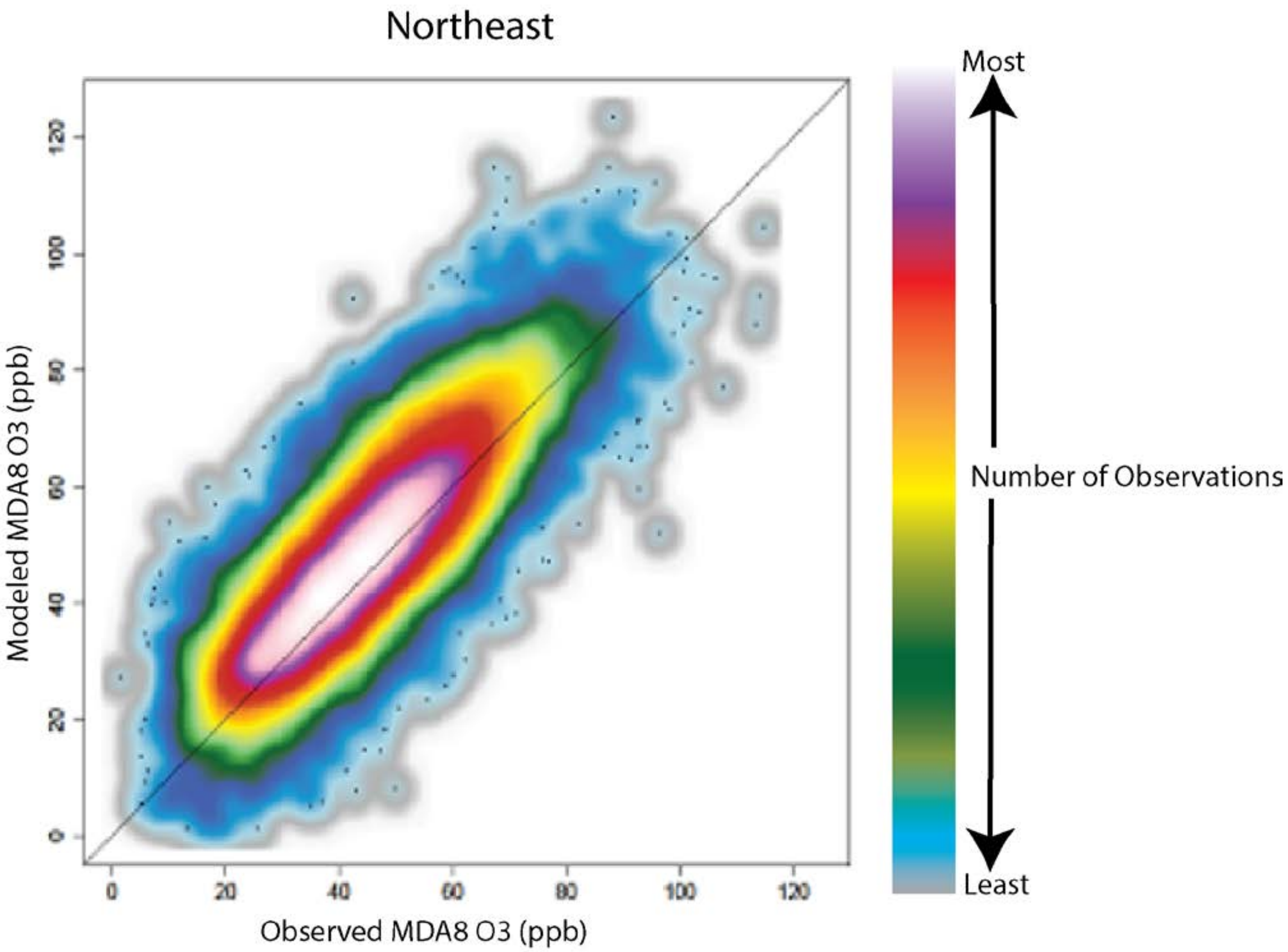

Figure 8-4. Greater Connecticut Mean Modeled and Observed Ozone Concentration

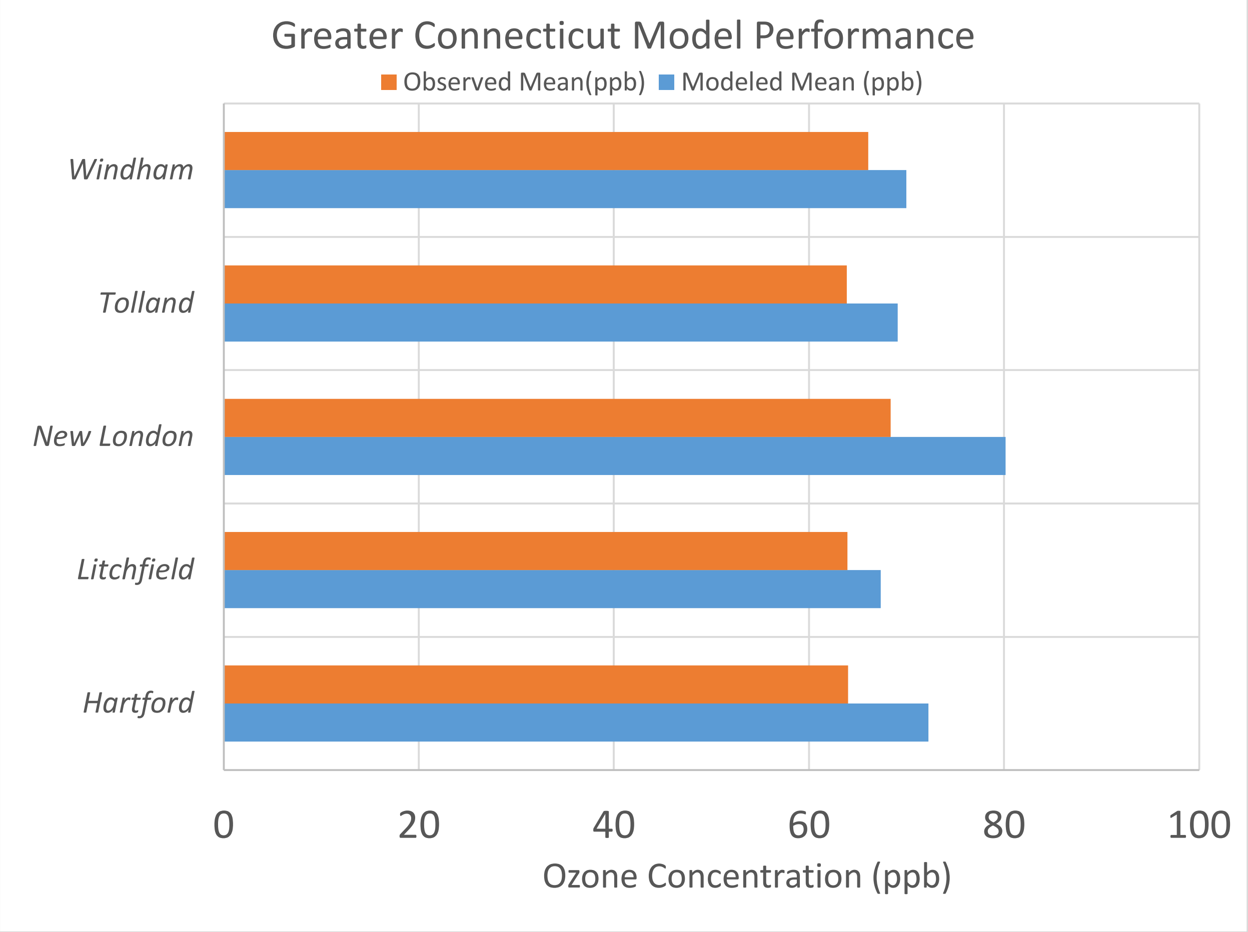

Table 8-5. Model Performance Statistics for Greater Connecticut Area Receptors

Receptor, County	Normalized Mean Bias	Normalized Mean Error
East Hartford, Hartford	5.27	12.30
Cornwall, Litchfield	1.93	10.36
Groton, New London	13.02	20.86
Stafford, Tolland	3.11	9.09
Abington, Windham	2.65	15.61

Overall, the modeling system reasonably estimates 8-hour average surface ozone throughout the Greater Connecticut area. This confidence in the modeling results allows for the modeling system to be used to support the development of emissions control scenarios to meet the 8-hour ozone NAAQS.

Modeled Attainment Test (MAT)

Consistent with EPA's guidance[96], CAMx modeled results were applied in a relative sense, assuming that measured values from the baseline period would decrease in proportion to modeled improvements between the baseline and future projection years. EPA applied the "modeled attainment test" (MAT) to each monitor using the following equation:

$$\mathbf{(DV_F)_I = (RRF)_I\,(DV_B)_I} \qquad \textbf{(MAT Equation)}$$

Where:

$(DV_F)_I$ = the estimated future design value for the year of interest, in ppb

$(DV_B)_I$ = the baseline measured concentration at site I, in ppb

$(RRF)_I$ = the relative response factor determined as the ratio of CAMx modeled results between the future year and the baseline year, calculated near site I

EPA uses a five-year weighted design value using the three design values centered about the base year. The design value for a site is the three-year average of the annual fourth highest daily maximum 8-hour average ozone concentration. The 2011 base year design value is obtained from averaging the design values for the years 2009-2011, 2010-1012 and 2011-2013. The 2017 design value is obtained by applying the appropriate RRF to the five-year weighted design value.

