5.0 ATTAINMENT DEMONSTRATION

5.1 Introduction

As discussed in Section 1.1, states are required to submit State Implementation Plans (SIPs) that contain attainment demonstrations for their 8-hour ozone nonattainment areas within 3 years after the effective date of an area's nonattainment designation. The designation date for both the Northern New Jersey/New York/Connecticut (NNJ/NY/CT) nonattainment area and the Southern New Jersey/Philadelphia (SNJ/Phila.) nonattainment area was June 15, 2004. These SIPs must demonstrate that the measures and rules contained within them are adequate to provide for the timely attainment and maintenance of the 8-hour ozone National Ambient Air Quality Standard (NAAQS) of 0.08 ppm. In accordance with 40 C.F.R. §51.112, each demonstration must include:

- A summary of the computations, assumptions, and judgments used to determine the degree of reduction of emissions (or reductions in the growth of emissions) that will result from the implementation of the control strategy;
- A presentation of emission levels expected to result from implementation of each measure of the control strategy;
- A presentation of the air quality levels expected to result from implementation of the overall control strategy showing expected maximum pollutant concentration;
- A description of the dispersion models used to project air quality and to evaluate control strategies; and
- For interstate regions, the analysis from each constituent State must, where practicable, be based upon the same regional emission inventory and air quality baseline.

According to the United States Environmental Protection Agency (USEPA) guidance,[1] areas that have an attainment date of no later than June 15, 2010, must implement the emission reductions needed for attainment no later than the beginning of the 2009 ozone season (June 2009). Otherwise the emission reductions will not affect the monitored ozone in 2009, which is the last ozone season before the attainment date of June 15, 2010.

Chapter 4 discussed and summarized New Jersey and regional efforts to identify control measures. This Chapter identifies those control measures used to demonstrate

[1] The USEPA finalized modeling guidance for 8-hour ozone attainment demonstrations in October of 2005 but subsequently incorporated the ozone guidance in the final 2007 guidance for regional haze and $PM_{2.5}$:
USEPA. Guidance on the Use of Models and Other Related Analyses in Attainment Demonstrations for the 8-Hour Ozone NAAQS. United States Environmental Protection Agency, Office of Air Quality Planning and Standards, Emissions, Monitoring, and Analysis Division, Air Quality Modeling Group, Research Triangle Park, NC, EPA-454/R-05-002, October 2005.
USEPA. Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, PM2.5, and Regional Haze. United States Environmental Protection Agency, Office of Air Quality Planning and Standards, Air Quality Analysis Division, Air Quality Modeling Group, Research Triangle Park, NC, EPA-454/B-07-002, April 2007.

attainment, and Chapter 11 provides for contingencies in the event of a nonattainment area's failure to reach either Reasonable Further Progress or attainment milestones. This Chapter presents the State's analyses of the impact that the implementation of the control measures identified for attainment and contingency, in combination with existing and already on the way measures, would have on the State's air quality by the summer of 2009.

New Jersey uses a comprehensive approach to this attainment demonstration. This approach considers the cumulative body of science and is comprised of numerous technical tools, including rigorous data analysis, observations and modeling. The net result of applying this comprehensive approach is that the Northern New Jersey/New York/Connecticut and Southern New Jersey/Philadelphia nonattainment areas are projected to attain the 8-hour ozone NAAQS by 2010. In addition, there are supplemental analyses to support this conclusion. These supporting analyses and data include a modeling analysis for 2012, which predicts even lower 8-hour ozone values in each of the nonattainment areas by that year. This is also relevant since the USEPA is considering revisions to the 8-hour ozone standard that would make it more stringent, thereby requiring greater emission reductions in the nonattainment areas. The remainder of this chapter outlines the photochemical modeling results and comprehensive analysis of those results on which New Jersey bases its attainment demonstration.

5.2 Photochemical Modeling

5.2.1 Introduction

The Clean Air Act requires that states use "…photochemical grid modeling or any other analytical method determined by the [USEPA] Administrator... to be at least as effective [as photochemical grid modeling]" as part of their demonstration of attainment of the ozone health-based standard by the required attainment date.[2] As such, New Jersey's attainment demonstrations for both Northern New Jersey/New York/Connecticut and the Southern New Jersey/Philadelphia nonattainment areas include photochemical grid modeling, supplemented by other analytical methods, to demonstrate attainment of the 8-hour ozone health-based standard by 2010. This approach is consistent with the USEPA's final guidance on modeling for 8-hour ozone attainment demonstrations.[3]

The objective of the photochemical modeling test is to enable New Jersey, in coordination with the other state and local agencies within its multi-state nonattainment areas,[4] to analyze the efficacy of various control strategies in reducing air pollution.

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[2] 42 U.S.C. § 7511a(c)(2)(A) (see also 40 C.F.R. §51.908(c)).

[3] USEPA. Guidance on the Use of Models and Other Related Analyses in Attainment Demonstrations for the 8-Hour Ozone NAAQS. United States Environmental Protection Agency, Office of Air Quality Planning and Standards, Emissions, Monitoring, and Analysis Division, Air Quality Modeling Group, Research Triangle Park, NC, EPA-454/R-05-002, October 2005.

[4] Delaware Department of Natural Resources and Environmental Control, Pennsylvania Department of Environmental Protection, the Philadelphia Air Management Services, and the Maryland Department of the Environment for the Southern New Jersey/Philadelphia nonattainment area and New York Department of

The Ozone Transport Commission (OTC) on behalf of its member states (which include New Jersey, New York, Connecticut, Maryland, Delaware, and Pennsylvania) undertook a photochemical modeling study to demonstrate compliance with the 8-hour ozone NAAQS for their multi-state nonattainment areas. The OTC Modeling Committee, which consisted of the following workgroups, directed the 8-hour ozone attainment modeling study: OTC Photochemical Workgroup, OTC Meteorological Modeling Workgroup, OTC Emissions Inventory Development Workgroup, and the OTC Control Strategy Workgroup. The emissions inventory work was performed in conjunction with MANE-VU. The OTC Air Directors served on the OTC Oversight Committee and provided oversight of the process. The remainder of this section discusses the model used in this regional modeling analysis, the specific modeling parameters, including inventory development, and the results of that modeling exercise.

5.2.2 "One-Atmosphere" Air Quality Model

The photochemical model selected for the attainment modeling demonstration was the USEPA's Models-3/Community Multi-scale Air Quality (CMAQ) modeling system. Under the direction of the OTC Modeling Committee, several states and modeling centers performed the regional modeling runs and/or contributed to the preparation of technical information for the regional modeling effort. Those organizations included:

1) the New York State Department of Environmental Conservation (NYSDEC),
2) the Ozone Research Center at University of Medicine & Dentistry of NJ/Rutgers University,
3) the University of Maryland,
4) the Virginia Department of Environmental Quality,
5) the Northeast States for Coordinated Air Use Management (NESCAUM)
6) the Maryland Department of the Environment,
7) the New Hampshire Department of Environmental Services, and
8) the Mid-Atlantic Regional Air Management Agency (MARAMA).

The lead agency for coordinating the running of the CMAQ model and performing the modeling runs for the OTC was the NYSDEC.[5] The NYSDEC ran the CMAQ model using the protocol in Appendix D1, and was responsible for post-processing the results, including calculating the projected ozone concentrations using the relative response factor (RRF) method specified in the USEPA's Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, $PM_{2.5}$, and Regional Haze (April 2007) (hereafter referred to as the Modeling Guidance), included in Appendix D2-2.

The CMAQ modeling system was selected for the attainment demonstration primarily because it is a photochemical grid model capable of modeling a variety of pollutants over a range of time and space scales, i.e. a "one-atmosphere" photochemical grid model. Not

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Conservation and the Connecticut Department of Environmental Protection for the Northern New Jersey/New York/Connecticut nonattainment area.

[5] New Jersey wishes to thank the NYSDEC for its leadership in the regional modeling effort.

only was CMAQ used to model ozone, but it is also being used to model particles with an aerodynamic diameter less than or equal to a nominal 2.5 micrometers ($PM_{2.5}$) and Regional Haze in the Northeast. The model is also recommended in the USEPA's Modeling Guidance. All the regional modeling was conducted in accordance with the USEPA's Modeling Guidance.

The CMAQ model requires specific inputs, including meteorological information and emissions information. The remainder of this section discusses, in general, the needed data inputs for the CMAQ model, the particular parameters of the CMAQ model chosen for the OTC modeling runs, and the validation of the CMAQ model for use in the OTC regional modeling effort. For more specific information, see Appendices G and I.

5.2.2.1 Meteorology Data

As explained in the USEPA's Emission Inventory Guidance,[6] 2002 was designated as the base year for 8-hour ozone and $PM_{2.5}$ SIPs and regional haze plans; therefore, wherever possible, 2002 was used for baseline modeling for the 8-hour ozone standard. The Pennsylvania State University/National Center for Atmospheric Research Mesoscale Meteorological Model (MM5) version 3.6 was used to generate the annual 2002 meteorology for the OTC modeling analysis. The MM5 model is a non-hydrostatic, prognostic meteorological model routinely used for urban- and regional-scale photochemical regulatory modeling studies. Professor Da-Lin Zhang (University of Maryland) performed the MM5 modeling for the OTC in consultation with the NYSDEC and Maryland Department of the Environment staff. The analyses showed that in general, the performance of the MM5 is reasonable both at the surface and in the vertical, thereby providing confidence in the use of these data in the CMAQ simulations. The documents supporting the MM5 modeling analysis are provided in Appendix D4. Based on model validation and sensitivity testing, the model results met the evaluation criteria and the MM5 configurations were used for the regional modeling effort.

5.2.2.2 Regional Emission Inventories

Both the nonattainment areas associated with New Jersey have an attainment date of no later than June 15, 2010. Since June 15th is early in the 2010 ozone season, attainment must be demonstrated for the last full ozone season; in this case the 2009 ozone season.[7] Emission reductions, therefore, need to be implemented no later than the beginning of the 2009 ozone season. As such, the attainment modeling run is designed to show the incremental emission reductions associated with the implementation of control measures between the base year (2002) and the "attainment" year (2009).

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[6] USEPA. Emissions Inventory Guidance for Implementation of Ozone and Particulate Matter National Ambient Air Quality Standards (NAAQS) and Regional Haze Regulations. United States Environmental Protection Agency, Emissions Inventory Group, Emissions, Monitoring, and Analysis Division, Office of Air Quality Planning and Standards, Research Triangle Park, NC, EPA-454/R-05-001, August 2005, updated November 2005.

[7] Success will be judged by three years of data, i.e., 2007, 2008, and 2009, to calculate the 2009 design value.

To complete this modeling exercise, two regional emission inventories were developed to represent the 2002 base case and the 2009 control case. In addition, two other future control case emission inventories (for 2012 and 2018, respectively) were developed simultaneous with the 2009 control case emission inventory to allow for additional modeling exercises. These future year emission inventories were developed by projecting the 2002 base year emissions inventory using standard emissions projection techniques discussed in Appendices D3-1, D5, and D6. These future year emission inventories include emissions growth due to projected increases in economic activity as well as the emissions reductions due to the implementation of control measures. All of the regional emission inventories in this chapter are hereafter referred to as the modeling inventories.

The 2002 emissions were first generated by the individual Ozone Transport Region states. MARAMA then coordinated and quality assured the 2002 inventory data, and projected it for the relevant control years. The 2002 emissions for non-Ozone Transport Region areas within the modeling domain were obtained from other Regional Planning Organizations for their corresponding areas. These Regional Planning Organizations included the Visibility Improvement State and Tribal Association of the Southeast (VISTAS), the Midwest Regional Planning Organization and the Central Regional Air Planning Association. The documentation for the OTC base and control modeling inventories are presented in Appendices D7 and D8, respectively. The use of emission inventory data from the non-Mid-Atlantic/Northeast Visibility Union (MANE-VU) states is documented in Appendix D8.

As discussed in detail in Chapter 4, the OTC member states selected several control strategies for inclusion in the attainment demonstration modeling. These strategies were selected from groups of measures developed by the technical subcommittees responsible for identifying and developing the regulations and/or control measures. Consideration was given to maintaining consistency with control measures likely to be implemented in other Regional Planning Organizations. Emission reduction requirements mandated by the Clean Air Act were also included in projecting future year emissions. Additional information on the emissions used in future year modeling is provided in Appendices D8 and D9. The following sections provide a more detailed discussion of base and control inventories used in the regional modeling:

5.2.2.2.1 Base Emission Inventory

Version 3 of the 2002 base year emission inventory was used in the regional modeling exercises. A technical support document for this inventory, which is included in Appendix D7, explains the data sources, methods, and results for preparing this version of the 2002 base year criteria air pollutant and ammonia emissions inventories for point, area, onroad, nonroad, and biogenic sources for the MANE-VU Regional Planning Organization. In addition to relying on this base inventory for ozone SIP-related activities, the MANE-VU states will use this base inventory to support air quality modeling, control measure development, and implementation activities for the upcoming Regional Haze Rule and $PM_{2.5}$ SIP efforts.

The inventory and supporting data prepared includes the following:

1) Comprehensive, county-level, mass emissions and modeling inventories for 2002 emissions for criteria air pollutants and ammonia for the State and Local agencies included in the MANE-VU region;
2) The temporal, speciation, and spatial allocation profiles for the MANE-VU region inventories;
3) Inventories for wildfires, prescribed burning, and agricultural field burning for the southeastern provinces of Canada; and
4) Inventories for other Regional Planning Organizations, Canada, and Mexico.

The mass emissions inventory files were converted to the National Emissions Inventory Input Format Version 3.0. As discussed in greater detail in Section 5.2.2.3, the modeling inventory files were processed in Sparse Matrix Operator Kernel Emissions/Inventory Data Analyzer (SMOKE).

The inventories include annual emissions for oxides of nitrogen (NO_x), volatile organic compounds (VOC), carbon monoxide, ammonia, particles with an aerodynamic diameter less than or equal to a nominal 10 micrometers (PM_{10}) and $PM_{2.5}$. The inventories also included summer day, winter day, and average day emissions. However, not all states included daily emissions in their inventories. In these instances, temporal profiles prepared for this project were used to calculate daily emissions.

Work on Version 1 of the 2002 MANE-VU inventory began in April 2004. The consolidated inventory for point, area, onroad, and nonroad sources was prepared by starting with the inventories that MANE-VU state/local agencies submitted to the USEPA from May through July of 2004 as a requirement of the Consolidated Emissions Reporting Rule. The USEPA's format and content quality assurance (QA) programs (and other QA checks not included in USEPA's QA software) were run on each inventory to identify format and/or data content issues.[8] A contractor, E.H. Pechan & Associates, Inc. (Pechan), worked with the MANE-VU state/local agencies and the MARAMA staff to resolve QA issues and augment the inventories to fill data gaps in accordance with the Quality Assurance Project Plan prepared for this project.[9] The final inventory and SMOKE input files were finalized during January 2005.

Work on Version 2 (covering the period from April through September 2005) involved incorporating revisions requested by some MANE-VU state/local agencies on the point, area, and onroad inventories. Work on Version 3 (covering the period from December 2005 through April 2006) included additional revisions to the point, area, and onroad inventories as requested by some states. Thus, the Version 3 inventory for point, area, and onroad sources were built upon Versions 1 and 2. This work also included

[8] USEPA. Basic Format & Content Checker 3.0 (Formerly known as the Quality Assurance / Quality Control Software 3.0) - March 2004; Extended Quality Control Tool - Updated May 18, 2004. United States Environmental Protection Agency, 2004.
[9] MANE-VU. Quality Assurance Project Plan (QAPP) for Area and Point Source Emissions Modeling Inventory Project, Final. Prepared for the Mid-Atlantic/Northeast Visibility Union by E.H. Pechan & Associates, Inc. and Carolina Environmental Program, August 3, 2004.

development of the biogenics inventory. In version 3, the nonroad inventory was completely redone because of changes that the USEPA made to the NONROAD2005 model.

5.2.2.2.2 Emission Control Inventories

An inventory technical support document for these future inventories is included in Appendix D8-2 and explains the data sources, methods, and results for future year emission forecasts for three years; three emission sectors; two emission control scenarios; seven pollutants; and eleven states plus the District of Columbia. The following is a summary of the future year inventories that were developed:

- The three projection years are 2009, 2012, and 2018;
- The three source sectors are non-Electric Generating Units (non-electrical generating units (EGUs)) point sources, area sources, and nonroad mobile sources. Under separate efforts, MANE-VU prepared EGU projections using the Integrated Planning Model and onroad mobile source projections using the SMOKE emission modeling system. The documentation for those efforts is included in Appendix D8-1.
- The two emission control scenarios are:
  a) a combined "on-the-books/on-the-way" (OTB/W) control strategy accounting for emission control regulations already in place, as well as some emission control regulations that are not yet finalized but are likely to achieve additional reductions by 2009 (i.e., adoption of the six shortfall measures by states outside the core Ozone Transport Region states); and
  b) a beyond on the way (BOTW) scenario to account for controls from potential new regulations that may be necessary to meet attainment and other regional air quality goals.
- The inventories were developed for seven pollutants, which are sulfur dioxide, NO_x, VOCs, carbon monoxide, $PM_{10\text{-}Primary}$ (sum of the filterable and condensable components), $PM_{2.5\text{-}Primary}$ (sum of the filterable and condensable components), and ammonia.
- The states are those that comprise the MANE-VU region. In addition to the District of Columbia, the 11 MANE-VU states are Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont.

5.2.2.3 Emissions Processor Selection and Configuration

The SMOKE Processing System was selected for the OTC modeling analysis. SMOKE is principally an emissions processing system, as opposed to a true emissions inventory preparation system, in which emissions estimates are simulated from "first principle". This means that, with the exception of mobile and biogenic sources, its purpose is to provide an efficient, modern tool for converting emissions inventory data into the formatted emissions files required for a photochemical air quality model.

Inside the Ozone Transport Region, the modeling inventories were processed by the NYSDEC using the SMOKE (Version 2.1) processor to provide inputs for the CMAQ model. Wherever possible, the mobile source emission inventories (in vehicles miles traveled format) were replaced with source classification code specific county level emissions to more accurately reflect actual emissions for typical ozone season day. In addition, NESCAUM provided the mobile source files processed through SMOKE.

A detailed description of all SMOKE input files such as area, mobile, fire, point and biogenic emissions files and the SMOKE model configuration are provided in Appendices D3-1, D5, and D6**.**

5.2.2.4 Regional Modeling Coordination

The CMAQ model was installed at all participating modeling centers and diagnostic tests were run to insure that the model was operating as designed. In addition, the CMAQ model was benchmarked against other modeling platforms to ensure similar results. The OTC modeling committee oversaw the modeling effort and reported to the OTC Oversight Committee through regular briefings and presentations, and when needed offered additional information in cases where specific technical decisions had policy implications. The New Jersey Department of Environmental Protection (NJDEP) participated as a member of the various OTC committees.

5.2.2.5 Domain and Data Base Issues

5.2.2.5.1 Episode Selection

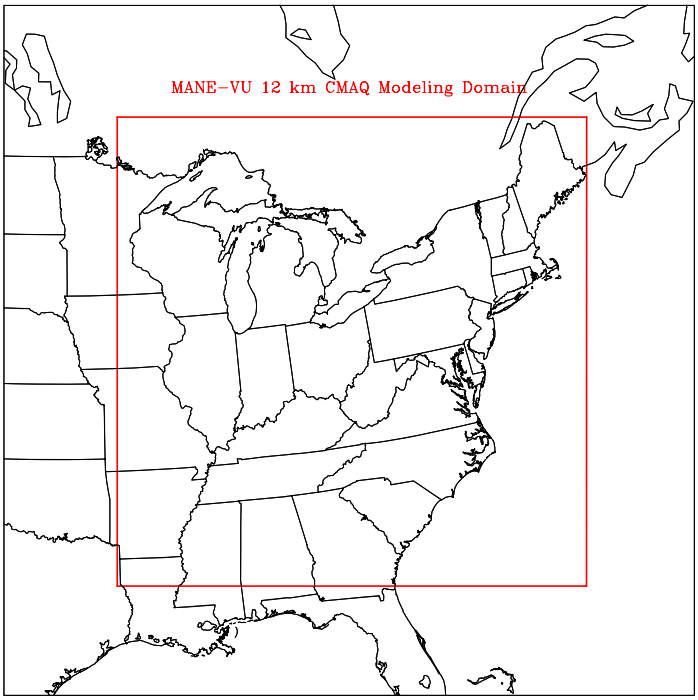
The entire ozone season was simulated for the 2002 and 2009 (with 2002 meteorology conditions) modeling runs (May 1 to September 30). As a result, the total number of days examined for the complete ozone season far exceeds the USEPA Modeling Guidance, and provides for better assessment of the simulated pollutant fields.