8.2 CAMx Model Projected Attainment

As summarized in Table 8-6, all four monitors located in the Greater Connecticut moderate nonattainment area are projected by the CAMx model to reach attainment of the 75 ppb 8-hour ozone NAAQS by 2017 (attainment is based on the 2017 projected average design value). Even the maximum predicted design values, commonly only evaluated for determining maintenance status, are compliant with the NAAQS. Therefore, the monitors in Greater Connecticut satisfy the modeled attainment test to demonstrate attainment.

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[96] *Draft Modeling Guidance for Demonstrating Attainment of Air Quality Goals for Ozone, PM2.5, and Regional Haze*, EPA, 2014.

Table 8-6. *EPA's CAMx Model Air Quality Results for Greater Connecticut*

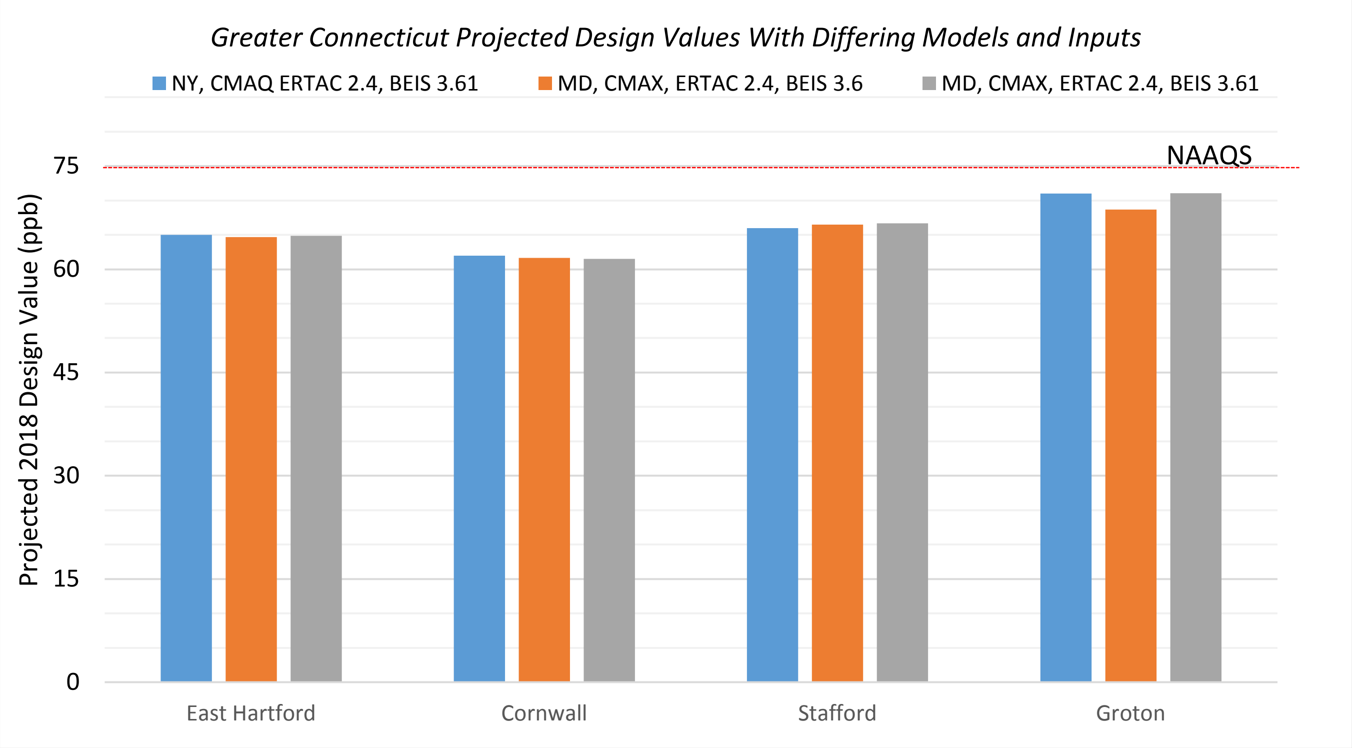
Monitor ID	County	Monitor Name	2009-2013 Average Design Value	2009-2013 Maximum Design Value	**2017 Projected Average Design Value**	2017 Projected Maximum Design Value
90031003	*Hartford*	East Hartford	73.7	75.0	**66.5**	67.7
90050005	*Litchfield*	Cornwall	70.3	71.0	**62.5**	63.1
90110124	*New London*	Fort Griswold-Groton	80.3	84.0	**71.5**	74.8
90131001	*Tolland*	Stafford	75.3	77.0	**67.2**	68.7

8.3 Corroborating Modeling Results

Air quality modeling is complex, especially when projecting to a future year. Varying inputs such as growth factors, chemistry, and predicted changes in energy dispatch can result in differing conclusions. In addition, there are different model platforms that give varying results. Therefore, CT DEEP has reviewed a variety of recent modeling in and around the attainment year to determine the confidence of the Greater Connecticut area attaining the 2008 standard in 2017 ozone season.

There are currently several ongoing modeling studies evaluating ozone transport and production to support other states' implementation plans. The New York and Maryland modeling centers have provided Connecticut with several screening level analyses for 2018 which can be used to evaluate the likelihood of attainment in the Greater Connecticut area. The New York study uses a different EPA approved photochemical model, CMAQ, with projected future year utility emissions determined by the ERTAC 2.4 model, biogenic emissions determined with BEIS version 3.61, and anthropogenic emissions based on the MARAMA inventory. Maryland used the CAMx photochemical model to compare performance of an update to the BEIS biogenic emissions model. Figure 8-7 presents the resulting design values determined using these differing modeling approaches. The results are consistent those produced by EPA for 2017 using CAMx with the IPM utility emissions model and BEIS 3.6.1, in that the projected average design values are below the NAAQS and of a similar level. Thus, results from the alternative modeling approaches further support the likelihood of attainment for the Greater Connecticut area in 2017.

Figure 8-7. *Screening Modeling Results for Greater Connecticut Area Based on Other Modeling Studies*



9. Weight of Evidence

While the modeling studies support the conclusion that the Greater Connecticut area will reach attainment with the 2008 ozone NAAQS by 2017, there is additional weight of evidence (WOE) to further support that conclusion. Several mobile source strategies and energy efficiency measures, not fully reflected in the inventories and modeling, should help to further reduce ozone concentrations. Additionally, as EPA more fully addresses ozone transport concerns and acts on Connecticut's existing and forthcoming CAA Section 126 petitions to reduce emissions from out-of-state sources, sustained compliance with the 2008 ozone standard in the Greater Connecticut area becomes more likely.

9.1 Mobile Source Initiatives

Connecticut transportation related initiatives have been established which, though not sufficient to advance the attainment date, cumulatively reduce emissions of ozone precursors. These initiatives promote clean alternatives, reduce traffic congestion, encourage carpooling and improve public transportation.

In collaboration with EPA and other states, initiatives like the Diesel Emissions Reduction Act (DERA), Lawn Equipment Exchange Fund (LEEF), SmartWay® and Electric Vehicle (EV) Connecticut help promote the early adoption of clean mobile sources.

Connecticut has made full use of all available State DERA allocations to reduce diesel emissions and improve air quality. The initial allocation made implementation of the 2007 Connecticut Clean School Bus Program possible, installing emission controls on 353 school buses from 24 school districts. In addition, DERA funds have resulted in the retrofit of 188 state trucks and 24 pieces of construction equipment. Two marine engines have been upgraded and four have been replaced with DERA funds. State DERA funds have contributed to the early replacement of 14 vehicles. In addition, FY14 State DERA funds were used to install locomotive idle reduction technology on two switch engines. Using EPA's Diesel Emission Quantifier, the projected annual NOx reductions from these projects are 125 tons/year and the lifetime reductions in NOx from these projects are projected to be over 2,300 tons.

The LEEF program provided funding from 2010 – 2012 to municipalities and school districts for the replacement of older dirtier lawn equipment. While not built into the attainment modeling demonstration the reductions achieved from this program are provide ongoing early reduction of summer day ozone precursor emissions. The program resulted in 71 municipalities and school districts exchanging their equipment.

Connecticut affiliated with EPA's Smartway® program in 2015. While currently this program's emission reductions are not enough to advance attainment, this program builds efficiencies into transportation and shipping in order to reduce emissions. Five Connecticut trucking companies have already partnered with Smartway® reducing their NOx emissions by 6.97 tons per million miles driven.

EVConnecticut is a partnership between the CT DEEP and CTDOT to introduce more electric vehicles into Connecticut. EVConnecticut has helped build the infrastructure for electric vehicles and partnerships to enhance the technology, markets and choices for electric vehicles. Using funds made available from the Regional Green House Gas Initiative (RGGI) and the settlement agreement associated with the merger of Northeast Utilities and NStar, EVConnecticut has initiated a successful program to promote increased ownership of EVs in the state, including:

- the Connecticut Hydrogen and Electric Automobile Purchase Rebate program providing rebates up to $5,000 for the purchase or lease of a new hydrogen or electric vehicle;
- an easily accessible network of over 500 public charging outlets in over 40 cities and towns across the state (see www.ct.gov/deep/evconnecticut for locations such as town halls, train stations, town centers, college campuses, auto dealers and other businesses);

- the DC Fast Charger Pilot Project which placed DC fast chargers at DOT travel plazas along main transportation corridors in the state.

Additionally, Connecticut has joined seven other states in adopting the Zero Emission Vehicle (ZEV) Memorandum of Understanding (MOU).[97] The states have set a target of 3.3 million ZEVs on the road by 2025 -- approximately 25% of projected vehicle sales.