5.2.2.5.2 Size of the Modeling Domain

In defining the modeling domain, one must consider the location of the local urban area, the downwind extent of the elevated ozone levels, the location of large emission sources, and the availability of meteorological and air quality data. The domain or spatial extent to be modeled includes as its core the nonattainment area. Beyond this, the domain includes enough of the surrounding area such that major upwind sources fall within the domain and the emissions produced in the nonattainment area remain within the domain throughout the day.

Figure 5.1 shows the OTC modeling boundaries. This domain covers the Northeast region, including the Northeastern, Central and Southeastern United States as well as Southeastern Canada. The final SIP modeling analysis utilized this modeling domain. Further discussion of the OTC modeling domain selection is provided in Appendices D3-1 and D3-6.

Figure 5.1: MANE-VU 12-Kilometer CMAQ Modeling Domain



5.2.2.5.3 Horizontal Grid Size

The basic CMAQ modeling platform utilized a 36 km horizontal grid resolution for the continental United States domain. A larger domain was selected for the MM5 simulations to provide a buffer of several grid cells around each boundary of the CMAQ 36 km domain. This was designed to minimize any errors in the meteorology from boundary effects. A 12 km inner domain was selected to better characterize air quality in the Ozone Transport Region and surrounding Regional Planning Organization regions. The horizontal grid definitions for the CMAQ and MM5 modeling domains are contained in Appendices D3-1, D3-4, D4-1, and D4-5.

5.2.2.5.4 Vertical Resolution

The vertical grid used in the CMAQ modeling was primarily defined by the MM5 vertical structure. The MM5 model employed a terrain following coordinate system defined by atmospheric pressure. The layer averaging scheme adopted for CMAQ is designed to reduce the computational cost of the CMAQ simulations, therefore only the uppermost layers of the CMAQ domain were coalesced. All layers in the planetary boundary layer were left undisturbed in moving from the MM5 to the CMAQ simulation. This ensures that the near-surface processes that affect air pollution the most are represented realistically in CMAQ, while the meteorological systems that are driven by upper level winds are allowed to develop properly in MM5. The effects of layer averaging have a relatively minor effect on the model performance metrics when

compared to ambient monitoring data. The vertical layer definitions other details related to the MM5 and CMAQ modeling domains are contained in Appendices D3-1, D3-5, D4-1, and D4-6.

5.2.2.5.5 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. When initializing a modeling simulation, the exact concentration fields are not known in every grid cell for the start time. Therefore, typically photochemical grid models begin with clean conditions within the domain and are allowed to stabilize before the period of interest is simulated. In practice this is accomplished by starting the model several days prior to the period of interest; this is called spin-up time.

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 concentration of pollutants at the edge of the domain, and therefore the quantity of pollutants moving into the domain, is needed as an input to the model. These are called boundary conditions. The 12 km grid boundary conditions were extracted from the 36 km CMAQ simulation. To estimate the boundary conditions for the modeling study, boundary conditions for the outer 36 km domain were derived every three hours from an annual model run performed by researchers at Harvard University using the GEOS-CHEM global chemical transport model.[10,11]

The influence of initial conditions was minimized by using a 15-day spin-up period, which is sufficient to establish pollutant levels that are encountered in the Eastern United States. Additionally, the predominate winds flow from west to east, thus New Jersey is not influenced by nearby boundary conditions. Additional information on the extraction of boundary conditions is provided in Appendix D3-6.

5.2.2.6 Quality Assurance

All the air quality, emissions, and meteorological data within the MANE-VU Regional Planning Organization used in the regional modeling effort were reviewed to ensure completeness, accuracy, and consistency before proceeding with modeling. Any errors, missing data or inconsistencies, were addressed using appropriate methods that are consistent with standard practices. All modeling was benchmarked through the duplication of a set of standard modeling results across different modeling centers. Emissions inventories obtained from the other Regional Planning Organizations were examined to check for errors in the emissions estimates. When such errors were

[10] Moo, N. and Byun, D. A Simple User's Guide For "geos2cmaq" Code: Linking CMAQ with GEOS-CHEM. Version 1.0. Institute for Multidimensional Air Quality Studies (IMAQS). University of Houston, Houston, Texas, 2004.

[11] Baker, K. Model Performance for Ozone in the Upper Midwest over 3 Summers. Presentation given at the Lake Michigan Air Directors Consortium, 2005 AWMA Annual Conference, Minneapolis, MN, June 24, 2005.

discovered, the problems in the input data files were corrected, and the models were run again.

The CMAQ air quality model inputs and outputs were plotted and examined to ensure sufficiently accurate representation of the observed data in the model ready fields, and temporal and spatial consistency and reasonableness. The CMAQ model underwent operational and scientific evaluations in order to facilitate the quality assurance review of the meteorological and air quality modeling procedures and are discussed in greater detail in Section 5.2.2.7.

5.2.2.7 Model Performance Evaluation

The first step in the modeling process is to verify the model's performance in terms of its ability to predict ozone and precursor concentration fields in the right locations and at the right levels. To do this, model predictions for the base year simulation are compared to the actual ambient data observed in the historical episode. This verification is a combination of statistical and graphical evaluations. If the model appears to be predicting ozone in the right locations for the right reasons, then the model can be used as a predictive tool to evaluate various control strategies and their effects on ozone. The purpose of the model performance evaluation is to assess how accurately the model predicts ozone levels observed in the historical episode and to use the knowledge of CMAQ's performance to put CMAQ's predictions of future year air quality in the appropriate context so that future policy decisions are informed by CMAQ's predictions and its performance.

The results of a model performance evaluation were examined prior to using CMAQ's results to support the attainment demonstration. The performance of CMAQ was evaluated using both operational and diagnostic methods. Operational evaluation refers to the model's ability to replicate observed concentrations of ozone and/or precursors (surface and aloft), whereas diagnostic evaluation assesses the model's accuracy with respect to characterizing the sensitivity of ozone to changes in emissions (i.e., relative response factors).

The NYSDEC conducted a performance evaluation of the 2002 base case CMAQ simulation (May 15-September 30) on behalf of the Ozone Transport Region member States. Appendix D10 provides comprehensive operational and diagnostic evaluation results, including spreadsheets containing the assumptions made to compute statistics. Highlights of this evaluation are summarized in Section 5.2.2.7.1.

5.2.2.7.1 Summary of Model Performance

The CMAQ model was employed to simulate ozone for the full 2002 ozone season (May through September). A comparison of the temporal and spatial distributions of ozone and its precursors was conducted for the study domain, with additional focus placed on performance in both the Northern New Jersey/New York/Connecticut and Southern New Jersey/Philadelphia nonattainment areas.

This evaluation showed that the CMAQ model performance for surface ozone is quite good, with low bias and error. Model performance is generally consistent from day to day. The results of the 2002 ozone season show that the modeling system tends to over-predict minimum concentrations and slightly underpredict peak concentrations. The over-prediction of minimum concentrations is not of great regulatory concern since attainment tests are based on the application of relative response factors (RRF), to daily peak concentrations. Prediction of minimum concentrations is still important to appropriately model regional transport and nighttime ozone removal processes in order to accurately estimate peak concentrations.

The model performance for both Northern New Jersey/New York/Connecticut and the Southern New Jersey/Philadelphia nonattainment areas averaged over all stations and all days met the guidelines in the USEPA Modeling Guidance. Applying those criteria to individual days is a much more stringent test that is not required by the USEPA.

No significant differences in model performance for ozone and its precursors were encountered across different areas of the Ozone Transport Region. While there are some differences in the spatial data among sub-regions, there is nothing to suggest a tendency for the model to respond in a systematically different manner between regions. Examination of the statistical metrics by sub-region confirms the absence of significant performance problems arising in one area but not in another, building confidence that the CMAQ modeling system is operating consistently across the full Ozone Transport Region domain.

As stated previously, the model performance for the 2002 ozone season meets all USEPA guidelines and thus demonstrates that the modeling platform is appropriate for modeling emissions control scenarios for the Northern New Jersey/New York/Connecticut and the Southern New Jersey/Philadelphia nonattainment areas 8-hr ozone SIPs. At the same time it must be remembered that CMAQ has been evaluated by using measures that reflect its ability to represent average conditions instead of its ability to respond to changes in emissions. Therefore, although CMAQ has met the traditional performance measures as stated in the USEPA Modeling Guidance, it may in fact under predict the magnitude of ozone changes due to various control measures being modeled. This means future year (i.e., 2009) modeling results should not be viewed as exact, but should be utilized in a relative manner (see Section 5.2.4). Additional discussion on the uncertainty associated with the CMAQ model results is provided in Section 5.3.

5.2.3 Control Measures Modeled

As previously stated, the objective of the photochemical modeling analysis is to enable state air agencies to analyze the efficacy of various control strategies, and to demonstrate that the measures adopted as part of the SIP will result in attainment of the 8-hour ozone standard by 2009. New Jersey's attainment demonstration relies on the Beyond-on-the-Way (BOTW) 2009 modeling run, which predicts future 2009 air quality conditions, after accounting for all air pollution controls that have been implemented since the base year of 2002 (OTB measures), and applying new control measures (BOTW measures) that will be implemented in time to reduce emissions in 2009. Table 5.1 lists all of the control measures included for New Jersey in the projected 2009 BOTW CMAQ modeling run. Each of these control measures is discussed in detail in Chapter 4.

Table 5.1: Modeled Control Measures Included in the 2009 BOTW Model Run

Pre-2002 with benefits achieved Post-2002 - On the Books
Federal
Residential Woodstove NSPS
Onboard Refueling Vapor Recovery (ORVR) beyond Stage II
Tier 1 Vehicle Program
National Low Emission Vehicle Program (NLEV)
Tier 2 Vehicle Program/low sulfur fuels
HDDV Defeat Device Settlement
HDDV Engine Standards
Nonroad diesel engines
Large industrial spark-ignition engines over 19 kilowatts
Recreational Vehicles (includes snowmobiles, off-highway motorcycles and all-terrain vehicles)
Diesel Marine Engines over 37 kilowatts
Phase 2 standards for small spark-ignition handheld engines at or below 19 kilowatts
Phase 2 standards for new nonroad spark-ignition nonhandheld engines at or below 19 kilowatts
Post-2002 - On the Books
New Jersey Measures Done Through a Regional Effort
Consumer Products 2005
Architectural Coatings 2005
Portable Fuel Containers 2005
Mobile Equipment Repair and Refinishing
Solvent Cleaning
NO_x RACT rule 2006 (including distributed generation)
Stage I and Stage II - Gasoline Transfer Operations
On-Board Diagnostics – I/M
New Jersey Heavy Duty Diesel Rules Including "Not-To-Exceed" (NTE) Requirements

Federal
USEPA MACT Standards including Industrial Boiler/Process Heater MACT
CAIR
Refinery Enforcement Initiative
Post-2002 - Beyond on the Way
New Jersey Measures Done Through a Regional Effort
Consumer Products 2009 Amendments
Portable Fuel Containers 2009 Amendments
Asphalt Paving
Adhesives and Sealants
Certain Categories of ICI Boilers

While Table 5.1 shows all the OTB and BOTW measures that New Jersey took credit for in the 2009 attainment demonstration model run, the overall attainment demonstration is reliant upon all the states' in the Ozone Transport Region implementing measures to reduce ozone in order for New Jersey to achieve its goals. As such, Table 5.2 shows which BOTW measures each state in the Ozone Transport Region believed would be implemented in time to achieve benefits in 2009. These were the measures included in the BOTW model run for each state.

Table 5.2: Ozone Transport Region-Wide Modeling Assumptions for the 2009 BOTW Model Run

	Consumer Products 2005/2009	PFC 2005/ 2009	Asphalt Paving	Adhesives & Sealants	ICI Boilers - Area Sources			ICI Boilers - Non-EGU Point Sources					Cement Kilns	Glass Furnances	Asphalt Plants
					< 25 mmBtu/ hr	25-50 mmBtu/ hr	50-100 mmBtu/ hr	< 25 mmBtu/ hr	25-50 mmBtu/ hr	50-100 mmBtu/ hr	100-250 mmBtu/ hr	>250 mmBtu/ hr			
NY NAA															
Connecticut	x	x	x	x	x	x	x	x	x	x	x				x
New Jersey	x	x	x	x		x	x	x			x				
New York	x	x	x	x	x	x	x	x	x	x	x		x	x	x
Phila. NAA															
Delaware	x	x		x							x				
Maryland	x	x	x	x							x		x	x	
New Jersey	x	x	x	x		x	x	x			x				
Pennsylvania	x	x		x										x	
Other States															
Maine	x	x		x									x		
New Hampshire	x	x	x						x	x	x				
Vermont															
Massachusetts	x		x	x										x	
Rhode Island	x	x	x	x											
DC	x	x	x	x											x

*Source: MACTEC. Development of Emission Projections for 2009, 2012, and 2018 for NonEGU Point, Area, and Nonroad Sources in the MANE-VU Region, Final TSD. Prepared for the Mid-Atlantic Regional Air Management Association by MACTEC Federal Programs, Inc., February 28, 2007.

5.2.4 Photochemical Modeling Results

The USEPA recommends using the model estimates in a "relative" rather than "absolute" sense, due to the uncertainties and biases in the modeling system. Thus, the assumption is that the change between the modeled base year and the modeled future year (2009) reflects the impact of growth and control over time, is appropriate use of the results. The "absolute" modeled results are used in a "relative" sense by applying the ratios of the model's future to current (baseline) predictions at each ozone monitor to the actual 2002 design values, thereby grounding the future design value to the monitored results. These ratios are termed "relative reduction factor" (RRF).

The first step in converting the modeled output to a "relative" result requires the creation of an RRF. An RRF is defined by the USEPA as the ratio of the future 8-hour daily maximum concentration predicted "near a monitor" to the baseline 8-hour daily maximum concentration predicted "near the monitor" averaged over selected days.[12, 13] More simply put, the RRF is the ratio of average future concentrations over average baseline concentrations for each monitoring site. For more information about the calculation of RRFs and the selection of relevant days for each monitoring site in both New Jersey-associated nonattainment areas, see Appendix D11.

Once calculated, the RRF is then used to project the baseline modeling design values (DVs) at each monitoring site into the future.[14] The baseline design values used in the modeling application are calculated differently from the monitored design values discussed in Chapter 3, although both are based on monitored ambient air quality data. The monitoring design values are calculated as the 3-year average of the fourth highest monitored daily 8-hour maximum value at each monitoring site. For modeling purposes the baseline design value is calculated by averaging three design value periods, centered around the base inventory year of 2002. Specifically, the modeling baseline design value was calculated using the 2000-2002, 2001-2003, and 2002-2004 periods. Since the baseline design value is the anchor point for the future year projected concentrations it is believed that the average of the three design value periods best represents the baseline concentrations, while taking into account the variability of the meteorology and emissions (over a five year period).[15] For more information about the modeling design values and how they were calculated, see Appendix D11.

The following equation illustrates how New Jersey calculated the future design values for each monitor:

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[12] ibid.

[13] "Near a monitor" was determined by using a 3x3 array of grid cells surrounding each monitor, as recommended by the USEPA for 12-km grid resolution modeling.

[14] Design value is calculated as the 3-year average of the fourth highest monitored daily 8-hour maximum value at each monitoring site.

[15] USEPA. Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, PM2.5, and Regional Haze. United States Environmental Protection Agency, Office of Air Quality Planning and Standards, Air Quality Analysis Division, Air Quality Modeling Group, Research Triangle Park, NC, EPA-454/B-07-002, April 2007.

$DV_{F-I} = RRF_I * DV_{B-I}$

Where:

DV_{B-I} = the base concentration monitored at site I, in parts per billion (ppb)

RRF_I = the relative response factor, calculated near site I

DV_{F-I} = the estimated future design value for the time attainment is required, in ppb.

Table 5.3 shows the modeling results for the 2009 BOTW run.

Table 5.3: 2009 Modeled Design Values for the Northern New Jersey/New York/Connecticut and Southern New Jersey/Philadelphia Nonattainment Areas

Site Name – County, State	Site Number	Air Monitoring Data	Modeling Results
		2002 Modeling Baseline (DV_B) (ppb)	2009 Modeled (DV_F) (ppb)
NNJ/NY/CT Nonattainment Area			
Teaneck - BERGEN CO, NJ	340030005	91	85
Bayonne - HUDSON, NJ	340170006	84	77
Flemington - HUNTERDON, NJ	340190001	95	83
Rutgers Univ. - MIDDLESEX CO, NJ	340230011	96	83
Monmouth Univ. - MONMOUTH CO, NJ	340250005	95	84
Chester - MORRIS CO, NJ	340273001	95	84
Ramapo - PASSAIC CO, NJ	340315001	86	77
Botanical Garden - BRONX CO, NY	360050083	83	78
Queens College - QUEENS CO, NY	360810124	83	74
Susan Wagner - RICHMOND CO, NY	360850067	93	84
Babylon - SUFFOLK CO, NY	361030002	93	85
Holtsville - SUFFOLK CO, NY	361030009	97	89
Riverhead - SUFFOLK CO, NY	361030004	83	74
White Plains - WESTCHESTER CO, NY	361192004	91	85
Danbury - FAIRFIELD CO, CT	90011123	95	85
Greenwich - FAIRFIELD CO, CT	90010017	95	87
Stratford - FAIRFIELD CO, CT	90013007	98	90
Westport - FAIRFIELD CO, CT	90019003	94	85
Middletown - MIDDLESEX CO, CT	90070007	95	84
Hamden - NEW HAVEN CO, CT	90099005	93	85
Madison - NEW HAVEN CO, CT	90093002	98	88

SNJ/Phila. Nonattainment Area			
Fairhill - CECIL CO, MD	240150003	97	81
Brandywine Creek - NEW CASTLE CO, DE	100031010	92	81
Bellefonte - NEW CASTLE CO, DE	100031013	90	78
Killens Pond - KENT CO, DE	100010002	88	78
Lewes - SUSSEX CO, DE	100051003	87	77
Lums Pond - NEW CASTLE CO, DE	100031007	94	79
Seaford - SUSSEX CO, DE	100051002	90	75
Bristol - BUCKS CO, PA	420170012	99	88
West Chester - CHESTER CO, PA	420290050	95	82
New Garden - CHESTER CO, PA	420290100	94	79
Chester - DELAWARE CO, PA	420450002	91	81
Norristown - MONTGOMERY CO, PA	420910013	92	81
Elmwood - PHILADELPHIA CO, PA	421010136	83	75
Lab - PHILADELPHIA CO, PA	421010004	71	64
Roxborough - PHILADELPHIA CO, PA	421010014	90	82
Northeast Airport - PHILADELPHIA CO, PA	421010024	96	87
Colliers Mills - OCEAN CO, NJ	340290006	106	92
Rider - MERCER CO, NJ	340210005	97	86
Ancora State Hospital - CAMDEN CO, NJ	340071001	100	87
Camden - CAMDEN CO, NJ	340070003	98	88
Clarksboro - GLOUCESTER CO, NJ	340155001	98	88
Millville - CUMBERLAND CO, NJ	340110007	95	81
Nacote Creek - ATLANTIC CO, NJ	340010005	89	77

NOTE: Highlighted sites are the monitor in each nonattainment area with the highest ozone design value, e.g. the controlling monitor.

5.3 Demonstrations

5.3.1 Introduction

New Jersey is applying a comprehensive approach to the attainment demonstrations for its two multi-state 8-hour ozone nonattainment areas. This approach considers the cumulative body of science and is comprised of numerous technical tools including rigorous data analysis, observations, and modeling.

While the USEPA attainment demonstration guidance emphasizes a single design value from a single modeling simulation as the core of any attainment demonstration, [16] it also supports, in conjunction with the Clean Air Act Advisory Committee (CAAAC), states utilizing a multi-analysis approach to their 8-hour ozone attainment demonstrations (as

[16] USEPA. Guidance on the Use of Models and Other Related Analyses in Attainment Demonstrations for the 8-Hour Ozone NAAQS. United States Environmental Protection Agency, Office of Air Quality Planning and Standards, Emissions, Monitoring, and Analysis Division, Air Quality Modeling Group, Research Triangle Park, North Carolina, EPA-454/R-05-002, October 2005.

they did for the 1-hour ozone attainment demonstrations).[17] This is because the principles of atmospheric science acknowledge that, in using models, all of the uncertainties and biases need to be considered. Uncertainties associated with emission inventories, meteorological data, and the representation of ozone photochemistry in the model can result in over or under predictions in design values. The CAAAC also recommends that states decrease reliance on modeling results to demonstrate attainment and rather focus more on ambient air monitoring data. These recommendations are reflected in the USEPA's modeling guidance, which provides for other evidence to address model uncertainties so that a more robust assessment of the probability to attain the 8-hour ozone standard can be made. Therefore, a variety of data is collectively analyzed to determine whether the 8-hour ozone standard will be met, instead of the results of the modeling attainment test alone. This more comprehensive view of the modeling results ultimately produces not a single design value, but a range of predicted future design values.

The guidelines presented by the USEPA are intended to assist states with demonstrating attainment in their 8-hour ozone SIPs.[18] However, there are no requirements specific to using a multi-analysis approach in the Phase 1[19] or Phase 2[20] implementation rules, 40 C.F.R. 51.112, or 42 U.S.C. § 7502(c)(1). As such, no one specific air modeling system is recommended and the inherent uncertainty and limitations within such modeling systems is acknowledged and addressed by the array of supplemental analyses possible as explained within the USEPA modeling guidance.[21] Further, while the regional transport of ozone has a major influence on ozone concentrations in a given area, analyses conducted on a local-scale are suggested in addition to the regional-scale modeling efforts.

The net result of applying this comprehensive multi-analysis approach to the photochemical modeling outputs is a plausible demonstration of attainment for the Northern New Jersey/New York/Connecticut and Southern New Jersey/Philadelphia 8-hour ozone nonattainment areas by 2010. Figures 5.2a and 5.2b show the range of modeled design values adjusted for transport for 2009 for all monitoring sites in the multi-state nonattainment areas. Ranges are provided, instead of single values, for each site in order to better represent the uncertainty of the modeling. The remainder of this section discusses the fundamental knowledge gained from the comparisons of observations and sensitivity model runs that resulted in these design value ranges.

[17] ibid.
[18] 42 U.S.C. § 7511a(c)(2)(A) (see also 40 C.F.R. §51.908(c)).
[19] 69 Fed. Reg. 23951 (April 30, 2004).
[20] 70 Fed. Reg. 71612 (November 29, 2005).
[21] op. cit., note 1

Figure 5.2a: 2009 Modeled 8-Hour Ozone Design Values Adjusted for Transport for Monitoring Sites in the NNJ/NY/CT Nonattainment Area

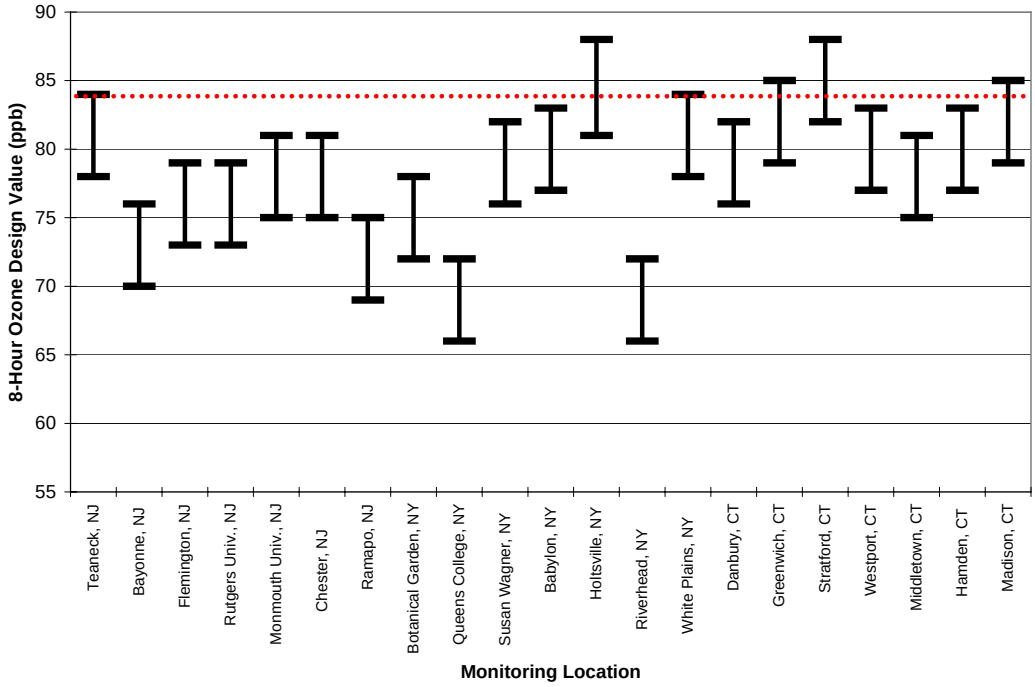
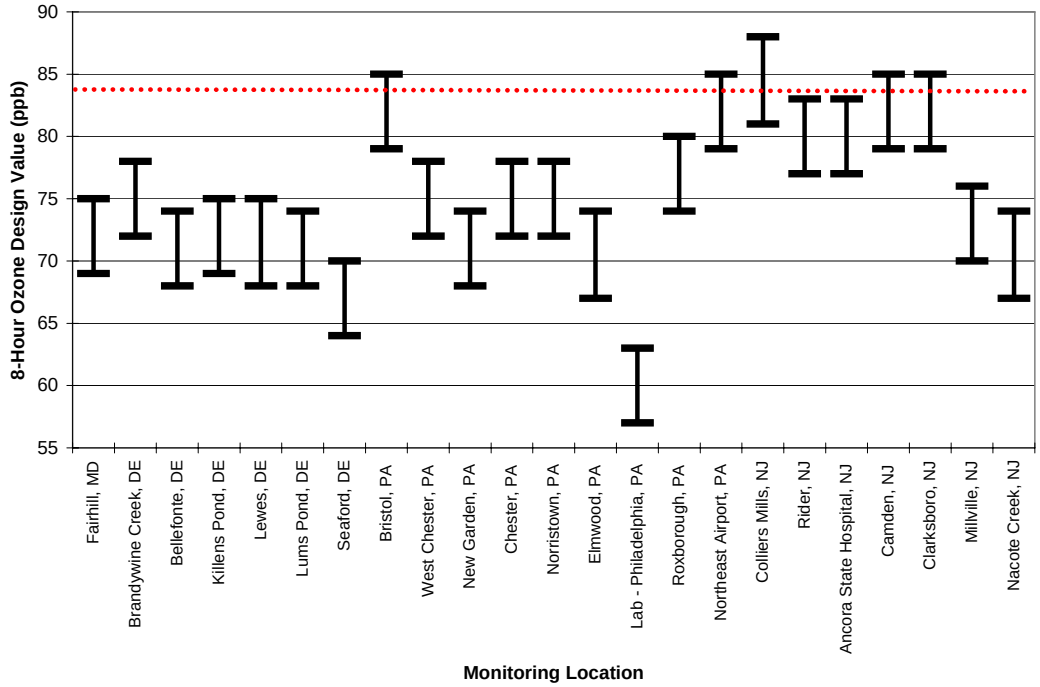


Figure 5.2b: 2009 Modeled 8-Hour Ozone Design Values Adjusted for Transport for Monitoring Sites in the SNJ/Phila. Nonattainment Area



5.3.1.1 Modeling and Transport - Transport Mechanisms

Transport of pollutants and the affect of transport on ozone levels were discussed in Chapter 2. A brief review of that material is presented here, as it pertains to regional photochemical modeling.

Transport of air pollution is an important factor in understanding how ground-level ozone is produced and what geographical areas influence ozone production. New Jersey and its associated nonattainment areas are part of the Ozone Transport Region, which is a region of the eastern United States from Maine to the District of Columbia Consolidated Metropolitan Statistical Area. During ozone events, the high levels of ozone extends beyond the Ozone Transport Region's borders and impacts over 200,000 square miles across the eastern United States. In addition to air pollution transported hundreds of miles from distant sources in and outside the Ozone Transport Region, local sources of air pollution also contribute to New Jersey's and the multi-state nonattainment areas' air quality problems.

There are three meteorological mechanisms that contribute to the transport of air pollution into and within the Ozone Transport Region: ground level transport, transport by the nocturnal low level jet, and westerly transport aloft.

Ground-level transport is the result of interaction between the broad meteorological feature and local effects, such as sea breeze and the Appalachian lee side trough.

Transport within the Ozone Transport Region can also occur via the nocturnal low level jet that forms late at night or in the very early morning hours. The nocturnal low level jet is a regional scale phenomenon of higher wind speeds that often forms a few hundred meters above the ground just above the stable nocturnal boundary layer. This phenomenon is a result of the differential heating of the air between the Appalachian Mountains and the Atlantic Ocean. The land, sea, mountain, and valley breezes can selectively affect relatively local areas and they play a vital role in drawing ozone-laden air into some areas, such as coastal areas, that are far removed from major emission source regions. The nocturnal low level jet can transport ozone that formed within the Ozone Transport Region to other areas, can transport ozone formed outside the region into the Ozone Transport Region or can move locally formed ozone within the confines of the Ozone Transport Region. It extends the entire length of the Northeast corridor from Virginia to Maine, and has been observed as far south as Georgia.

Finally, westerly transport aloft is dominated by the anti-cyclonic flow around a high pressure system, which can lead to transport of an ozone reservoir, created by emissions in areas that lie outside the Ozone Transport Region, into the Ozone Transport Region. Local emissions within the Ozone Transport Region add to the polluted air mixing down from above that arrived from more distant locations.

It is important that air quality models replicate these transport mechanisms correctly, as they significantly affect ground-level ozone concentrations throughout the East Coast.

Furthermore, it is critical that the models correctly capture the amount of ozone at the different atmospheric heights.

5.3.1.2 Characterizing Ground Level Transport at Special Sites

Given the importance of large-scale transport in the formation of ozone, meteorological conditions are particularly important to the site selection process.[22] Regional scale monitors are placed upwind and downwind of metropolitan areas to evaluate the ozone entering a geographic area or to help evaluate the peak ozone concentrations experienced within a geographic area.

The highest monitored 8-hour ozone design value in the Southern New Jersey/ Philadelphia nonattainment area is at Colliers Mills, Ocean County, New Jersey. Two major upwind urban areas, Washington DC-Baltimore and Philadelphia, influence this monitor. Colliers Mills is downwind of both these areas and therefore provides a view of the peak ozone concentrations experienced in the region. However, given this monitor's proximity to the Atlantic Ocean, ozone concentrations are often influenced by a sea breeze. Field studies and numerical modeling efforts around the country and internationally have shown that a sea breeze circulation can influence local ozone concentrations.[23,24,25,26,27,28,29] A sea breeze may exacerbate air pollution levels by constricting horizontal and vertical ventilation, and re-circulates air that would otherwise move offshore. On other occasions, a sea breeze may move relatively clean air onshore, which will rapidly lower ozone concentrations. The Maryland Department of the Environment examined the theoretical impact of the Chesapeake Bay sea breeze on the ozone monitor site in Edgewood, Maryland.[30] The conclusions of this analysis were that

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[22] USEPA. Guideline on Ozone Monitoring Site Selection. United States Environmental Protection Agency, Office of Air Quality Planning and Standards, Emissions, Monitoring, and Analysis Division, Research Triangle Park, NC, EPA-454/R-98-002, August 1998.

[23] Seaman, N. L. and Michelson, S.A. Mesoscale Meteorological Structure of a High-Ozone Episode during the 1995 NARSTO-Northeast Study. *Journal of Applied Meteorology*, 39, 384-398, 1998.

[24] McElroy, M.B. and Smith, T.B. Vertical Pollutant Distributions and Boundary Layer Structure Observed by Airborne LIDAR near the Complex California Coastline. *Atmospheric Environment*, 20, 1555-1566, 1986.

[25] Bornstein, R.D., Thunis, P., and Schayes, G. Simulation of Urban Barrier Effects on Polluted Urban Boundary-Layers Using the Three Dimensional URBMET/TVM Model with Urban Topography-New Results from New York City. In: Zanetti, P. (Ed), Air Pollution, Computational Mechanics Publications, Southampton, Boston, 15-34, 1993.

[26] Cheng, W. L. Ozone Distribution in Coastal Central Taiwan under Sea-Breeze Conditions. *Atmospheric Environment*, 36, 3445-3459, 2002.

[27] Boucouvala, D. and Bornstein, R. Analysis of Transport Patterns during an SCOS97-NARSTO Episode. *Atmospheric Environment*, 37(S2), S73-S94, 2003.

[28] Martilli, A., Roulet, Y.A., Junier, M., Kirchner, F., Mathias, W. R., and Clappier, A. On the Impact of Urban Surface Exchange Parameterizations on Air Quality Simulations: The Athens Case. *Atmospheric Environment*, 37, 4217-4231, 2003.

[29] Evtyugina, M. G., Nunes, T., Pio, C., and Costa, C. S. Photochemical Pollution under Sea Breeze Conditions, during Summer, at the Portuguese West Coast. *Atmospheric Environment*, 40, 6277-6293, 2006.

[30] Maryland Department of the Environment. Appendix G-11: The Role of Land-Sea Interactions on Ozone Concentrations at the Edgewood, Maryland Monitoring Site, Cecil County, Maryland 8-Hour Ozone

a local-scale sea breeze circulation can exacerbate peak ozone concentrations not only during regional-scale high ozone episodes, but also during periods when local scale circulation is more significant than regional transport. These conclusions likely apply at Colliers Mills as well. The impact of the sea breeze is an important consideration because it is highly likely that CMAQ could be making the planetary boundary layer too shallow, thus forcing ventilation to calm conditions which would effectively create CMAQ over-predictions of 8-hour ground-level ozone concentrations at Colliers Mills.

The highest monitored 8-hour ozone design value in the Northern New Jersey/New York/ Connecticut nonattainment area is at Stratford, Fairfield County, Connecticut. The Stratford monitoring site is located directly downwind from a major highway, I-95, and the major metropolitan area of New York City, which makes it heavily influenced by transported air pollutants. Also, the Stratford monitoring site is situated very close to Long Island Sound making it susceptible to a bay breeze affect that is similar to a sea breeze effect.

The ground level transport effects at the controlling monitors for 8-hour ozone in Northern New Jersey/New York/Connecticut and Southern New Jersey/Philadelphia nonattainment areas are likely not reflected accurately in the CMAQ predicted ozone concentrations. This is because the model does not accurately capture these ground level transport effects.

5.3.1.3 Characterizing Westerly Transport of the Ozone Reservoir Using High Elevation Monitors

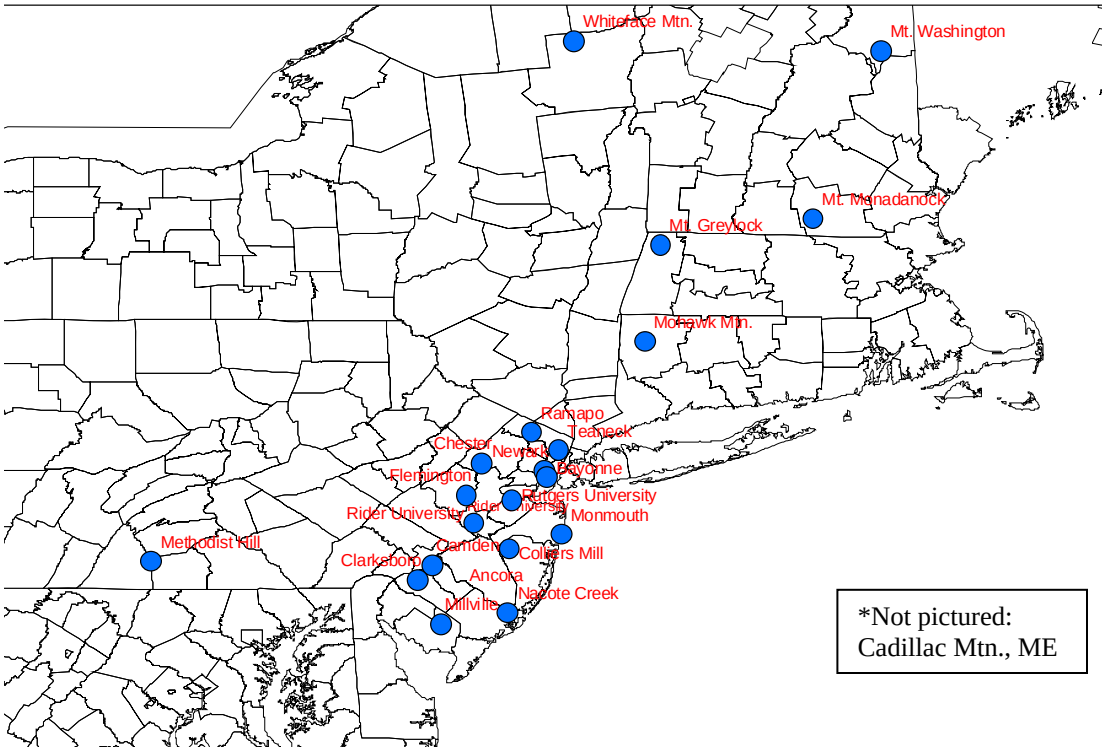
As discussed in Chapter 2, there are several elevated monitoring sites located inside the Ozone Transport Region (see Figure 5.3). Between the hours of 2:00 – 7:00 a.m. EST, these high elevation monitors exhibit remarkably different ozone concentrations from the lower elevation monitors. In fact, during these hours, the high elevation monitors can register concentrations up to 85 ppb. That concentration level is more than 4 times the average sampled at most of lower elevation monitoring sites (20 ppb concentrations).

As an example, the Methodist Hill monitor recorded ozone concentrations above 80 ppb in the early morning hours of August 12, 2002 (e.g., 5 a.m.).[31] This concentration was significantly higher than the concentrations recorded at the surrounding lower elevation monitors (e.g., Little Buffalo State Park, PA, South Carroll County, MD, Frederick, MD, Ashburn, VA, Long Park, VA) for that date and time period (see Figure 5.4). A similar effect was seen at the other high elevation monitors in the Ozone Transport Region (specifically, Mohawk Mountain, CT; Cadillac Mountain, ME; Mt. Greylock, MA; Mt. Monadanock, NH; Mt. Washington, NH; and Whiteface Mountain, NY) on the same day, as compared to surrounding lower elevation sites below the nocturnal inversion (e.g., Danbury, CT) (see Figure 5.5).

State Implementation Plan and Base Year Inventory. Maryland Department of the Environment, June 15, 2007.

[31] The ozone monitor at Methodist Hill, PA is located at 1900 ft in altitude in south central Pennsylvania, and is above the nocturnal inversion.

Figure 5.3: Location of New Jersey Monitors and Upper Air Monitoring Stations in the Northeastern United States*



A significant ozone reservoir, which is above the nocturnal inversion layer, develops during daylight hours and is transported into the region. The high night time ozone levels recorded at the elevated monitoring sites indicate the presence of the ozone reservoir. Based on what is being seen at the high elevation monitors, this ozone reservoir extends across the entire Ozone Transport Region. With the break up of the nocturnal inversion after sunrise (e.g., starting about 7 a.m.), ozone concentrations at the lower elevation monitors rapidly increase. By mid-day, the nocturnal boundary layer has broken down, mixing the transported ozone from the reservoir above into the precursor laden, locally produced ozone below.