On June 28, 2016 the U.S. government along with other complainant states and EPA entered into a partial consent decree with Volkswagen (VW) to settle litigation brought against VW for the use of defeat devices on diesel vehicles. The consent decree establishes both the "National ZEV Investment Plan" (ZEV Plan) and the "Environmental Mitigation Trust" (Trust). These two elements of the decree are likely to help improve air quality in Connecticut in the near future.

The ZEV Plan, as detailed in Appendix C of the decree, requires VW to provide $1.2 billion to areas of the United States outside of California to promote and advance the use and availability of zero emission vehicles (ZEV). The plan includes: installation of ZEV infrastructure, brand neutral education and public outreach to increase public awareness of ZEVs.

The Trust, as detailed in Appendix D of the decree, requires VW to establish a trust for environmental mitigation programs including: scrappage or repower of certain heavy duty vehicles, buses, freight switching locomotives, ferries, and airport ground support equipment, shore power projects, and installation of ZEV supply equipment. Connecticut was granted $51,635,237.63 in the initial consent decrees for these programs.

Connecticut DOT continues to implement a variety of transportation control measures (TCMs) such as telecommuting initiatives, rail and bus transit improvements, and signalization optimization projects. DOT recently completed the first phase of its CT*fastrak* system -- Connecticut's first Bus Rapid Transit system. The system began operation on March 28, 2015 and was designed to reduce congestion on Interstate-84. By March 28, 2016, CT*fastrak* surpassed its first year ridership goal of 11,180 daily passenger trips. CT DOT also plans to begin initial operation of the New Haven-Hartford-Springfield commuter rail program in 2018, providing an alternative transportation option for travellers along the Interstate-91 corridor, with connections to the existing Metro-North and Shoreline East commuter rail lines to New York City and New London, respectively, and to the Amtrak Acela high-speed rail service that serves the Northeast Corridor.

9.2 Energy Efficiency and Renewable Energy

Connecticut has been and continues to be one of the nation's leaders in promoting energy efficiency. In 2015, Connecticut was ranked 6th in the nation by the American Council for an Energy-Efficient Economy (ACEEE) for its policies supporting energy efficiency.[98] Much of the renewable energy and energy efficiency initiatives are inherent to the future year electric generation forecasts that are used in the photochemical modeling described in Section 8. Both the ERTAC and IPM models used for forecasting energy sector emissions incorporate Annual Energy Outlook (AEO) forecasts, which are fed by local ISO's regional information. ISO-New England's energy forecasts include detailed calculations of energy generation avoided due to energy efficiency programs, both on an annual and peak energy demand basis. Figure 9-1, displays the forecasted of annual energy in Connecticut with and without energy efficiency programs. Figure 9-2, displays the summer peak demand with and without energy efficiency programs. While it is complex to evaluate each program's

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[97] http://ct.gov/deep/lib/deep/air/zeroemissionvehicle_mou.pdf

[98] http://database.aceee.org/state/connecticut

avoided emissions, the projected cumulative effect on reducing the overall energy demand produces significant emission reductions.[99] Connecticut's Energy Agenda[100] outlines these future initiatives in further detail.

Figure 9-1. *Connecticut's Annual Capacity with and without Energy Efficiency Programs*