Figure 5.4: Hourly Ozone Profiles in the Southern Ozone Transport Region, August 12, 2002

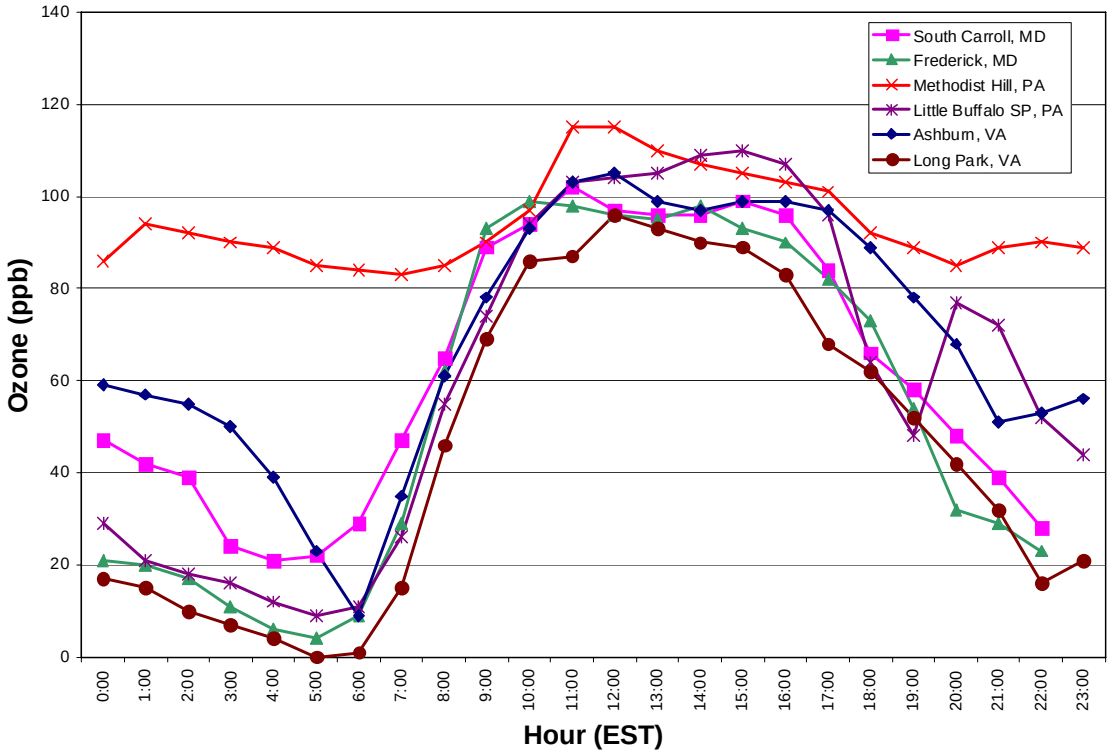
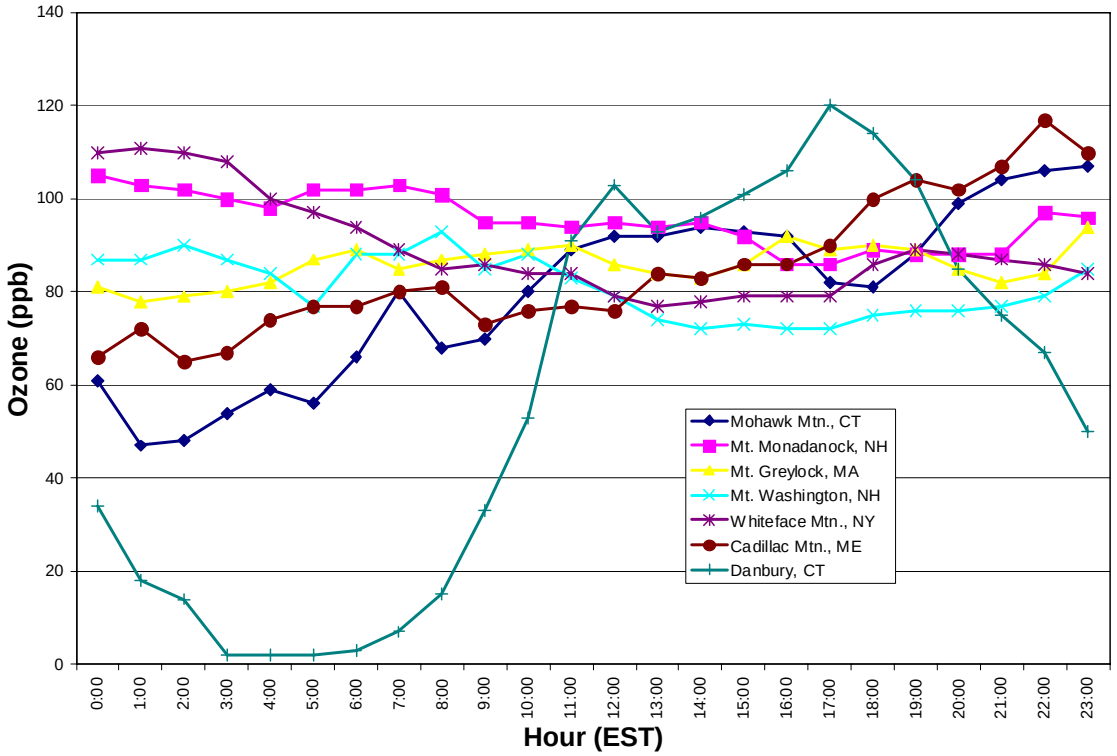


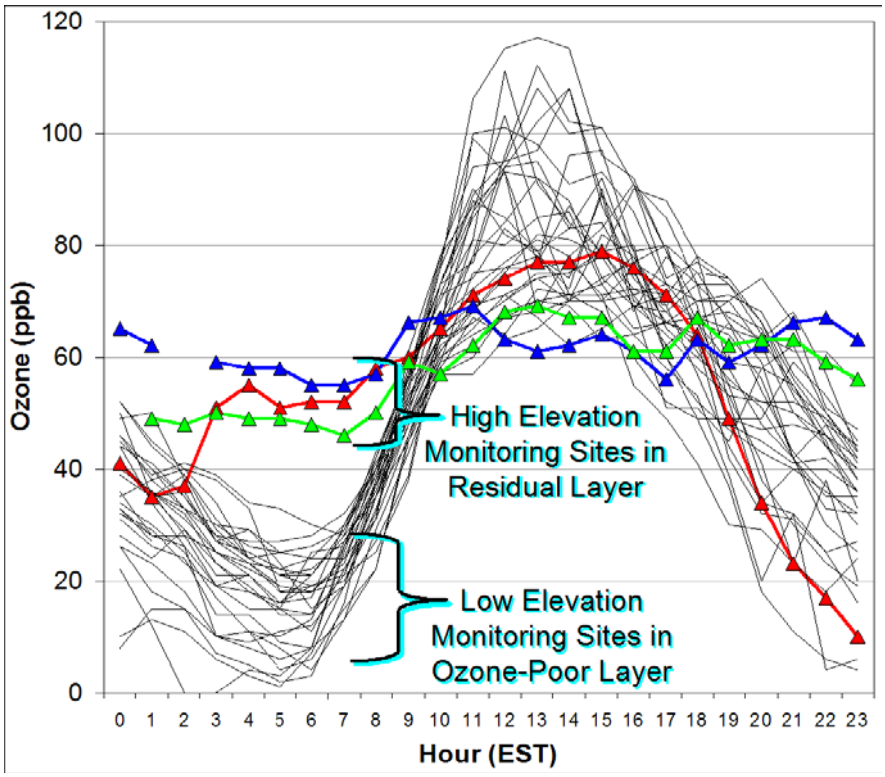
Figure 5.5: Hourly Ozone Profiles in the Northern Ozone Transport Region, August 12, 2002



Data provided by Tom Downs, Maine Department of Environmental Protection.

Staff at the Maryland Department of the Environment recently examined the 2005 data from the Methodist Hill, PA monitor.[32] Figure 5.6a is a snap shot of the air quality on August 13, 2005, which shows a marked improvement in the ozone levels at Methodist Hill monitor from the 2002 levels. During the night hours, this monitor registered concentrations of approximately 55 ppb, compared to approximately 85 ppb in 2002, indicating a reduction in the ozone reservoir concentration. Figure 5.6b shows that the reduction in the ozone reservoir concentration, as measured at Methodist Hill, have been reduced significantly. This decrease in the reservoir ozone levels is not an unexpected result. Reductions due to implementation of the NO_x SIP Call in states west of the Ozone Transport Region were fully implemented by 2005, accounting for some, if not most, of this reduction.

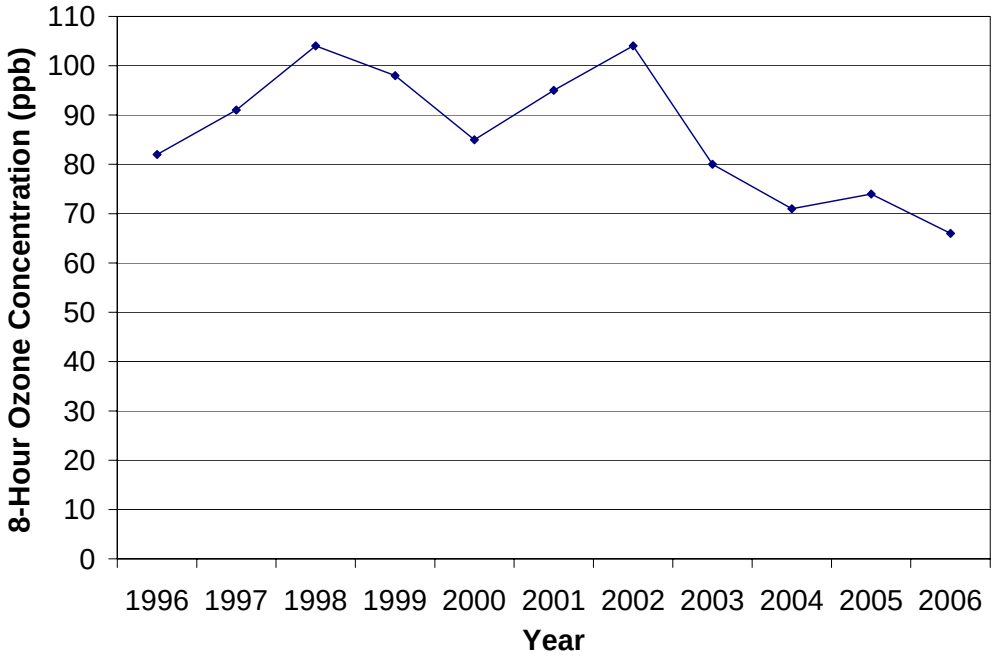
Figure 5.6a: Hourly Ozone at Various Monitors on August 13, 2005



High Elevation Monitoring Sites - Red = Piney Run, MD; Green = Methodist Hill, PA; Blue = Shenandoah National Park, VA; Black = Low Elevation Monitoring Sites in DE, MD, VA, and DC.

[32] Maryland Department of the Environment. Cecil County, Maryland, 8-Hour Ozone State Implementation Plan and Base Year Inventory: SIP Revision 07-05. Maryland Department of the Environment, June 15, 2007.

Figure 5.6b: Fourth Maximum 8-Hour Ozone Concentrations at the Methodist Hill, PA Monitor, 1996 - 2006



Collectively, the high elevation measurements show that when the morning mixing begins, ozone in the reservoir may have an immediate contribution of approximately 55 ppb or more to the daily ozone concentrations in New Jersey and other locations in the Ozone Transport Region. Starting a day with 55 ppb represents almost two-thirds of the ozone NAAQS and makes it difficult for downwind areas to attain especially when night time levels are approximately 20 ppb. This leaves little room for fresh emissions from the next day. The ozone in the reservoir is due to transport. Additional cost effective controls on the largest upwind sources are still needed to reduce the ozone and ozone precursors being transported into the Ozone Transport Region.

5.3.1.4 The Contribution of Transport to Nonattainment

Representing the amount of transported ozone, and ozone precursors, correctly in the regional modeling not only affects the accuracy of the modeling results but also the contribution of regional sources to nonattainment at a particular location. This information ultimately helps to inform the process on what sources to control to reduce precursor pollutants and thus ozone.

Three studies conducted by the University of Maryland demonstrate why it is important to understand regional transport. The first study measured ground-level ozone in the Mid-Atlantic region to understand how ozone concentrations in this region are affected

by NO_x emissions.[33] This study analyzed 232 aircraft vertical profiles performed in the Mid-Atlantic and Northeast US between 1997 and 2003. The data showed that the ozone concentrations during the flights were strongly influenced by point source emissions. The study showed that if NO_x from upwind point source emissions were reduced, ozone in Maryland should also be reduced. Cecil County, Maryland is part of the Southern New Jersey/Philadelphia nonattainment area and Maryland is upwind of New Jersey on many days. Therefore, it is assumed that ozone in New Jersey would also be reduced.

A second study performed by the University of Maryland examined the relative contribution of transported and local photochemistry to the ozone levels for six exceedance days in August 2002. This study showed that if local photochemistry were the only source of ozone, none of the 6 days examined would have exceeded the 8-hour ozone standard.[34] The effect of the transported ozone is to add ozone early in the day, expanding the time interval over which the ozone levels may exceed 84 ppb.

In a third study, the University of Maryland conducted a cluster analysis of hundreds of aircraft profile spirals.[35] This analysis revealed that when the greatest cluster trajectory density lay over the Ohio River Valley (approximately 59 percent of the profiles), transport accounted for 69–82 percent of the afternoon boundary layer ozone for the Baltimore area. Even under stagnant conditions (approximately 27 percent of the profiles), transport still accounted for 58 percent of the afternoon boundary layer ozone. Combined, the three University of Maryland studies demonstrate that transport significantly affects 8-hour ground-level ozone concentrations, particularly in the Ozone Transport Region.

Additionally, ozone pollution apportionment modeling analyses show that transport from states outside and inside of the Ozone Transport Region are significant contributors to nonattainment in New Jersey. Modeling conducted in 1998 by the USEPA to support the NO_x SIP Call indicated that 85 percent of the predicted 8-hour ozone levels in 2007 in New Jersey would be attributable to out-of-state sources on high ozone days.[36] More recent modeling conducted in 2005 by the USEPA to support the implementation of the Clean Air Interstate Rule (CAIR) indicates that out-of-state contributions to Ocean

[33] Maryland Department of the Environment. Appendix G-1: Ozone Sensitivity to NO_x Emissions, Cecil County, Maryland, 8-Hour Ozone State Implementation Plan and Base Year Inventory: SIP Revision 07-05. Maryland Department of the Environment, June 15, 2007.

[34] Maryland Department of the Environment. Appendix G-7: Regional Nature of Ozone Transport, Cecil County, Maryland, 8-Hour Ozone State Implementation Plan and Base Year Inventory: SIP Revision 07-05. Maryland Department of the Environment, June 15, 2007.

[35] Taubman, B.F., Hains, J.C., Thompson, A.M., Marufu, L.T., Doddridge, B.G., Stehr, J.W., Piety, C.A., and Dickerson, R.R. Aircraft Vertical Profiles of Trace Gas and Aerosol Pollution over the Mid-Atlantic United States: Statistics and Meteorological Cluster Analysis. *Journal of Geophysical Research*., 111, D10S07, 2006.

[36] USEPA. Appendix E, 1-Hour and 8-Hour Percent Contribution Tables, Table E-34, Air Quality Modeling Technical Support Document for the NO_x SIP Call. United States Environmental Protection Agency, Office of Air and Radiation, September 23, 1998.

County, New Jersey are 82 percent of the projected 2010 8-hour ozone levels at the site.[37,38]

The same modeling conducted in 1998 by the USEPA to support the NO_x SIP Call indicated that 88 percent of the predicted 8-hour ozone levels in 2007 in Connecticut were attributable to out-of-state sources on high ozone days.[39] The more recent modeling conducted by the USEPA to support the CAIR indicates that out-of-state contributions to Fairfield County, Connecticut are 80 percent of the projected 2010 8-hour ozone levels at the site.[40]

The diverse array of studies and modeling analyses conducted by the University of Maryland and the USEPA demonstrate that regional transport into and within the Ozone Transport Region has a significant impact on ground-level ozone concentrations. Therefore, if the photochemical model used to evaluate future 8-hour ozone concentrations is not capturing transport correctly then the model results will not accurately reflect the magnitude of the transported precursors and ozone nor the magnitude of the benefits of control strategies.

5.3.2 2009 Modeled Design Value Ranges Adjusted for Transport

In this section, a case is made on why CMAQ under represents changes in ozone. Then the uncertainty in future year design values will be examined. In light of these discussions, it is shown that a single future year design value cannot be accurately predicted and therefore, a range of 2009 design values is appropriate.

5.3.2.1 Assessment of Model Response

In an effort to assess the ability of the CMAQ model to replicate ozone patterns and changes in ozone, particularly for high ozone events throughout the Ozone Transport Region, the Maryland Department of the Environment performed comparisons between surface and aircraft ozone measurements, and CMAQ ozone simulations using the 2002 base case B1 emissions inventory.[41] This analysis explored several methods of evaluating the CMAQ model by examining its performance only on high ozone days, by separating performance at rural, suburban, and urban sites, and by comparing CMAQ to

[37] The monitor with the highest modeled design value is termed the controlling monitor. In the Southern New Jersey/Philadelphia nonattainment area, the controlling monitor is in Colliers Mills, NJ, with a 2009 modeled design value of 92 ppb.

[38] USEPA. Appendix G: 8-Hour Contributions to Each Nonattainment County in 2010, Technical Support Document for the Final Clean Air Interstate Rule: Air Quality Modeling. United States Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC, March 2005.

[39] op. cit., note 37, Table E21

[40] The monitor with the highest modeled design value is termed the controlling monitor. In the Northern New Jersey/New York/Connecticut nonattainment area, the controlling monitor is in Stratford, CT, with a 2009 modeled design value of 90 ppb.

[41] Maryland Department of the Environment. Appendix G-8: Comparison of CMAQ-calculated Ozone to Surface and Aloft Measurements, Cecil County, Maryland 8-Hour Ozone State Implementation Plan and Base Year Inventory. Maryland Department of the Environment, June 15, 2007.

aloft ozone data from aircraft flights. The results of these comparisons show that CMAQ has shortcomings that appear to be magnified during periods when high ground level ozone concentrations are a concern.

In their first analysis, Maryland used 136 aircraft profiles from the Regional Atmospheric Measurement Modeling and Prediction Program flights to compare to CMAQ modeled results.[42] Agreement between CMAQ-calculated and aircraft-measured ozone varied substantially from flight to flight. CMAQ, in general, replicated the mean distribution of surface layer ozone during the ozone season and the spatial pattern of high ozone events, but often did not capture the full spatial extent or magnitude of the high ozone patterns. This analysis suggests that CMAQ over estimates ozone from the near surface to approximately 500 meter above ground by approximately 15 percent and under estimates ozone aloft, from 600 – 2600 meters, by approximately 10 percent. This under estimation aloft is indicative of an underestimation of ozone transport by CMAQ.

The University of Maryland also analyzed CMAQ model performance by comparing the mean CMAQ-calculated and measured 8-hour ozone values from 66 surface ozone monitors in the Baltimore, Washington, D.C., and Southern New Jersey/Philadelphia nonattainment areas. CMAQ-calculated and measured 8-hour ozone values were highly correlated (correlation coefficient, R=0.92) over the ozone season (May 15 – September 15) and well correlated (R=0.81) when a subset of 38 high ozone exceedance days were compared. Biases between CMAQ-calculated and measured 8-hour ozone concentrations were minimal (1-2 ppb) when averaged over the summer, but larger (7-8 ppb) on days when the air quality was poor.

The Maryland analyses also show that CMAQ exhibits its best performance in urban areas (small bias), less success in suburban areas (underestimates ozone, a larger negative bias), and its worst performance in rural areas (significantly underestimates ozone, larger negative bias). This bias may indicate that CMAQ's relatively coarse vertical resolution is unable to resolve the transport of emissions. In particular, performance at upwind sites with few nearby sources is poorer on the whole than it is at other sites. As a result, the significance of regional controls, including fleet turnover, heavy duty diesel controls, and the NO*x* SIP Call, are all probably under estimated.

In addition, Maryland's analyses show that CMAQ's performance in capturing surface ozone is poor in the Ohio River Valley, i.e. under predicted.[43] This area is known to be a source region of transported emissions for New Jersey during high ozone episodes.[44] Therefore, the performance of the CMAQ model adds uncertainty to estimates of transport into the Mid-Atlantic region and northeast corridor.

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[42] ibid., page 125

[43] Maryland Department of the Environment. Appendix G-8: Comparison of CMAQ-calculated Ozone to Surface and Aloft Measurements, Cecil County, Maryland 8-Hour Ozone State Implementation Plan and Base Year Inventory. Maryland Department of the Environment, June 15, 2007.

[44] USEPA. Technical Support Document for the Final Clean Air Interstate Rule: Air Quality Modeling, page 31. USEPA, Office of Air Quality Planning and Standards, Research Triangle Park, NC, March 2005.

Other studies suggest that the CMAQ model, and likely photochemical models in general, under predict the change in ozone concentrations that result from a change in NO_x emissions, particularly those from power plants.

A study of the August 2003 Northeast Blackout offers some of the most compelling information regarding response of the CMAQ model to emission changes.[45] University of Maryland flight data collected 24 hours into the Northeast Blackout shows that ozone was 30 ppb lower throughout the 0.5-1.5 km section of the atmosphere and 38 ppb lower at ground level, than on a meteorologically similar day. When the ozone levels on the blackout day were compared to a reference day it was shown that the blackout caused a drop of at least 7 ppb ozone, and likely considerably more. However, a modeling study of the same event using CMAQ predicted only a 2 ppb change.[46] These results seem to clearly demonstrate that CMAQ greatly under predicts transport and changes in ozone due to emission reductions, primarily at power plants, by a factor of approximately 3.

The USEPA is currently concluding a modeling study that offers a more detailed analysis of CMAQ response to emission reductions at power plants. In this study, the USEPA is performing a CMAQ simulation of 2002 and 2004 summertime air quality to determine the benefits of the NO_x SIP Call. While the results have not yet been published, they suggest that although observed median 8-hour ozone levels changed by about 18 ppb, the CMAQ model only simulated a change of about 8 ppb.[47] Therefore, these results suggest that the CMAQ model under predicts changes in ozone, especially power plant emissions, by a factor of approximately 2.

The results of these studies show that CMAQ under predicts transport and therefore, under predicts ozone changes due to emission reductions by a factor of at least 2. This information will be used later in this section to calculate a range of future year design values.

5.3.2.2 Model Uncertainty

Two sources of uncertainty in modeling future year design values are relatively straight forward to quantify: 1) the representativeness of the modeling base year design values as indicators of current air quality and 2) how the model responds to changes in emissions. There are other sources of uncertainty, i.e., model formulation or degree to which the meteorological fields represent actual conditions in 2002, however they are difficult to quantify. Maryland examined sources of uncertainty and calculated reasonable estimates of the uncertainty, not to be confused with model error.

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[45] Marufu, L.T., Taubman, B. F., Bloomer, B., Piety, C. A., Doddridge, B. G., Stehr, J. W., and Dickerson, R. R. The 2003 North American Electrical Blackout: An Accidental Experiment in Atmospheric Chemistry. *Geophysical Research Letters*, 31, L13106, 2004.

[46] Hu, Y., Odman, M. T., and Russell, A. G. Re-examination of the 2003 North American Electrical Blackout Impacts on Regional Air Quality. *Geophysical Research Letters*, 33, 2006.

[47] The University of Maryland is reviewing preliminary results of the study, which were unavailable to New Jersey as of the date of this final SIP revision.

5.3.2.2.1 Uncertainty in Modeling Base Year Design Value

The USEPA's recommended procedure for calculating modeling design values calls for creating 3-year averages of the fourth highest 8-hour average ozone reading for the individual years. Since there is some variability in these 3-year averages, the USEPA further recommends averaging three such values from successive years to obtain a design value that is centered on the base year (e.g., for 2002, one would take the 3-year averages from 2000-2002, 2001-2003 and 2002-2004, thereby giving 2000 and 2004 single weight, 2001 and 2003 double weight, and 2002 triple weight in a 5-year average). Since variations in meteorology lead to substantive variations in year-to-year peak ozone values, the degree to which the base year, or any of these 3-year periods, is representative of overall conditions in the area is one source of uncertainty in determining whether or not an area will come into attainment in the future.

Currently, most ozone monitoring locations throughout the Northeast show improving trends in ozone concentrations over the years that went into the 5-year weighted average, though the design values at some have risen modestly. The average difference between the highest and lowest 3-year design values is 6 ppb. Similarly, the average standard deviation for each site over this time period is +/- 3 ppb (using standard deviation only as an estimate of variability and not suggesting that a 3-data point standard deviation is adequate for any individual station). Both these measures suggest that variations in meteorology can reasonably be expected to produce substantial variability in the design values themselves. Therefore, it appears resonable that the representativeness of the design value can produce an uncertainty of 3 ppb about some central value.

5.3.2.2.2 Uncertainty in Model Response to Changes

Results from similar 2009 photochemical modeling scenarios that predict 8-hour ozone concentrations were used to provide insight into how the CMAQ model responds to changes in emissions. The modeling scenarios used were the OTC base A and base B modeling, model outputs at overlapping monitors from VISTAS Regional Planning Organization, and OTC's 2009 BOTW modeling run. The OTC base A and base B cases utilize two different versions of the CMAQ model (4.4 and 4.5) and different versions of the base year inventory. The VISTAS modeling represented a different, partially independent, attempt at modeling future year design values using somewhat different emissions, different meteorology, and a slightly different modeling platform. The OTC BOTW modeling run was also examined because its results are similar to the other 2009 future base scenarios, except for a few additional emissions control strategies.

There were not enough scenarios to generate a proper standard deviation at each site. However, the average difference from the predictions give an estimate of variability between model runs at ozone monitoring sites across the OTC modeling domain. The average difference was +/- 0.8 ppb. The range represents the variability to be expected from different attempts at modeling future year air quality, and some of the variability expected from small errors in the emissions inventory. The range of 2009 projections does not represent the full uncertainty in future year results, but represents the sensitivity

of the model to small variations in emissions. Therefore, the range represents only part of the uncertainty in the modeled result. Emissions are likely more uncertain than these simple estimates would suggest, with uncertainty in some emissions inventory categories as high as 50 percent.[48]

5.3.2.2.3 Results

The results of these analyses can be combined to give a conservative estimate of the uncertainty in future year design values. Since the representativeness of the base year design year and variations in future year design values due to emission changes are not correlated, standard error propagation techniques can be used, namely by squaring and adding the uncertainties, and taking the square root of the sum to get the combined uncertainty. The uncertainties (+/- 3 ppb and +/- 0.8 ppb) do not add because they are not correlated, so one is as likely to be positive as the other is to be negative. Therefore, the combination gives an uncertainty in future year design values of 3.1 ppb.

5.3.2.3 Design Value Ranges

The previously discussed analyses show that on the highest ozone days, CMAQ's performance is not as good as on lower ozone days, which is a statistical reflection of CMAQ's inability to capture large-scale deviations from average or median conditions. This conclusion is a reasonable assumption since all the USEPA modeling performance criteria are strongly geared toward average performance at the surface. However, excellent performance in predicting domain-wide ozone averages does not mean CMAQ will predict excessive ozone concentrations, ozone changes, or the dynamic range of ozone concentrations at particular locations with similar accuracy. These deviations occur on days with poor air quality. Therefore, these shortcomings and associated uncertainties need to be taken into consideration when producing future year design values.

In order to account for CMAQ's under prediction of transport and emission reduction benefits, the 2009 model results presented in Table 5.3 are adjusted. This adjustment is based on a methodology developed by the Maryland Department of the Environment.[49] Staff at the Maryland Department of the Environment calculated a range of 2009 design values at each site in the Southern New Jersey/Philadelphia nonattainment area. The Maryland methodology was then used to calculate a range of 2009 design values at each site in the Northern New Jersey/New York/Connecticut nonattainment area.

The methodology and calculations employed in arriving at the 2009 modeled design value ranges adjusted for transport are outlined in Table 5.4. As previously discussed, the CMAQ model seems to under predict emission reduction benefits by a factor of at

[48] Choi, Y.J., Ehrman, S. H., Calabrese, R. V., Stehr, J. W., and Dickerson, R. R. A Combined Approach for the Evaluation of a VOC Emissions Inventory. *Journal of the Air and Waste Management Association*, 56, 169–178, February 2006.

[49] Maryland Department of the Environment. Appendix G-9: Uncertainty in CMAQ and Over-predictions of Future Year Ozone Design Values, Cecil County, Maryland 8-Hour Ozone State Implementation Plan and Base Year Inventory. Maryland Department of the Environment, June 15, 2007.

least 2 (i.e. 100%). In order to be conservative, in these calculations it is assumed that CMAQ under predicts by a factor of 1.5 (i.e. 50%).

Table 5.4: Methodology for Calculating 2009 Modeled Design Value Ranges Adjusted for Transport

Note: All values are 8-hour ozone design values (ppb)

The monitoring station at Fairhill, Maryland, which is part of the Southern New Jersey/ Philadelphia nonattainment area, was used for the following sample calculations.

Given:

Observed 2002 = 97.7 ppb
Modeled 2009 BOTW = 81 ppb
Modeled Benefit = Observed 2002 –Modeled 2009 BOTW-B4
= 97.7 ppb – 81 ppb = **16.7 ppb**

'Actual' Benefit = Modeled Benefit x 2 →

Explanation: Factor of 2 is used to account for the 100% under estimation of the emissions reduction benefits by CMAQ. This is due to the model's insensitivity to emissions changes.

Allowing for considerable margin, the under estimation of the 'Actual' Benefit is conservatively cut in half (50%). The conservative 'Actual' Benefit is calculated as follows:

$$\text{'Actual' Benefit}_{\text{Conservative}} = \text{Modeled Benefit} \times 1.5 = 16.7 \text{ ppb} \times 1.5 = \underline{\mathbf{25.05 \text{ ppb}}}$$

$$\text{2009 Transport Adjusted} = \text{Observed 2002} - \text{'Actual' Benefit}_{\text{Conservative}}$$
$$= 97.7 \text{ ppb} - 25.05 \text{ ppb} = \underline{\mathbf{72.7 \text{ ppb}}}$$

2009 Transport Adjusted Range Calculations:

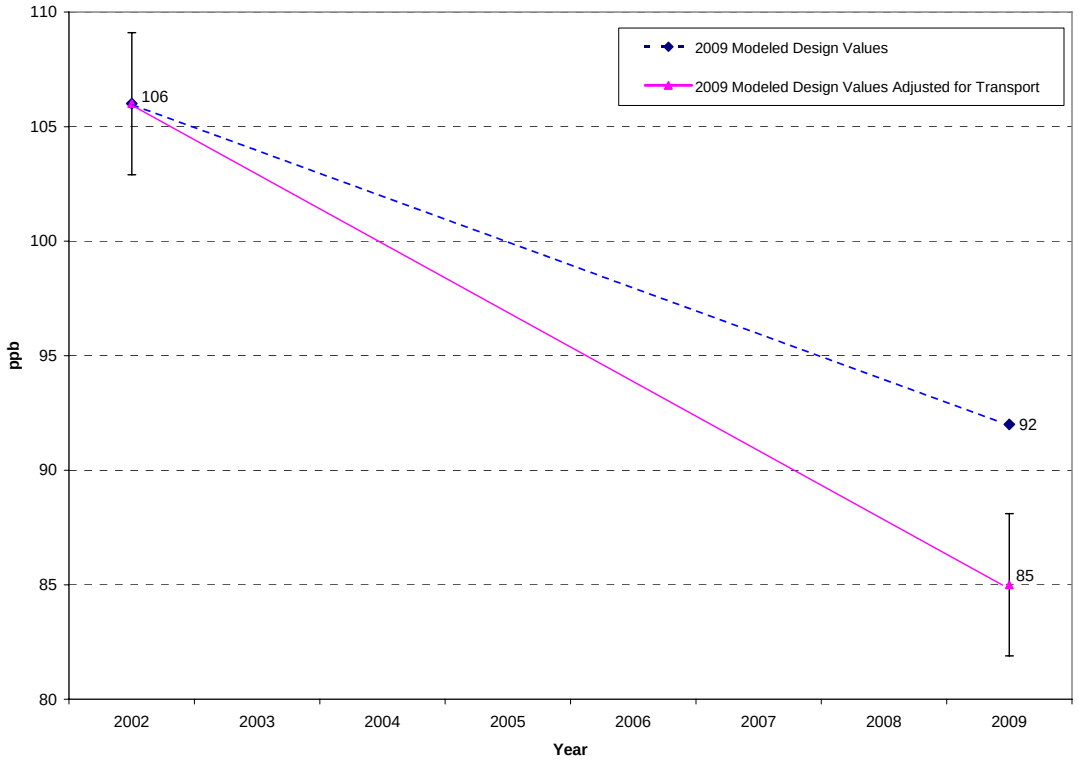
Upper Bound = 2009 Transport Adjusted + 3.1 ppb = 72.7 ppb + 3.1 ppb = **75.8 ppb**
Lower Bound = 2009 Transport Adjusted – 3.1 ppb = 72.7 ppb – 3.1 ppb = **69.6 ppb**

The 3.1 ppb adjustment to calculate the lower bound and upper bound represents the uncertainty in future design values.[50]

As an example, the comparison of the 2009 modeled design value and the 2009 modeled design value ranges adjusted for transport for Colliers Mills is presented in Figure 5.7.

[50] Maryland Department of the Environment. Appendix G-9: Uncertainty in CMAQ and Over-predictions of Future Year Ozone Design Values, Cecil County, Maryland 8-Hour Ozone State Implementation Plan and Base Year Inventory. Maryland Department of the Environment, June 15, 2007.

Figure 5.7: 2009 Modeled Design Value vs. 2009 Modeled Design Value Ranges Adjusted for Transport for Colliers Mills, New Jersey



The base year (2002) design values, the CMAQ modeled design values for 2009, and the 2009 modeled design value ranges adjusted for transport, which are based on the conservative 50 percent under response estimate and accounts for the CMAQ model's lack of responsiveness, are presented in Table 5.5 and Figure 5.8a and Figure 5.8b.

Table 5.5: Observed (DV_B), Modeled (DV_F) and Modeled Adjusted for Transport (DV_{AT}) Design Values for the NNJ/NY/CT and SNJ/Phila. Nonattainment Areas

Site Name - County, State	Site Number	Air Monitoring Data	Modeling Results	Modeling Results Adjusted for Transport			
		2002 Modeling Baseline (DV_B) (ppb)	2009 Modeled Results (DV_F) (ppb)	2009 DV_{AT} (ppb)	Upper and Lower Bound of 2009 DV_{AT} (ppb)		
NNJ/NY/CT Nonattainment Area							
Teaneck - BERGEN CO, NJ	340030005	91	85	81	84	-	78
Bayonne - HUDSON, NJ	340170006	84	77	73	76	-	70
Flemington - HUNTERDON, NJ	340190001	95	83	76	79	-	73
Rutgers Univ. - MIDDLESEX CO, NJ	340230011	96	83	76	79	-	73
Monmouth Univ. - MONMOUTH CO, NJ	340250005	95	84	78	81	-	75
Chester - MORRIS CO, NJ	340273001	95	84	78	81	-	75
Ramapo - PASSAIC CO, NJ	340315001	86	77	72	75	-	69
Botanical Garden - BRONX CO, NY	360050083	83	78	75	78	-	72
Queens College - QUEENS CO, NY	360810124	83	74	69	72	-	66
Susan Wagner - RICHMOND CO, NY	360850067	93	84	79	82	-	76
Babylon - SUFFOLK CO, NY	361030002	93	85	80	83	-	77
Holtsville - SUFFOLK CO, NY	361030009	97	89	85	88	-	81
Riverhead - SUFFOLK CO, NY	361030004	83	74	69	72	-	66
White Plains - WESTCHESTER CO, NY	361192004	91	85	81	84	-	78
Danbury - FAIRFIELD CO, CT	90011123	95	85	79	82	-	76
Greenwich - FAIRFIELD CO, CT	90010017	95	87	82	85	-	79
Stratford - FAIRFIELD CO, CT	90013007	98	90	85	88	-	82
Westport - FAIRFIELD CO, CT	90019003	94	85	80	83	-	77
Middletown - MIDDLESEX CO, CT	90070007	95	84	78	81	-	75
Hamden - NEW HAVEN CO, CT	90099005	93	85	80	83	-	77
Madison - NEW HAVEN CO, CT	90093002	98	88	82	85	-	79
SNJ/Phila. Nonattainment Area							
Fairhill - CECIL CO, MD	240150003	97	81	72	75	-	69
Brandywine Creek - NEW CASTLE CO, DE	100031010	92	81	75	78	-	72
Bellefonte - NEW CASTLE CO, DE	100031013	90	78	71	74	-	68
Killens Pond - KENT CO, DE	100010002	88	78	72	75	-	69
Lewes - SUSSEX CO, DE	100051003	87	77	72	75	-	68
Lums Pond - NEW CASTLE CO, DE	100031007	94	79	71	74	-	68
Seaford - SUSSEX CO, DE	100051002	90	75	67	70	-	64
Bristol - BUCKS CO, PA	420170012	99	88	82	85	-	79
West Chester - CHESTER CO, PA	420290050	95	82	75	78	-	72
New Garden - CHESTER CO, PA	420290100	94	79	71	74	-	68
Chester - DELAWARE CO, PA	420450002	91	81	75	78	-	72
Norristown - MONTGOMERY CO, PA	420910013	92	81	75	78	-	72
Elmwood - PHILADELPHIA CO, PA	421010136	83	75	71	74	-	67
Lab - PHILADELPHIA CO, PA	421010004	71	64	60	63	-	57
Roxborough - PHILADELPHIA CO, PA	421010014	90	82	77	80	-	74
Northeast Airport - PHILADELPHIA CO, PA	421010024	96	87	82	85	-	79
Colliers Mills - OCEAN CO, NJ	340290006	106	92	85	88	-	81
Rider - MERCER CO, NJ	340210005	97	86	80	83	-	77
Ancora State Hospital - CAMDEN CO, NJ	340071001	100	87	80	83	-	77
Camden - CAMDEN CO, NJ	340070003	98	88	82	85	-	79
Clarksboro - GLOUCESTER CO, NJ	340155001	98	88	82	85	-	79
Millville - CUMBERLAND CO, NJ	340110007	95	81	73	76	-	70
Nacote Creek - ATLANTIC CO, NJ	340010005	89	77	71	74	-	67

NOTE: Highlighted sites are the monitor in each nonattainment area with the highest ozone design value, e.g. the controlling monitor.

Figure 5.8a: Various Design Values for the Ozone Monitoring Sites in the Northern New Jersey/New York/Connecticut Nonattainment Area

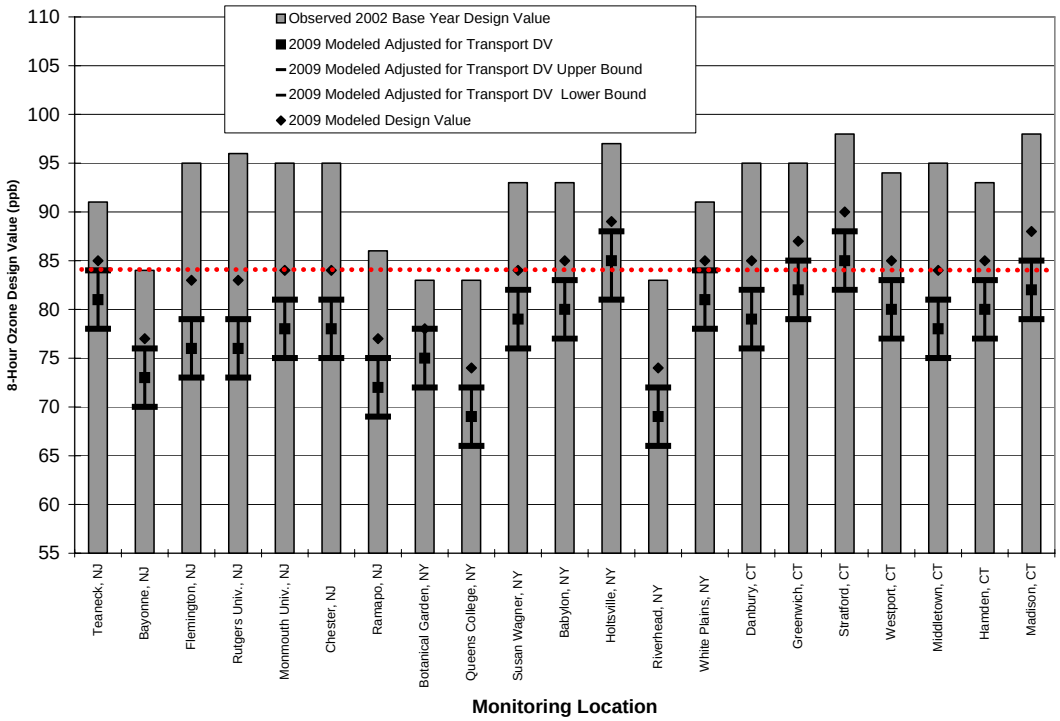
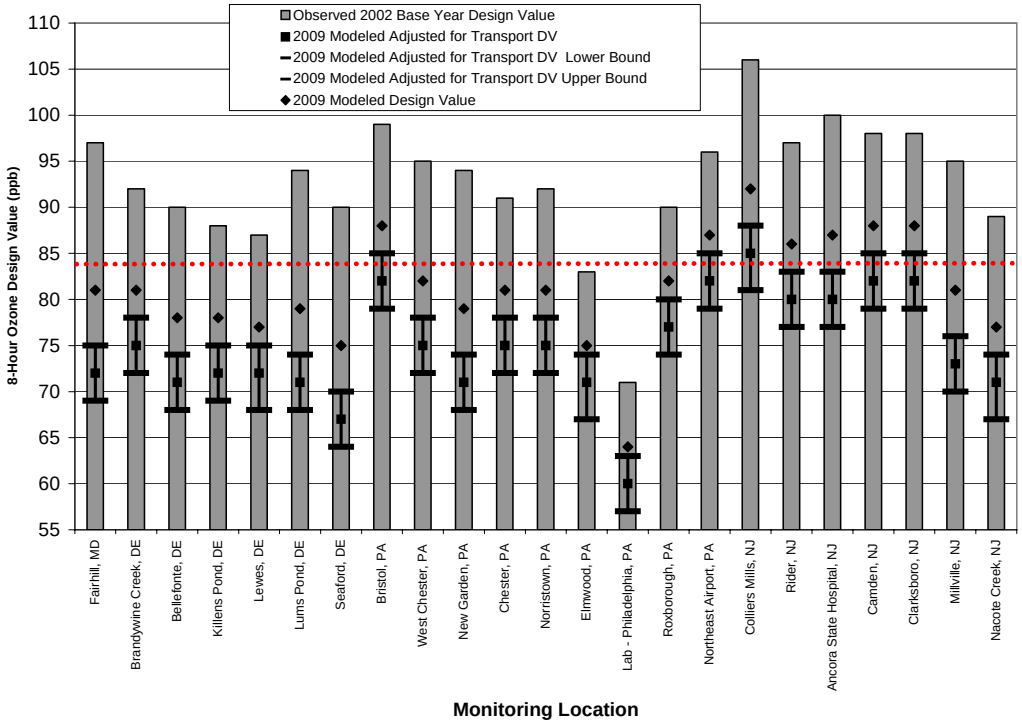


Figure 5.8b: Various Design Values for the Ozone Monitoring Sites in the Southern New Jersey/Philadelphia Nonattainment Area



With respect to the demonstration of attainment for 8-hour ozone, the results of these analyses indicate that New Jersey's air quality should be better than CMAQ predicts. Based on the 2009 modeled design value ranges adjusted for transport, the New Jersey monitors in the Northern New Jersey/New York/Connecticut and Southern New Jersey/Philadelphia nonattainment areas show plausible attainment of the 8-hour ozone standard in 2010.