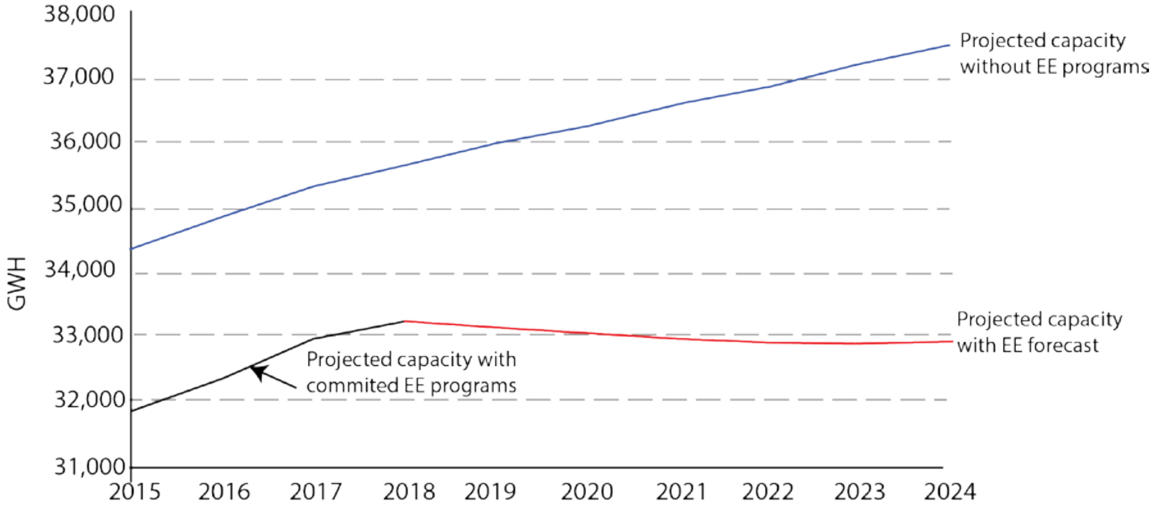
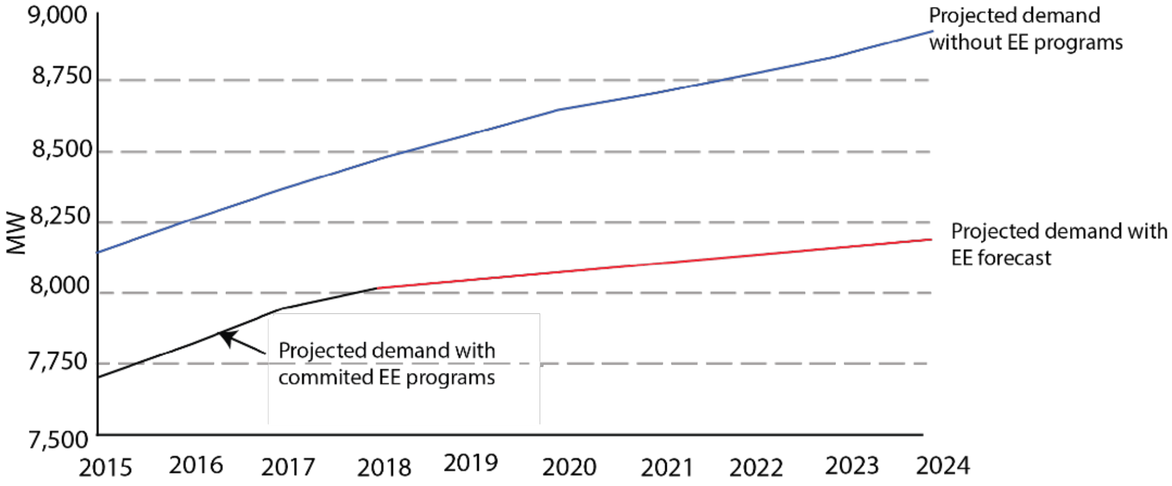


Figure 9-2. *Connecticut's Summer Peak Demand with and without Energy Efficiency Programs (90/10)*



9.3 Recent Ozone Monitoring Data

Recent monitoring data indicate that the Greater Connecticut area is very close to measuring ozone levels that are compliant with the 2008 NAAQS. Table 9-1 summarizes final ozone design values for 2014 and 2015, as well as preliminary design values for 2016. The 2016 data are based on data through September 30, 2016 that have not yet been fully quality-assured and are not certified. As of 2015, only the East Hartford and Stafford

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[99] May 1, 2015 ISO-NE Energy Efficiency Forecast for 2019-2024.

[100] http://www.ct.gov/deep/cwp/view.asp?a=4405&Q=499356&deepNav_GID=2121

sites were in violation of the 2008 NAAQS. Preliminary data for 2016 indicate that all sites may achieve compliant 2016 design values, dependent upon any final QA adjustments.