5.4 Supporting Analyses to Address Uncertainty

This section provides analyses and data that address the uncertainty in the modeled results and support New Jersey's conclusion that the 2009 modeled design values adjusted for transport reflect future ozone concentrations that demonstrate plausible attainment of the 8-hour ozone standard by 2010 in the Northern New Jersey/New York/Connecticut and Southern New Jersey/Philadelphia nonattainment areas.

5.4.1 2009 Modeled Ozone Design Values Are Being Measured Now

Monitored 8-hour ozone design values for the controlling monitors in both of the New Jersey multi-state associated nonattainment areas have decreased between 2002, the baseline year for this SIP, and 2006 (Figure 5.9). In fact, the 2006 monitored ozone concentrations for the controlling monitors in both of the New Jersey associated multi-state nonattainment areas are almost equal to the 2009 modeled design values (also shown in Figure 5.9 and Table 5.6).

Stratford, Connecticut and Colliers Mills, New Jersey, the controlling monitors in the Northern New Jersey/New York/Connecticut and Southern New Jersey/ Philadelphia nonattainment areas, respectively, had 2006 monitored design value that were only 2ppb and 1 ppb, respectively, higher than that modeled for 2009. Additional control measures being implemented between 2006 and 2009 will result in additional air quality benefits. This comparison supports the argument that 2009 monitored design values will be lower than those predicted by CMAQ, i.e., the 2009 modeled design values.

Figure 5.9: 2002-2006 Monitored 8-Hour Ozone Design Values Compared to 2009 Modeled Ozone Design Values

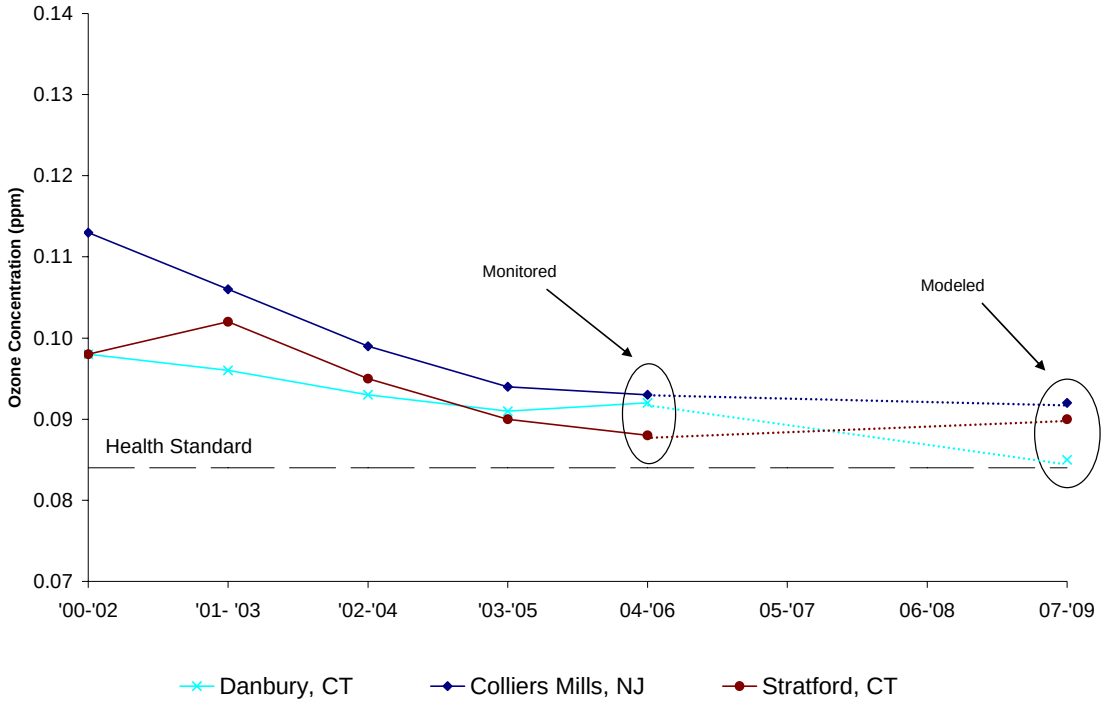


Table 5.6: 2002 and 2006 Monitored Ozone Design Values Compared to 2009 Modeled Ozone Design Values

Site Name - County, State	Site Number	Air Monitoring Data		Modeling Results
		2002 Modeling Baseline (DV_B)(ppb)	2004-2006 Actual Design Values (ppb)	2009 Modeled Results (DV_F) (ppb)
NNJ/NY/CT Nonattainment Area				
Teaneck - BERGEN CO, NJ	340030005	91	86	85
Bayonne - HUDSON, NJ	340170006	84	86	77
Flemington - HUNTERDON, NJ	340190001	95	89	83
Rutgers Univ. - MIDDLESEX CO, NJ	340230011	96	88	83
Monmouth Univ. - MONMOUTH CO, NJ	340250005	95	85	84
Chester - MORRIS CO, NJ	340273001	95	82	84
Ramapo - PASSAIC CO, NJ	340315001	86	80	77
Botanical Garden - BRONX CO, NY	360050083	83	74	78
Queens College - QUEENS CO, NY	360810124	83	72	74
Susan Wagner - RICHMOND CO, NY	360850067	93	89	84
Babylon - SUFFOLK CO, NY	361030002	93	89	85
Holtsville - SUFFOLK CO, NY	361030009	97	***	89
Riverhead - SUFFOLK CO, NY	361030004	83	85	74
White Plains - WESTCHESTER CO, NY	361192004	91	85	85
Danbury - FAIRFIELD CO, CT	90011123	95	92	85
Greenwich - FAIRFIELD CO, CT	90010017	95	87	87
Stratford - FAIRFIELD CO, CT	90013007	98	88	90
Westport - FAIRFIELD CO, CT	90019003	94	86	85
Middletown - MIDDLESEX CO, CT	90070007	95	89	84
Hamden - NEW HAVEN CO, CT	90099005	93	77	85
Madison - NEW HAVEN CO, CT	90093002	98	88	88
SNJ/Phila. Nonattainment Area				
Fairhill - CECIL CO, MD	240150003	97	90	81
Brandywine Creek - NEW CASTLE CO, DE	100031010	92	82	81
Bellefonte - NEW CASTLE CO, DE	100031013	90	81	78
Killens Pond - KENT CO, DE	100010002	88	80	78
Lewes - SUSSEX CO, DE	100051003	87	82	77
Lums Pond - NEW CASTLE CO, DE	100031007	94	78	79
Seaford - SUSSEX CO, DE	100051002	90	80	75
Bristol - BUCKS CO, PA	420170012	99	86	88
West Chester - CHESTER CO, PA	420290050	95	***	82
New Garden - CHESTER CO, PA	420290100	94	86	79
Chester - DELAWARE CO, PA	420450002	91	83	81
Norristown - MONTGOMERY CO, PA	420910013	92	85	81
Elmwood - PHILADELPHIA CO, PA	421010136	83	72	75
Lab - PHILADELPHIA CO, PA	421010004	71	62	64
Roxborough - PHILADELPHIA CO, PA	421010014	90	78	82
Northeast Airport - PHILADELPHIA CO, PA	421010024	96	90	87
Colliers Mills - OCEAN CO, NJ	340290006	106	93	92
Rider - MERCER CO, NJ	340210005	97	87	86
Ancora State Hospital - CAMDEN CO, NJ	340071001	100	89	87
Camden - CAMDEN CO, NJ	340070003	98	84	88
Clarksboro - GLOUCESTER CO, NJ	340155001	98	86	88
Millville - CUMBERLAND CO, NJ	340110007	95	84	81
Nacote Creek - ATLANTIC CO, NJ	340010005	89	79	77

*** Not enough data to calculate a 2006 design value.
NOTE: Highlighted sites are the monitor in each nonattainment area with the highest ozone design value, e.g. the controlling monitor.

5.4.2 Accounting for Unusual Meteorology

The impact of meteorology has a significant effect on year to year variations in ozone concentrations. Hot days of summer are particularly conducive to ozone formation and can produce long periods of elevated ozone concentrations. Several analyses demonstrate that the summer of 2002 was one of the worst ozone seasons since the early 1990s. As discussed in Appendix B, 2002 was also the year with the largest number of days equal to or greater than 90°F in the period 1997-2006 for both the Philadelphia International Airport and New York City-Central Park National Oceanic and Atmospheric Administration weather stations. Figures B37 and B38 show that the greatest exceedances of the 8-hour NAAQS in both the Northern New Jersey/New York/Connecticut and Southern New Jersey/Philadelphia nonattainment areas during this period occurred during 2002. In addition, the State of Connecticut determined the period of 2001-2003 as having the highest number of maximum temperatures in any 3-year period over the past 30 years at the Bradley International Airport weather station.[51] Furthermore, the USEPA analyzed meteorological effects on ozone levels and concluded that 2002 experienced above-normal ozone producing conditions, with above-normal temperatures and below-normal precipitation in most of the country.[52,53] As such, a year with abnormal meteorological conditions should not unduly influence the ozone modeling baseline design value for photochemical modeling and resulting planning actions.

As discussed in Section 5.2.4, the USEPA recommended method for calculating a monitor's modeling baseline design value places more emphasis on the 2002 ozone season than the other years used in the calculation. In the USEPA recommended method, the modeling design value is the average of three–three year periods centered around 2002. Therefore, the 2002 ozone season contributes a third of the baseline concentration; 2001 and 2003 contribute approximately 22% each, and 2000 and 2004 contribute about 11% each. Thus, this methodology more heavily weighs ozone concentrations for 2002 than for other years, thus biasing, on the high side, the modeling baseline design values.

An alternate method of calculating the modeling baseline design values that would not bias the results is to take the straight average of the 4th highest ozone values over the same five years used in the traditional calculation of the 2002 baseline (2000 to 2004). This approach weighs each year equally and results in a reduction of the 2002 modeling baseline design value by an average 2 ppb, as shown in the example in Table 5.7.

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[51] Connecticut Department of Environmental Protection. Revision to Connecticut's State Implementation Plan: Meeting the Interstate Air Pollution Transport Requirements of Clean Air Act Section 110(a)(2)(D)(I). Connecticut Department of Environmental Protection, March 13, 2007.

[52] USEPA. Evaluating the Ozone Control Programs in the Eastern United States: Focus on the NO_x Budget Trading Program, 2004. United States Environmental Protection Agency, Office of Air and Radiation, Office of Air Quality Planning and Standards, and Office of Atmospheric Programs, Washington, D.C., EPA454-K-05-001, August 2005.

[53] USEPA. 2005 Program Compliance and Environmental Results: NO_x Budget Trading Program. United States Environmental Protection Agency, Office of Air and Radiation, Office of Air Quality Planning and Standards, and Office of Atmospheric Programs, Air Quality Assessment Division, Washington, D.C., EPA430-R-06-013, September 2006.

Table 5.7: Alternate Modeling Baseline Design Value (DV_{Balt}) Using the Average of the Fourth Highest Maximum Ozone Concentration in the Five Year Period Centered Around 2002 for Colliers Mills, New Jersey

	2000	2001	2002	2003	2004	USEPA DV_B	Alternate DV_{Balt}
Fourth Maximum 8-Hour Ozone Concentration (ppb)	115	108	116	95	88	106	104

Use of an alternate modeling baseline design value based on a straight average is not an unreasonable proposition. In the current case (2000-2004), the straight average removes a high bias. However, use of the straight average with data from other years could remove a low bias. For example, consider a modeling baseline design value for Colliers Mills centered on 2004, i.e., the years 2002-2006. 2004 is generally considered to be an unusually cool summer with ozone concentrations that were generally lower than years before or after it. Using the USEPA method for calculating a monitor's modeling baseline design value places more emphasis on the modeling baseline year ozone season (2004 in this example) than the other years used in the calculation, and results in a modeling baseline design value of 96 ppb.[54] The straight average of the 4th highest ozone values over the same five years (2002-2006) is 98 ppb. In this case, the straight average method produces a higher baseline design value than the USEPA method. Thus illustrating that the alternate method provides a more robust approach.

If a 2002 alternate modeling baseline design value were used, the 2009 modeled design values would be lower, as shown in Table 5.8. The calculations on how the Alternative Modeling Baseline Design Values, or DV_{Balt}, were calculated are shown in Appendix D12.

[54] The fourth maximum 8-hour ozone concentrations at Colliers Mills, New Jersey for 2005 was 100 ppb and for 2006 was 92 ppb.

Table 5.8: Calculated and Modeled Design Values for the Northern New Jersey/New York/Connecticut and Southern New Jersey/Philadelphia Nonattainment Areas

Site Name - County, State	Site Number	Air Monitoring Data		Modeling Results	
		2002 Modeling Baseline (DV_B) (ppb)	2002 Modeling Alternate Baseline (DV_{Balt}) (ppb)	2009 Modeled Results (DV_F) (ppb)	2009 Modeled Results using Alternate Baseline (DV_{Falt}) (ppb)
NNJ/NY/CT Nonattainment Area					
Teaneck - BERGEN CO, NJ	340030005	91	88	85	81
Bayonne - HUDSON, NJ	340170006	84	84	77	76
Flemington - HUNTERDON, NJ	340190001	95	94	83	82
Rutgers Univ. - MIDDLESEX CO, NJ	340230011	96	94	83	82
Monmouth Univ. - MONMOUTH CO, NJ	340250005	95	94	84	82
Chester - MORRIS CO, NJ	340273001	95	92	84	81
Ramapo - PASSAIC CO, NJ	340315001	86	84	77	75
Botanical Garden - BRONX CO, NY	360050083	83	79	78	74
Queens College - QUEENS CO, NY*	360810124	83	83	74	74
Susan Wagner - RICHMOND CO, NY	360850067	93	91	84	82
Babylon - SUFFOLK CO, NY	361030002	93	90	85	82
Holtsville - SUFFOLK CO, NY	361030009	97	94	89	87
Riverhead - SUFFOLK CO, NY	361030004	83	81	74	72
White Plains - WESTCHESTER CO, NY	361192004	91	88	85	82
Danbury - FAIRFIELD CO, CT	90011123	95	93	85	83
Greenwich - FAIRFIELD CO, CT	90010017	95	91	87	83
Stratford - FAIRFIELD CO, CT	90013007	98	95	90	87
Westport - FAIRFIELD CO, CT	90019003	94	91	85	82
Middletown - MIDDLESEX CO, CT	90070007	95	93	84	82
Hamden - NEW HAVEN CO, CT*	90099005	93	93	85	84
Madison - NEW HAVEN CO, CT	90093002	98	94	88	85
SNJ/Phila. Nonattainment Area					
Fairhill - CECIL CO, MD	240150003	97	97	81	80
Brandywine Creek - NEW CASTLE CO, DE	100031010	92	90	81	78
Bellefonte - NEW CASTLE CO, DE*	100031013	90	85	78	74
Killens Pond - KENT CO, DE	100010002	88	87	78	77
Lewes - SUSSEX CO, DE	100051003	87	85	77	75
Lums Pond - NEW CASTLE CO, DE	100031007	94	88	79	74
Seaford - SUSSEX CO, DE	100051002	90	89	75	75
Bristol - BUCKS CO, PA	420170012	99	96	88	86
West Chester - CHESTER CO, PA*	420290050	95	95	82	82
New Garden - CHESTER CO, PA*	420290100	94	94	79	78
Chester - DELAWARE CO, PA	420450002	91	90	81	79
Norristown - MONTGOMERY CO, PA	420910013	92	92	81	81
Elmwood - PHILADELPHIA CO, PA	421010136	83	81	75	73
Lab - PHILADELPHIA CO, PA	421010004	71	69	64	62
Roxborough - PHILADELPHIA CO, PA	421010014	90	88	82	80
Northeast Airport - PHILADELPHIA CO, PA	421010024	96	94	87	84
Colliers Mills - OCEAN CO, NJ	340290006	106	104	92	90
Rider - MERCER CO, NJ	340210005	97	95	86	84
Ancora State Hospital - CAMDEN CO, NJ	340071001	100	99	87	86
Camden - CAMDEN CO, NJ	340070003	98	94	88	84
Clarksboro - GLOUCESTER CO, NJ	340155001	98	97	88	87
Millville - CUMBERLAND CO, NJ	340110007	95	94	81	79
Nacote Creek - ATLANTIC CO, NJ	340010005	89	87	77	76

Note: 2002 Modeling Alternate Baseline Design Value calculated using the average of less than 5 years of monitoring data.
NOTE: Highlighted sites are the monitor in each nonattainment area with the highest ozone design value, e.g. the controlling monitor.

The 2009 modeled design values calculated using the alternate 2002 modeling baseline design value are lower than the 2009 modeled values by an average 2 ppb. For the Northern New Jersey/New York/Connecticut nonattainment area, 9 monitors showed 2009 modeled design values greater than 84 ppb using the USEPA baseline methodology but only 3 monitors showed 2009 modeled design values greater than 84 ppb (87, 87 and 85 ppb) using the alternate baseline methodology. For the Southern New Jersey/ Philadelphia nonattainment area, 7 monitors showed 2009 modeled design values greater

than 84 ppb using the USEPA baseline methodology but only 3 monitors showed 2009 modeled design values greater than 84 ppb (90, 86 and 86 ppb) using the alternate baseline methodology. Use of this alternative baseline design value calculation method removes the excessive use of unusual meteorological influence of the 2002 ozone season and results in lower 2009 modeled design values.

5.4.3 Using a Different Model Relative Response Factor

The 2009 modeled ozone design values were calculated by multiplying the modeling baseline design values, based on monitored data, with a Relative Response Factor (RRF). (RRF is discussed in detail in Section 5.2.4) The USEPA method uses the RRF associated with the maximum 8-hour ozone concentration in the grid cell associated with a monitoring site (i.e. maximum concentration of 9 grid cells - the monitoring grid cell plus the 8 grid cells surrounding the monitoring grid cell) averaged over a certain number of days when the ozone NAAQS is exceeded.

The use of an average response RRF to calculate the 2009 modeled ozone design values shows air quality improvements that are already being measured in the air monitors in 2006. Therefore, use of a maximum response[55] RRF might provide 2009 modeled zone design values that are more likely to be experienced in 2009. Therefore, the maximum response RRF for each of the New Jersey associated multi-state nonattainment areas (see Table 5.9) was applied to the model results for all the monitors in the nonattainment area and the 2009 modeled ozone design values were recalculated.

Table 5.9: Relative Response Factors for the Northern New Jersey/ New York/Connecticut and Southern New Jersey/Philadelphia Nonattainment Areas*

Nonattainment Area	Maximum Response	Minimum Response	Average Response
Northern New Jersey/ New York/Connecticut	0.874	0.939	0.905
Southern New Jersey/Philadelphia	0.831	0.911	0.878

*The values in this table are the minimum, maximum and average response RRFs from the 2009 BOTW modeling run for the ozone monitors in the entire nonattainment area.

The 2009 modeled design values were recalculated using the 2002 Modeled Alternate Baseline Design Value and the maximum response RRF (DV_{Falt-r}) for the Northern New Jersey/New York/Connecticut and Southern New Jersey /Philadelphia nonattainment areas, respectively. (see Table 5.10) These calculations are more fully described in Appendix D12.

[55] If a 9 cell maximum ozone value of 90 ppb was multiplied by the average response RRF value, 0.878, the result would be 79 ppb. If a 9 cell maximum ozone value of 90 ppb was multiplied by the maximum response RRF value, 0.831, the result would be 75 ppb. Therefore, a maximum response RRF reflects a larger air quality response and thus lower ozone concentrations.

Table 5.10: 2009 Modeled Design Values Using the Alternate Baseline Design Value and Alternate RRF for the Northern New Jersey/New York/Connecticut and Southern New Jersey/Philadelphia Nonattainment Areas

Site Name - County, State	Site Number	Air Monitoring Data		Modeling Results	
		2002 Modeling Baseline (DV_B) (ppb)	2002 Modeling Alternate Baseline (DV_{Balt}) (ppb)	2009 Modeled Results (DV_F) (ppb)	2009 Modeled Results using Alternate Baseline and RRF (DV_{Falt-r}) (ppb)
NNJ/NY/CT Nonattainment Area					
Teaneck - BERGEN CO, NJ	340030005	91	88	85	76
Bayonne - HUDSON, NJ	340170006	84	84	77	73
Flemington - HUNTERDON, NJ	340190001	95	94	83	82
Rutgers Univ. - MIDDLESEX CO, NJ	340230011	96	94	83	82
Monmouth Univ. - MONMOUTH CO, NJ	340250005	95	94	84	82
Chester - MORRIS CO, NJ	340273001	95	92	84	80
Ramapo - PASSAIC CO, NJ	340315001	86	84	77	73
Botanical Garden - BRONX CO, NY	360050083	83	79	78	69
Queens College - QUEENS CO, NY*	360810124	83	83	74	73
Susan Wagner - RICHMOND CO, NY	360850067	93	91	84	79
Babylon - SUFFOLK CO, NY	361030002	93	90	85	78
Holtsville - SUFFOLK CO, NY	361030009	97	94	89	82
Riverhead - SUFFOLK CO, NY	361030004	83	81	74	70
White Plains - WESTCHESTER CO, NY	361192004	91	88	85	76
Danbury - FAIRFIELD CO, CT	90011123	95	93	85	81
Greenwich - FAIRFIELD CO, CT	90010017	95	91	87	79
Stratford - FAIRFIELD CO, CT	90013007	98	95	90	83
Westport - FAIRFIELD CO, CT	90019003	94	91	85	79
Middletown - MIDDLESEX CO, CT	90070007	95	93	84	81
Hamden - NEW HAVEN CO, CT*	90099005	93	93	85	81
Madison - NEW HAVEN CO, CT	90093002	98	94	88	82
SNJ/Phila. Nonattainment Area					
Fairhill - CECIL CO, MD	240150003	97	97	81	80
Brandywine Creek - NEW CASTLE CO, DE	100031010	92	90	81	74
Bellefonte - NEW CASTLE CO, DE*	100031013	90	85	78	71
Killens Pond - KENT CO, DE	100010002	88	87	78	72
Lewes - SUSSEX CO, DE	100051003	87	85	77	70
Lums Pond - NEW CASTLE CO, DE	100031007	94	88	79	73
Seaford - SUSSEX CO, DE	100051002	90	89	75	73
Bristol - BUCKS CO, PA	420170012	99	96	88	79
West Chester - CHESTER CO, PA*	420290050	95	95	82	79
New Garden - CHESTER CO, PA*	420290100	94	94	79	78
Chester - DELAWARE CO, PA	420450002	91	90	81	74
Norristown - MONTGOMERY CO, PA	420910013	92	92	81	76
Elmwood - PHILADELPHIA CO, PA	421010136	83	81	75	67
Lab - PHILADELPHIA CO, PA	421010004	71	69	64	57
Roxborough - PHILADELPHIA CO, PA	421010014	90	88	82	73
Northeast Airport - PHILADELPHIA CO, PA	421010024	96	94	87	78
Colliers Mills - OCEAN CO, NJ	340290006	106	104	92	86
Rider - MERCER CO, NJ	340210005	97	95	86	78
Ancora State Hospital - CAMDEN CO, NJ	340071001	100	99	87	82
Camden - CAMDEN CO, NJ	340070003	98	94	88	78
Clarksboro - GLOUCESTER CO, NJ	340155001	98	97	88	80
Millville - CUMBERLAND CO, NJ	340110007	95	94	81	78
Nacote Creek - ATLANTIC CO, NJ	340010005	89	87	77	72

Note: 2002 Modeling Alternate Baseline Design Value calculated using the average of less than 5 years of monitoring data.
For the Southern New Jersey/Philadelphia nonattainment area, the RRF_{min} = 0.831; for the Northern New Jersey/New York/Connecticut nonattainment area, the RRF_{min} = 0.874.

NOTE: Highlighted sites are the monitor in each nonattainment area with the highest ozone design value, e.g. the controlling monitor.

The 2009 modeled design values calculated using the alternate baseline and RRF values are lower by an average 5 ppb. Use of this alternative baseline design value calculation method removes the unusual meteorological influence of the 2002 ozone season and uses an RRF applying the maximum response to emission reductions within the nonattainment area. This calculation results in 2009 modeled design values within the range of the 2009 modeled design value ranges adjusted for transport. For example, the 2009 modeled design value range adjusted for transport for Colliers Mills is 81-88 ppb. The 2009 modeled design value is 92 ppb. And the 2009 modeled design value using the alternate 2002 modeling baseline value and maximum response RRF value is 86 ppb. This results in a modeled value, using the 2009 modeled design value (the USEPA's traditional approach), that falls within the range of design values adjusted for transport, therefore, further supporting New Jersey's demonstration of attainment.

5.4.4 Additional Measures Not Included in the 2009 Attainment Modeling

5.4.4.1 Introduction

New Jersey is working to propose and implement a number of additional control measures that were not included in the attainment demonstration modeling. These additional measures were the result of the efforts of the Ozone Transport Commission, the MARAMA, New Jersey's reasonably available control technology analysis, or other New Jersey initiatives to identify measures that would improve air quality. The purpose of this section is to:

- outline the methodology for making the conversion from emission reductions to air quality benefits, and
- provide the total air quality benefit (in ppb) that New Jersey estimates from the implementation of these additional measures, or refinements to the modeled measures.

5.4.4.2 Additional Quantifiable Measures

Table 5.11 lists the additional control measures and refinements that New Jersey is planning to propose by no later than November 2007, and adopt by May 2008, in accordance with the New Jersey Administrative Procedures Act (APA) (N.J.S.A. 52:14B-1 et. seq.) and the Air Pollution Control Act (APCA) (N.J.S.A. 26:2C-1 et. seq.). While these additional measures and refinements were finalized too late to be included in the 2009 BOTW modeling, they will provide additional emission reductions by 2009. As such, they provide additional evidence to support New Jersey's conclusion that both of its associated nonattainment areas will attain the 8-hour ozone standard by their required attainment dates. The remainder of this section outlines the methodology for making the conversion from emission reductions to air quality benefits.

Table 5.11: Additional Quantifiable Measures Not Included in the 2009 BOTW Modeling

Pre-2002 with benefits achieved Post-2002 - On the Books
New Jersey
New Source Review (NSR)
Post-2002 - On the Books
New Jersey Measures Done Through a Regional Effort
Additional Benefits from Modeled Measures
NO_x RACT rule 2006 (includes distributed generation)
Portable Fuel Containers 2005
Post-2002 - Beyond on the Way
New Jersey Measures Done Through a Regional Effort
Portable Fuel Containers 2009 Amendments
Certain Categories of ICI Boilers
Refinery rules[a]
High Electric Demand Day Program
New Jersey Only Measures
Petroleum Storage Tank Measures[b]
USEPA CTGs (5 categories)[c]
Case by case VOC and NO_x determinations (FSELs/AELs)
Municipal Waste Combustor Measures
Diesel Idling[d]
Diesel Inspection and Maintenance
Federal
New nonroad engine standards

[a] Includes proposed requirements for process heaters, flares, FCCs/FCUs and leak detection and repair

[b] Includes proposed requirements for floating roof top sleeves, degassing, cleaning and landing losses

[c] Includes state review and action on four new CTGs covering five categories, including flexible packaging printing materials, lithographic printing materials, letterpress printing materials, industrial cleaning solvents, and flat wood paneling coatings.

[d] The Diesel Idling Rule changes were adopted in June 2007

5.4.4.3 Methodology for Converting Emission Reductions to Air Quality Benefits

In calculating the shortfalls for 1-hour ozone SIPs, the USEPA established a simple method to estimate a change in ozone due to a change in emissions.[56] In general, this methodology compares the actual emission inventory and an estimated future year emission inventory for VOC and NO_x to monitoring data for those same time periods. This approach was updated to incorporate the latest inventory and 8-hour ozone air quality data and is used here to estimate a change in ozone. From this method, New Jersey was able to express the VOC and NO_x benefits for the additional emission reductions as decreases in ozone concentrations. For a more detailed description of this conversion methodology, see Appendix D13.

5.4.4.4 Results

When added together, all the control measures and refinements listed in Table 5.11 result in an additional 5 tons per day (tpd) reduction in VOC and 23 tpd reduction in NO_x in the Northern New Jersey/New York/ Connecticut nonattainment area, and 2 tpd reduction in VOC and 14 tpd reduction in NO_x in Southern New Jersey/Philadelphia nonattainment area.[57] In order to relate these emission reductions to the modeled attainment results discussed in Section 5.3, they need to be converted to air quality benefits, i.e., ozone concentrations in ppb.

Using the USEPA conversion methodology, reductions in ozone concentrations can be estimated based on the implementation of control measures and refinements not included in the modeling. If the measures described in Table 5.11 are implemented in New Jersey and for HEDD, regionally, the estimated air quality benefits are 0.2 – 2 ppb in the Northern New Jersey/New York/Connecticut nonattainment area and 0.3 – 4 ppb in the Southern New Jersey/Philadelphia nonattainment area.

These estimated air quality benefits further reduce the uncertainty associated with the 2009 modeled design value ranges adjusted for transport and supports New Jersey's plausible demonstration of attainment of the 8-hour ozone NAAQS in its two multi-state nonattainment areas.

The comprehensive regional modeling assessment discussed in Section 5.3 demonstrates that the New Jersey-associated nonattainment areas demonstrate plausible attainment of the 8-hour ozone NAAQS by their designated attainment date. Therefore, New Jersey is not relying on these additional measures as part of the attainment demonstration. Nor are these control measures and refinements being considered as "bundled measures" for this

[56] USEPA Region II. Technical Support Document: Modeling for the Trenton, New Jersey Portion of the Philadelphia Ozone Nonattainment Area. United States Environmental Protection Agency (USEPA), Region II, December 14, 1999

[57] These are approximate emission reduction totals as the additional control measures and refinements need to be proposed by November 2007 and adopted by May 2008, in accordance with New Jersey Administrative Procedures Act (N.J.S.A. 52:14B-1 et. seq.) and the Air Pollution Control Act (N.J.S.A. 26:2C-1 et. seq.).

final SIP revision.[58] Rather, this evaluation of emission reductions expected from these additional control measures and refinements provides further confidence that New Jersey will attain the 8-hour ozone standard by 2010, and gives the State an abundance of additional emission reductions to rely upon in the event of exceedance. The benefits of these measures and refinements will be reflected in the ambient air monitors. These measures are discussed further as part of the State's contingency measure strategy for attainment in Chapter 8.

5.4.5 Non-Quantifiable Emission Reductions Which Improve Air Quality

Unlike the quantitative measures discussed, some measures were purposely not included in the photochemical modeling exercise. While there are numerous reasons why certain emission control measures were not including in a modeling scenario, the two most significant are:

- The preparatory work needed to run these models is resource-intensive, making it neither practical nor reasonable to model every possible control measure.
- The uncertainty in calculating emission reduction benefits from certain types of control measures is acknowledged by the USEPA in its guidance for emerging measures, or measures that are difficult to accurately quantify.[59] Examples of these types of measures include tree planting or replacing roofs with reflective material, both of which help to decrease the high temperatures in an urban area that result from the 'heat island effect' that indirectly impacts ozone concentrations.

Even though it is not yet possible to determine the associated emission reductions from certain type of programs with the precision necessary for full federal approval and for SIP credit toward attainment of the 8-hour ozone NAAQS, the programs discussed in this section provide a cumulative effect of reducing air emissions, which will help bring New Jersey and its associated nonattainment areas into attainment. However, emission reductions of these air pollution control strategies were not included in the scenarios utilized in the modeling analysis, as a quantified benefit is needed for each control measure that is used in photochemical modeling.

New Jersey is aware that these control measures do and will continue to improve the State's overall air quality by indirectly decreasing ground-level ozone concentrations. As such, these strategies will result in actual air quality benefits that will be reflected in the monitoring data in both the Northern New Jersey/New York/Connecticut and Southern New Jersey/Philadelphia nonattainment areas in the years leading up to 2010. New

[58] USEPA. Incorporating Bundled Measures in a State Implementation Plan (SIP). United States Environmental Protection Agency (USEPA), Office of Air and Radiation, Air Quality Strategies and Standards Division, Office of Air Quality Planning and Standards, and Office of Transportation and Air Quality, Transportation and Regional Programs Division, Research Triangle Park, NC, August 2005.
[59] USEPA. Incorporating Emerging and Voluntary Measures in a State Implementation Plan (SIP). United States Environmental Protection Agency (USEPA), Office of Air and Radiation, Air Quality Strategies and Standards Division, Office of Air Quality Planning and Standards, Research Triangle Park, NC, September 2004.

Jersey promotes and supports these measures, within state funding limits, but is not relying upon them to demonstrate attainment.

The non-quantifiable strategies can be grouped into five categories:

Voluntary Strategies

The strategies in this category are/will be implemented on a voluntary basis. Companies and organizations commit to various initiatives that reduce ozone precursors. Examples of these strategies include state-level programs for days with high levels of ozone, a federal campaign that targets reducing raw material usage, reusing waste products, and decreasing waste production, and a tool to help permit writers, enforcement officers, and the regulated community identify and employ pollution prevention methods to reduce or eliminate releases of hazardous materials to the environment.

Energy Savings and Alternative Energy Strategies

The strategies in this category are also implemented on a voluntary basis and are specific to reducing energy consumption and utilizing alternative energy sources. Examples of strategies in this category include New Jersey's Clean Energy Program, fuel cells, and USEPA's Green Power Partnership. Energy efficiency measures have a lasting "cumulative" effect on electric demand. The savings in the installation year of an energy efficiency measure continue for the duration of its life. Therefore, the efficiency savings installed one year can be added to the measures included in all of the preceding years within its life. These energy efficiency and renewable energy programs are designed to limit growth of electricity demand and avoid NO_x emissions associated with such growth.

The United States Department of Energy (USDOE), USEPA, NJDEP, and New Jersey Board of Public Utilities (NJBPU) collaborated on efforts to estimate emission reductions from energy efficiency.[60] The scenarios analyzed by this effort may be utilized in the future to determine SIP credit when the environmental benefits from the Clean Energy Program are realized with the implementation of the New Jersey CAIR NO_x Trading Program and the retirement of NO_x allowances issued for the Clean Energy Program by the NJBPU. The NJDEP expects to take SIP credit for the environmental benefits of the Clean Energy Program after 2009.[61]

[60] USDOE. Final Report on the Clean Energy/Air Quality Integration Initiative Pilot Project of the U.S. Department of Energy's Mid-Atlantic Regional Office. United States Department of Energy, Office of Energy Efficiency and Renewable Energy, Philadelphia, PA, May 2006.

[61] New Jersey's new rules for the CAIR NO_x Trading Program, adopted on July 16, 2007 (see Chapter 4), include the creation of an incentive reserve that requires the New Jersey's Clean Energy Program to retire NO_x allowances from the projects they fund for the benefit of the environment. The rules take effect beginning in 2009. These rules were adopted after the regional modeling for the 8-hour ozone attainment demonstration was completed, and were not included in the emission reductions.

Mobile Strategies

The strategies in this category focus on reducing vehicle miles traveled and fuel consumption, and increasing the use of alternative fuel sources. Mobile strategies target onroad and nonroad vehicles and equipment. Examples of strategies in this category include Carpool Makes $ense Program (Governor Corzine's Initiative), the USEPA's SmartWay Transport Partnership, and the Northeast Diesel Collaborative.

Particulate Matter Strategies with Benefits to Reduce Ozone

The strategies in this category serve to primarily reduce particulate matter but have co-benefits of reducing ozone precursors. This category includes various federal and State retrofit programs such as the USEPA's Voluntary Diesel Retrofit Program and projects under New Jersey's Diesel Risk Reduction Program.

While New Jersey did not attempt to quantify these "hard to quantify" emission reduction strategies, the University of Maryland conducted two studies in an attempt to quantify measures that are normally considered to be non-quantifiable. These studies offer a glimpse at the magnitude of air quality benefits that can occur from difficult to quantify measures.

The first study supports the importance of large-scale tree planting programs to maintain tree cover and prevent increases in ozone due to loss of tree cover.[62] Tree cover in urban areas helps to decrease surface temperatures, thus resulting in an ozone reduction. Results from the University of Maryland study suggest that decreases in ground level ozone concentrations on the order of 1-3 ppb could be realized with an increase in urban tree cover ranging from 20 – 40 percent, using the Baltimore nonattainment area as a model. The second study focused on the implementation of a regional Code Orange telecommuting program for the Baltimore, Washington D.C., and Southern New Jersey/Philadelphia nonattainment areas on the worst ozone days.[63] Changes in emissions were implemented as a flat 40% reduction in vehicle miles traveled in each county of the three non-attainment areas. No attempt was made to determine areas where workers were more or less likely to telecommute. The largest benefits from such a program occurred at the most problematic monitoring locations in Washington, D.C. nonattainment area (Arlington County, 3 ppb) and Southern New Jersey/Philadelphia nonattainment area (Colliers Mills, 3 ppb). These studies support New Jersey's contention that these types of strategies do provide additional air quality benefits and supports New Jersey's argument that 2009 design values will be lower than those modeled with CMAQ.

[62]Maryland Department of the Environment. Appendix G-13: The Relationship between Urban Tree Cover and Ground Level Ozone, Cecil County, Maryland, 8-Hour Ozone State Implementation Plan and Base Year Inventory: SIP Revision 07-05. Maryland Department of the Environment, June 15, 2007.
[63] Maryland Department of the Environment. Appendix G-14: Air Quality Benefits of an Aggressive Telecommute Strategy, Cecil County, Maryland, 8-Hour Ozone State Implementation Plan and Base Year Inventory: SIP Revision 07-05. Maryland Department of the Environment, June 15, 2007.

5.4.6 2012 Photochemical Modeling Results

The NYSDEC performed a BOTW 2012 CMAQ model run. The 2012 model run incorporated the control measures in the 2009 BOTW run plus new control measures that are expected to be implemented in time to reduce emissions in 2012. The CMAQ simulation was performed with 2012 BOTW emissions in the OTC States and the remainder of the modeling domain. All modeling assumptions (meteorology, horizontal and vertical grid size etc.) for the 2012 modeling run, other than the actual control measures considered, were the same as those considered for the 2009 BOTW run, and are discussed in detail in Section 5.2. Transport adjusted 2012 design value ranges support New Jersey's plausible demonstration of attainment by 2009 while insuring that additional measures will already be in place to maintain that attainment status post-2009.

5.4.6.1 Control Measures

Table 5.12 lists all of the control measures included for New Jersey in the projected 2012 BOTW CMAQ modeling run. Each of these control measures is discussed in detail in Chapter 4. As shown in the table, control measures for asphalt production, glass manufacturing, and industrial/combustion/institutional boilers (area sources) are in addition to those modeled as part of the 2009 attainment run.

Table 5.12: Control Measures Included in the 2012 BOTW Model Run

Pre-2002 with benefits achieved Post-2002- On the Books
Federal
Residential Woodstove NSPS
Onboard Refueling Vapor Recovery (ORVR) beyond Stage II
Tier 1 Vehicle Program
National Low Emission Vehicle Program (NLEV)
Tier 2 Vehicle Program/low sulfur fuels
HDDV Defeat Device Settlement
HDDV Engine Standards
Nonroad diesel engines
Large industrial spark-ignition engines over 19 kilowatts
Recreational Vehicles (includes snowmobiles, off-highway motorcycles and all-terrain vehicles)
Diesel Marine Engines over 37 kilowatts
Phase 2 standards for small spark-ignition handheld engines at or below 19 kilowatts
Phase 2 standards for new nonroad spark-ignition nonhandheld engines at or below 19 kilowatts
Post-2002 - On the Books
New Jersey Measures Done Through a Regional Effort
Consumer Products 2005
Architectural Coatings 2005
Portable Fuel Containers 2005

Mobile Equipment Repair and Refinishing
Solvent Cleaning
NO_x RACT rule 2006 (including distributed generation)
Stage I and Stage II - Gasoline Transfer Operations
On-Board Diagnostics – I/M
New Jersey Heavy Duty Diesel Rules Including "Not-To-Exceed" (NTE) Requirements
Federal
USEPA MACT Standards including Industrial Boiler/Process Heater MACT
CAIR
Refinery Enforcement Initiative
Post-2002 - Beyond on the Way
New Jersey Measures Done Through a Regional Effort
Consumer Products 2009 Amendments
Portable Fuel Containers 2009 Amendments
Asphalt Paving
Asphalt Production
Glass Manufacturing
Adhesives and Sealants
Certain Categories of ICI Boilers (additional sources)

***** Highlighted control measures are in addition to those modeled as part of the 2009 attainment run

The 2012 CMAQ model run also includes emissions reductions for other states in the Ozone Transport Region. Table 5.13 lists which BOTW measures each state in the Ozone Transport Region believed would be implemented in time to achieve benefits in 2012.