Table 9-1. Recent Ozone Design Values for Greater Connecticut Monitors

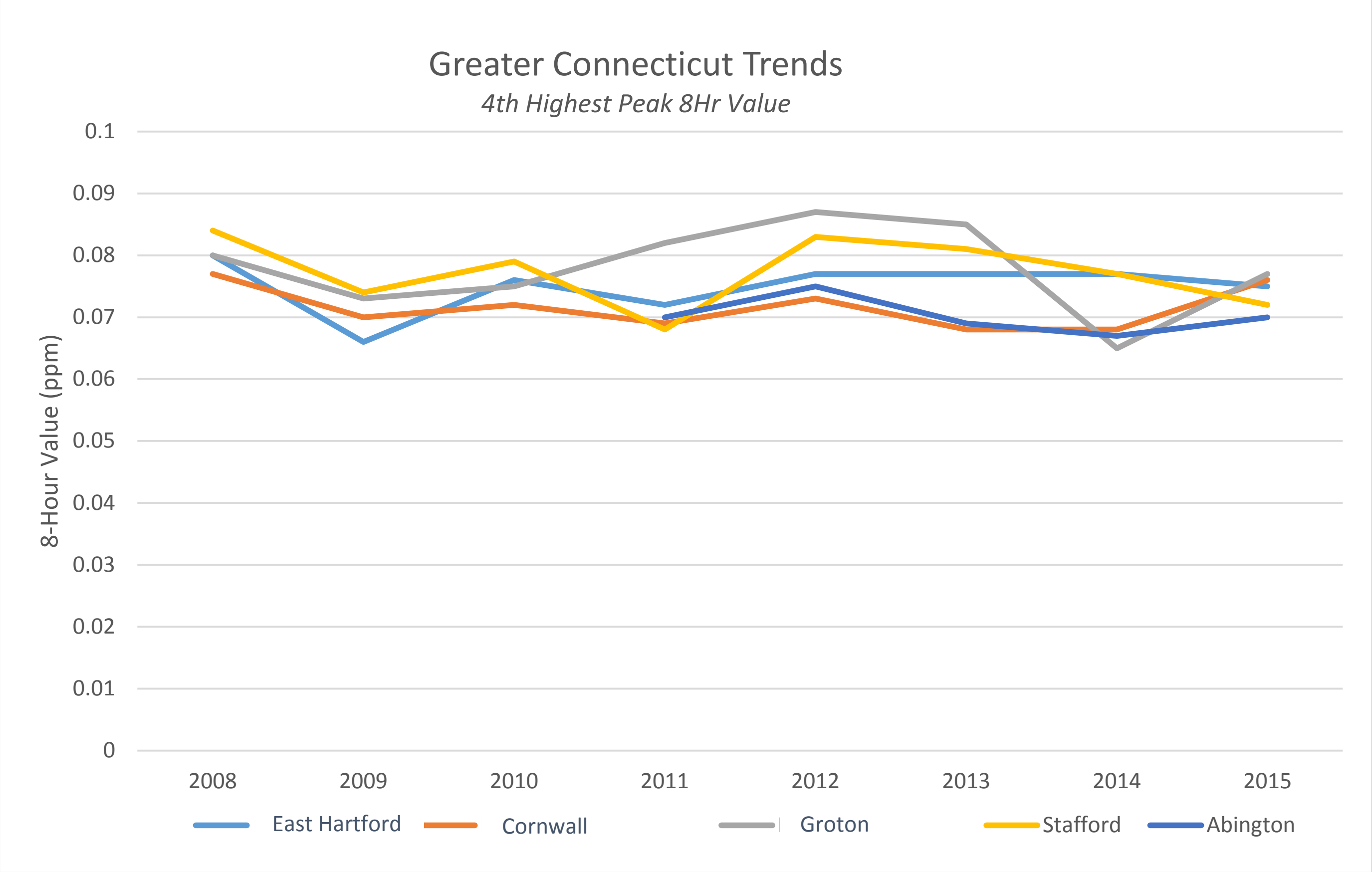
Monitor Site	2014 Design Value (ppb)	2015 Design Value (ppb)	2016 Preliminary Design Value (ppb)
Cornwall	69	70	73
East Hartford	77	76	75
Groton-Fort Griswold	79	75	72
Stafford	80	76	73
Abington	70	68	68

Table 9-2 and Figure 9-3 summarize recent 4th-highest daily 8-hour values measured at the Greater Connecticut monitors (2016 preliminary values are preliminary pending QA procedures). The table also lists the maximum 4th-high value that could occur in 2017 and still produce a 2017 design value that complies with the 2008 NAAQS. Based on the recent history of 4th-high levels, all sites appear to have a reasonable chance to achieve compliant 2017 design values. Cornwall, East Hartford and Groton are at greatest risk to fall short of measured compliance. Additional emission reductions from mobile source fleet turnover and other control strategies (e.g., CSAPR Update, CT's MWC rule) over the next year should help to reduce ozone levels, but 2017 ozone season meteorology will also play a major role in determining timely compliance.

Table 9-2. 4th-High Ozone Values for Greater Connecticut Monitors

Monitor Site	2011 4th-High Ozone Value (ppb)	2012 4th-High Ozone Value (ppb)	2013 4th-High Ozone Value (ppb)	2014 4th-High Ozone Value (ppb)	2015 4th-High Ozone Value (ppb)	2016 4th-High Ozone Value (ppb)	Max 2017 4th-High Ozone Value That Produces a Compliant 2017 Design Value (ppb)
Cornwall	69	73	68	66	76	78	73
East Hartford	72	77	77	77	75	75	77
Groton-Fort Griswold	82	87	85	65	77	75	75
Stafford	68	83	81	77	72	72	83
Abington	70	75	69	67	70	68	89

Figure 9-3. *Trends of 4th-High Ozone Levels at Greater Connecticut Monitors*



10. Contingency Measures

Section 172(c)(9) of the CAA requires ozone attainment plans to include contingency measures to be implemented should an area fail to achieve the required reductions for Reasonable Further Progress or fail to attain the NAAQS by the deadline. The implementation rule specifies that the contingency measures in each case should provide for an additional 1-year's worth of progress (i.e., 3% reduction in VOC and/or NOx emissions), relative to the base year inventory. These measures must be submitted for approval into the SIP as adopted measures that would take effect without further rulemaking action upon a determination by EPA that an area failed to meet the applicable RFP milestone or failed to attain by the required deadline. EPA allows the use of federal measures that provide ongoing reductions into the future (e.g., motor vehicle and non-road engine standards) to be used meet contingency measure requirements.

CT DEEP has elected to meet both the RFP and failure to attain contingency requirements with NOx emission reductions. Table 10-1 summarizes the calculation of the required contingency measure emission reductions. Based on the total Greater Connecticut NOx emissions of 91.9 tons/ozone season day (from Section 4), each contingency measure must provide at least 2.8 tons/ozone season day of NOx reductions to meet the requirements.

Table 10-1. *Calculation of Necessary NOx Emission Reductions to Satisfy Contingency Measure Requirements for the Greater Connecticut Nonattainment Area*

2011 Base Year Inventory Total NOx Emissions (tons/ozone season day)	3% Contingency Measure Requirement (tons/ozone season day)
91.9	2.8

Details regarding the specific control measures selected to meet the contingency plan requirements for RFP and failure-to-attain are described below.

10.1 RFP Contingency Measure

As indicated above, the RFP contingency plan must identify control measures sufficient to secure an additional 3% reduction in ozone precursor emissions beyond the 15% RFP reduction required to be achieved by 2017 in moderate 8-hour ozone nonattainment areas. The RFP contingency requirement may be met by including in the SIP a demonstration of at least 18% RFP between 2011 and 2017 and specifying which control measures capable of providing the excess reduction are to be used for the contingency plan.

As previously described in Section 5 (see Table 5-3), control programs implemented in the Greater Connecticut nonattainment area are projected to provide 28% surplus of NOx reductions and 15% surplus of VOC reductions compared to the 2017 RFP requirement. Excess reductions of both precursor pollutants far exceed the additional 3% reduction called for by the RFP contingency requirement. As a result, any combination of adopted SIP measures providing a 3% VOC and/or NOx reduction can satisfy the RFP contingency requirement.

Connecticut's RFP contingency plan requirement will be met by using a portion of the projected NOx emission reductions occurring between 2011 and 2017 from federal standards for non-road engines and equipment. Table 10-2 summarizes emissions estimates from non-road equipment determined using EPA's MOVES2014a model, as was described in Section 4. The modeled NOx reductions of 6.6 tons/ozone season day in 2017 exceed the RFP contingency measure requirement of 2.8 tons/ozone season day; therefore, the requirement is satisfied.

Table 10-2. *RFP Contingency Measure Demonstration for the Greater Connecticut Area*

2011 MOVES2014a* Non-Road NOx Emissions (tons/ozone season day)	2017 MOVES2014a* Non-Road NOx Emissions (tons/ozone season day)	2011 – 2017 Non-Road NOx Reductions (tons/ozone season day)	Required RFP Contingency Reduction (tons/ozone season day)
19.1	12.5	6.6	2.8

* EPA's NONROAD model, which is included within the MOVES2014a model, calculates emissions for all non-road categories, except for commercial marine, aircraft/ground support equipment and rail locomotives.

10.2 Failure to Attain Contingency

The failure-to-attain contingency plan must identify control measures sufficient to secure an additional 3% reduction in ozone precursor emissions should a moderate nonattainment area fail to attain the 8-hour ozone NAAQS by the July 2018 required attainment date. EPA will determine each moderate area's attainment status by early in 2019, using 2017 ozone design values. If EPA determines that an area has failed to attain, the contingency plan would be triggered for implementation beginning with the 2019 ozone season. Therefore, additional emission reductions occurring during the 2017 to 2019 period can be used to meet the failure to attain contingency requirement.

Connecticut's failure-to-attain contingency plan requirement will be met by using a portion of the expected emission reductions occurring from federal and state measures tightening engine and fuel standards for on-road vehicles between 2017 and 2019. As more fully described in Section 4, these adopted programs will continue to provide an increasing level of VOC and NOx emission reductions through 2017 and beyond. Table 10-3 summarizes NOx emission estimates for on-road vehicles, as determined using EPA's MOVES2014a model. Interpolated emission reductions for 2019 are also included, and compared to the 3% contingency requirement. The NOx emission reductions of 3.7 tons/ozone season day exceed the failure-to-attain contingency requirement of 2.8 tons/ozone season day, therefore the requirement is satisfied.

Table 10-3. *Failure-to-Attain Contingency Measure Demonstration for the Greater Connecticut Area*

2017 MOVES2014a On-Road NOx Emissions (tons/ozone season day)	2020 MOVES2014a On-Road NOx Emissions (tons/ozone season day)	2017-2020 On-Road NOx Reductions (tons/ozone season day)	2017-2019 Interpolated On-Road NOx Reductions (tons/ozone season day)	Required Failure-to-Attain Contingency Reduction (tons/ozone season day)
22.6	17.1	5.5	3.7	2.8