Table 5.13: Ozone Transport Region-Wide Modeling Assumptions for the 2012 BOTW Model Run

	Consumer Products 2005/2009	PFC 2005/ 2009	Asphalt Paving	Adhesives & Sealants	ICI Boilers - Area Sources			ICI Boilers - Non-EGU Point Sources					Cement Kilns	Glass Furnances	Asphalt Plants
					< 25 mmBtu/ hr	25-50 mmBtu/ hr	50-100 mmBtu/ hr	< 25 mmBtu/ hr	25-50 mmBtu/ hr	50-100 mmBtu/ hr	100-250 mmBtu/ hr	>250 mmBtu/ hr			
NY NAA															
Connecticut	x	x	x	x	x	x	x	x	x	x	x				x
New Jersey	x	x	x	x	x	x	x	x	x	x	x			x	x
New York	x	x	x	x	x	x	x	x	x	x	x		x	x	x
Phila. NAA															
Delaware	x	x		x							x				
Maryland	x	x	x	x							x		x	x	
New Jersey	x	x	x	x	x	x	x	x	x	x	x			x	x
Pennsylvania	x	x	x	x									x	x	
Other States															
Maine	x	x		x									x		
New Hampshire	x	x	x	x					x	x	x				
Vermont															
Massachusetts	x	x	x	x										x	
Rhode Island	x	x	x	x											
DC	x	x	x	x											x

*Source: MACTEC. Development of Emission Projections for 2009, 2012, and 2018 for NonEGU Point, Area, and Nonroad Sources in the MANE-VU Region, Final TSD. Prepared for the Mid-Atlantic Regional Air Management Association by MACTEC Federal Programs, Inc., February 28, 2007.

5.4.6.2 2012 Modeling Results

The CMAQ outputs from the 2012 model simulation were processed using RRFs (calculated using the USEPA method) as with the 2009 CMAQ outputs as discussed in Section 5.2. Table 5.14 shows the 2012 modeled design values. As shown in this table, New Jersey's continued efforts beyond 2009, as well as the efforts from the rest of the Ozone Transport Region states and the USEPA, show a marked improvement in air quality by 2012. The 2012 modeled design values for the controlling monitors, in both multi-state associated nonattainment areas, at Colliers Mills, NJ and Stratford, CT are both 86 ppb.

Also shown in Table 5.14 are the 2012 modeled design values adjusted for transport, as outlined in Section 5.3. The 2012 transport adjusted modeled design value ranges at the controlling monitors show substantial decreases in ozone; Colliers Mills, NJ 79-72 ppb and Stratford, CT 82-76 ppb. The 2012 transport adjusted modeled design value ranges provide further confidence that future ozone values will be considerably lower than those modeled.

It should be noted that while New Jersey is confident that this comprehensive analysis provides a plausible demonstration of attainment for its two multi-state 8-hour ozone nonattainment areas, New York State has chosen to demonstrate attainment for the Northern New Jersey/New York nonattainment area for 2012. However, New York State has indicated that they are not precluding the possibility that the area will attain by its USEPA mandated 2010 attainment date.

Table 5.14: Comparison of 2002 Observed Design Values to 2012 Modeled Design Values and 2012 Modeled Design Value Ranges Adjusted for Transport for the Northern New Jersey/New York/Connecticut and Southern New Jersey/Philadelphia Nonattainment Areas

Site Name - County, State	Site Number	Air Monitoring Data	Modeling Results	Modeling Results Adjusted for Transport			
		2002 Modeling Baseline (DV_B) (ppb)	2012 Modeled Results (DV_F) (ppb)	2012 DV_{AT} (ppb)	Upper and Lower Bound of 2012 DV_{AT} (ppb)		
NNJ/NY/CT Nonattainment Area							
Teaneck - BERGEN CO, NJ	340030005	91	81	75	78	-	72
Bayonne - HUDSON, NJ	340170006	84	75	70	73	-	67
Flemington - HUNTERDON, NJ	340190001	95	78	69	72	-	66
Rutgers Univ. - MIDDLESEX CO, NJ	340230011	96	79	70	73	-	67
Monmouth Univ. - MONMOUTH CO, NJ	340250005	95	80	72	75	-	69
Chester - MORRIS CO, NJ	340273001	95	79	70	73	-	67
Ramapo - PASSAIC CO, NJ	340315001	86	73	66	69	-	63
Botanical Garden - BRONX CO, NY	360050083	83	75	70	73	-	67
Queens College - QUEENS CO, NY	360810124	83	71	65	68	-	61
Susan Wagner - RICHMOND CO, NY	360850067	93	80	73	76	-	70
Babylon - SUFFOLK CO, NY	361030002	93	82	76	79	-	73
Holtsville - SUFFOLK CO, NY	361030009	97	86	80	83	-	77
Riverhead - SUFFOLK CO, NY	361030004	83	70	63	66	-	60
White Plains - WESTCHESTER CO, NY	361192004	91	82	77	80	-	74
Danbury - FAIRFIELD CO, CT	90011123	95	81	73	76	-	70
Greenwich - FAIRFIELD CO, CT	90010017	95	83	76	79	-	73
Stratford - FAIRFIELD CO, CT	90013007	98	86	79	82	-	76
Westport - FAIRFIELD CO, CT	90019003	94	81	74	77	-	71
Middletown - MIDDLESEX CO, CT	90070007	95	80	72	75	-	69
Hamden - NEW HAVEN CO, CT	90099005	93	81	74	77	-	71
Madison - NEW HAVEN CO, CT	90093002	98	83	75	78	-	72
SNJ/Phila. Nonattainment Area							
Fairhill - CECIL CO, MD	240150003	97	75	63	66	-	60
Brandywine Creek - NEW CASTLE CO, DE	100031010	92	76	67	70	-	64
Bellefonte - NEW CASTLE CO, DE	100031013	90	74	65	68	-	62
Killens Pond - KENT CO, DE	100010002	88	74	66	69	-	63
Lewes - SUSSEX CO, DE	100051003	87	74	67	70	-	64
Lums Pond - NEW CASTLE CO, DE	100031007	94	74	63	66	-	60
Seaford - SUSSEX CO, DE	100051002	90	70	60	63	-	56
Bristol - BUCKS CO, PA	420170012	99	84	76	79	-	73
West Chester - CHESTER CO, PA	420290050	95	77	68	71	-	64
New Garden - CHESTER CO, PA	420290100	94	73	62	65	-	59
Chester - DELAWARE CO, PA	420450002	91	77	69	72	-	66
Norristown - MONTGOMERY CO, PA	420910013	92	77	69	72	-	66
Elmwood - PHILADELPHIA CO, PA	421010136	83	71	65	68	-	61
Lab - PHILADELPHIA CO, PA	421010004	71	61	55	58	-	52
Roxborough - PHILADELPHIA CO, PA	421010014	90	78	71	74	-	68
Northeast Airport - PHILADELPHIA CO, PA	421010024	96	82	74	77	-	71
Colliers Mills - OCEAN CO, NJ	340290006	106	86	76	79	-	72
Rider - MERCER CO, NJ	340210005	97	81	73	76	-	69
Ancora State Hospital - CAMDEN CO, NJ	340071001	100	82	72	75	-	69
Camden - CAMDEN CO, NJ	340070003	98	83	75	78	-	72
Clarksboro - GLOUCESTER CO, NJ	340155001	98	83	75	78	-	72
Millville - CUMBERLAND CO, NJ	340110007	95	75	64	67	-	61
Nacote Creek - ATLANTIC CO, NJ	340010005	89	73	65	68	-	61

NOTE: Highlighted sites are the monitor in each nonattainment area with the highest ozone design value, e.g. the controlling monitor.

5.5 Unmonitored Area Analysis

The USEPA's modeling guidance requires an unmonitored area analysis:

> "The unmonitored area analysis for a particular nonattainment area is intended to address potential problems within or near that nonattainment area. The analysis should include, at a minimum, all nonattainment counties and counties surrounding the nonattainment area (located within the State)."[64]

All New Jersey counties are designated as nonattainment of the 8-hour ozone standard. Therefore, all modeling grid cells containing a monitor and the 8 adjoining grid cells were analyzed in New Jersey's attainment demonstrations. The extent of geographic coverage that results from this approach is shown in Figure 5.10. This map shows that there are very few grid cells within New Jersey, or located along New Jersey's borders, that were not specifically analyzed in the attainment demonstrations. Note, on this map, areas covered solely by New Jersey's monitoring stations are colored in orange (in black & white - lightly shaded) and areas covered by either New Jersey's monitoring stations or by those in another bordering State are shaded in red (in black & white - darker shaded).

The NJDEP staff reviewed the unmonitored area analyses performed by some of the other states with which New Jersey shares a nonattainment area. Both NYSDEC[65] and Delaware Department of Natural Resources and Environmental Control [66] performed their unmonitored area analyses using the USEPA's recently released Modeled Attainment Test Software to show that all areas of maximum ozone concentration in the ozone nonattainment areas associated with New Jersey are adequately reflected by the monitoring locations and the modeling performed (see Appendix D14). New Jersey is covered by both of these analyses (Northern New Jersey by the NYSDEC analysis and Southern New Jersey by the Delaware Department of Natural Resources and Environmental Control analysis).

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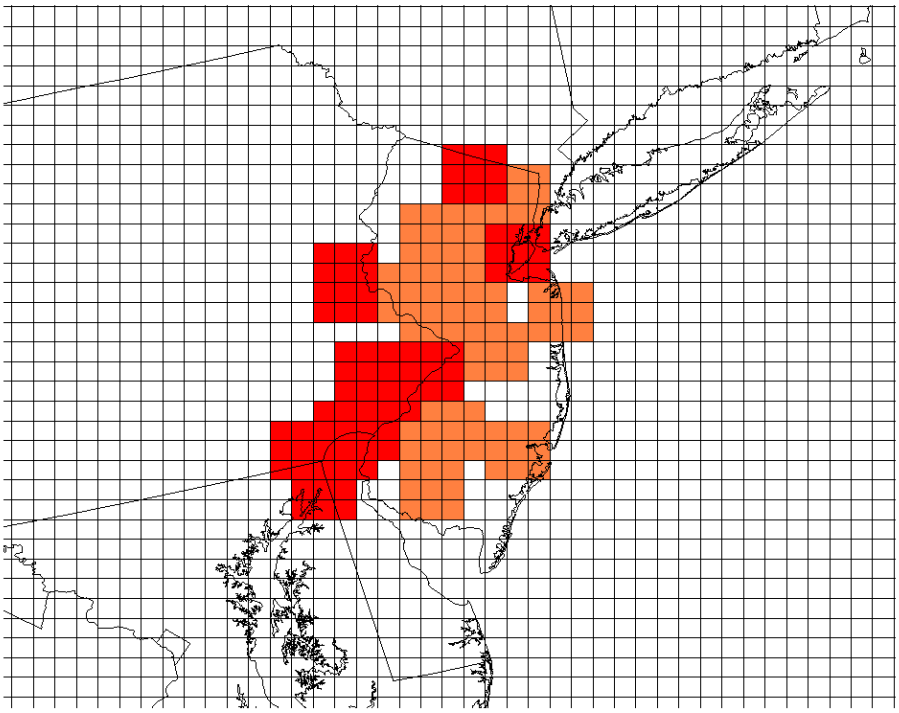
[64] USEPA. Guidance on the Use of Models and Other Related Analyses in Attainment Demonstrations for the 8-Hour Ozone NAAQS. United States Environmental Protection Agency, Office of Air Quality Planning and Standards, Emissions, Monitoring, and Analysis Division, Air Quality Modeling Group, Research Triangle Park, NC, EPA-454/R-05-002, October 2005.

[65] From personal e-mail communication: Dr. Gopal Sisla, NYSDEC to Ray Papalski, NJDEP, May 8, 2007- entitled "Unmonitored Area Analysis – draft."

[66] Delaware Department of Natural Resources and Environmental Control. Draft Proposed Delaware State Implementation Plan For Attainment of the 8-Hour Ozone National Ambient Air Quality Standard - Reasonable Further Progress and Attainment Demonstration. Delaware Department of Natural Resources and Environmental Control, May 2007.

<u>Figure 5.10</u>: Map of Grid Cells Used in Photochemical Modeling Associated with New Jersey Ozone Monitors[67]



5.6 Conclusions

While the USEPA modeling guidance emphasizes the use of a single design value from a single modeling simulation as the core of an attainment demonstration, they also support utilizing multiple analyses to identify and account for uncertainty and biases in the model results. Therefore, New Jersey applied a comprehensive approach to demonstrating attainment for the Northern New Jersey/New York/Connecticut and Southern New Jersey/Philadelphia multi-state nonattainment areas. A variety of data was assessed and analyzed to determine whether or not attainment would occur, rather than primarily basing attainment on the results of only a single model run.

The following analyses highlighted why it is important that air quality models represent ozone transport mechanisms correctly and why the models may not quite capture the mechanisms correctly.

1) An analysis of the westerly transport of the upper level ozone reservoir showed that when morning mixing begins, ozone from the reservoir has a significant contribution

[67] ibid.

to the daily ozone concentrations in New Jersey. In the case of August 13, 2005, this was a contribution of approximately 55 ppb.

2) Results of a cluster analysis revealed that when the greatest cluster trajectory density lay over the Ohio River Valley, transport accounted for a significant fraction of afternoon ozone concentrations in the Baltimore area. Since New Jersey is downwind of the Baltimore area, this result is also likely true for New Jersey.

3) Results of an ozone apportionment modeling analysis showed that out-of-state contributions to Ocean County, New Jersey are 82 percent of the projected 2010 8-hour ozone levels at that site.

4) Examination of the Colliers Mills, New Jersey and Stratford, CT monitor locations showed that ozone concentrations at these monitors were most likely susceptible to a local scale sea/bay breeze circulation effect. This effect likely exacerbates peak ozone concentrations not only during regional scale high ozone episodes, but also during periods when local scale circulation is more significant than regional transport. This type of transport mechanism is likely not reflected accurately in the air quality model.

The following analyses compared actual ozone measurements and model results in an attempt to quantify the model's under prediction of transport and ozone changes due to emission reductions.

1) Analyses suggest that CMAQ over predicts ozone concentrations in the lower atmosphere (surface to about 500 meters) and under predicts ozone concentrations in the upper atmosphere (~600-2600 meters). This low bias aloft is an indicator of under prediction of ozone transport.

2) The August 2003 Northeast Blackout offered an unexpected opportunity to examine the air quality benefits associated with significant emission reductions. When the ozone levels on the blackout day were compared to a day with similar meteorology, it was shown that the blackout caused a drop of at least 7 ppb ozone, and likely considerably more. However, a modeling study of the same event using CMAQ predicted only a 2 ppb change. These results seem to demonstrate that CMAQ under predicts transport and changes in ozone due to emission reductions, perhaps by a factor of approximately 3.

3) The USEPA is currently concluding a CMAQ simulation of 2002 and 2004 summertime air quality to determine the benefits of the NO_x SIP Call. The yet unpublished results suggest that although observed median 8-hour ozone levels changed by about 18 ppb, the CMAQ model only simulated a change of about 8 ppb. Therefore, these preliminary results suggest that the CMAQ model under predicted changes in ozone, especially power plant emissions, by at least a factor of 2.

4) The State of Maryland calculated reasonable estimates of uncertainty based on easily quantifiable factors, namely how representative the modeling base year design values are as indicators of current air quality and how the model responds to changes in emissions. The results of these analyses were combined to give a conservative estimate of the uncertainty in future year design values of +/- 3.1 ppb.

In order to account for CMAQ's under prediction of transport and emission reduction benefits, the 2009 model results were adjusted. To be conservative, it was assumed that CMAQ under predicted emission reduction benefits by a factor of 1.5, instead of 2 or 3. The simplified uncertainty factor (+/- 3.1) was applied, resulting in a range of design values. Based on the 2009 design values ranges adjusted for transport, all monitors in the Northern New Jersey/New York/Connecticut and Southern New Jersey/Philadelphia nonattainment areas show plausible attainment of the 8-hour ozone standard in 2010.

The following supporting analyses were presented to address the uncertainty in the 2009 modeled design values.

1) It was shown that average 2009 modeled design values were being met in 2006, as demonstrated by the 2006 monitored design values. Additional emission reductions due to CAIR, motor vehicle fleet turnover and other new and continuing programs from 2006 to 2009 are expected to lower monitored design values below their 2006 values.

2) It was shown that using an alternate modeling baseline design value which neutralizes the effect of a severe meteorological year (e.g., 2002) would result in a lower modeling baseline design values, on average 2 ppb, and thus would result in lower 2009 modeled ozone concentrations.

3) It was shown that using a nonattainment area maximum relative response factor (RRF), instead of the average RRF, in calculating the 2009 modeled design values may better approximate the effect that additional control measures would have on future year ozone concentrations, since predicted 2009 ozone concentrations are already being monitored. Use of the maximum response RRF plus the alternate modeling baseline design value reduces 2009 modeled design values by an average 5 ppb.

4) It was shown that additional quantifiable measures are being implemented or are expected to be implemented by 2009, in New Jersey's two multi-state nonattainment areas that were not included in the modeling. These measures should provide an additional 0.2 – 2 ppb ozone reduction in the Northern New Jersey/New York/Connecticut nonattainment area and 0.3 – 4 ppb ozone reduction in the Southern New Jersey/Philadelphia nonattainment by 2009.

5) It was shown that there are numerous air quality control strategies being implemented that are difficult to quantify and therefore were not included in the modeling.

However, these measures will provide air quality benefits that will be reflected in the monitored ozone concentrations.

6) Transport adjusted 2012 design value ranges support New Jersey's plausible demonstration of attainment by 2009 while insuring that additional measures will already be in place to maintain that attainment status post-2009.

A summary of the attainment modeling results and supporting analyses is presented in Table 5.15. Regarding the attainment modeling results, the 2009 modeled design value ranges adjusted for transport show plausible attainment in the two multi-state nonattainment areas. Application of estimated air quality benefits associated with quantifiable control measures not included in the modeling reduces the uncertainty of the demonstration.

Regarding the supporting analyses, when the 2009 modeled design values are recalculated using an alternate baseline design value and nonattainment area maximum response RRF, the results fall within the ranges of the attainment modeling results. Inclusion of the air quality benefits associated with quantifiable control measures not included in the modeling reduces the uncertainty and thus supports New Jersey's plausible demonstration of attainment of the 8-hour ozone standard by 2010 in the Northern New Jersey/New York/Connecticut and Southern New Jersey/Philadelphia nonattainment areas.

Table 5.15: Summary of Attainment Modeling Results and Supporting Analyses

Site Name - County, State	Site Number	Starting Point	Attainment Modeling Results			Supporting Analyses			
		2009 Modeled Results (DV_F) (ppb)	2009 Modeled Results Adjusted for Transport (DV_{AT}) (ppb)	**Upper and Lower Bound of 2009 DV_{AT} (ppb)**	2009 Modeled Results Adjusted for Transport and Taking Additional Quantifiable Measures Not Modeled into Account	2009 Modeled Results (DV_F) (ppb)	2009 Modeled Results using Alternate Baseline (DV_{Falt}) (ppb)	**2009 Modeled Results using Alternate Baseline and RRF (DV_{Falt-r}) (ppb)**	2009 Modeled Results using Alternate Baseline and RRF and Taking Additional Quantifiable Measures Not Modeled into Account
NNJ/NY/CT Nonattainment Area									
Teaneck - BERGEN CO, NJ	340030005	85	81	**84 - 78**	84 - 76	85	81	**76**	76 - 74
Bayonne - HUDSON, NJ	340170006	77	73	**76 - 70**	76 - 68	77	76	**73**	73 - 71
Flemington - HUNTERDON, NJ	340190001	83	76	**79 - 73**	79 - 71	83	82	**82**	82 - 80
Rutgers Univ. - MIDDLESEX CO, NJ	340230011	83	76	**79 - 73**	79 - 71	83	82	**82**	82 - 80
Monmouth Univ. - MONMOUTH CO, NJ	340250005	84	78	**81 - 75**	81 - 73	84	82	**82**	82 - 80
Chester - MORRIS CO, NJ	340273001	84	78	**81 - 75**	81 - 73	84	81	**80**	80 - 78
Ramapo - PASSAIC CO, NJ	340315001	77	72	**75 - 69**	75 - 67	77	75	**73**	73 - 71
Botanical Garden - BRONX CO, NY	360050083	78	75	**78 - 72**	78 - 70	78	74	**69**	69 - 67
Queens College - QUEENS CO, NY	360810124	74	69	**72 - 66**	72 - 64	74	74	**73**	73 - 71
Susan Wagner - RICHMOND CO, NY	360850067	84	79	**82 - 76**	82 - 74	84	82	**79**	79 - 77
Babylon - SUFFOLK CO, NY	361030002	85	80	**83 - 77**	83 - 75	85	82	**78**	78 - 76
Holtsville - SUFFOLK CO, NY	361030009	89	85	**88 - 81**	88 - 79	89	87	**82**	82 - 80
Riverhead - SUFFOLK CO, NY	361030004	74	69	**72 - 66**	72 - 64	74	72	**70**	70 - 68
White Plains - WESTCHESTER CO, NY	361192004	85	81	**84 - 78**	84 - 76	85	82	**76**	76 - 74
Danbury - FAIRFIELD CO, CT	90011123	85	79	**82 - 76**	82 - 74	85	83	**81**	81 - 79
Greenwich - FAIRFIELD CO, CT	90010017	87	82	**85 - 79**	85 - 77	87	83	**79**	79 - 77
Stratford - FAIRFIELD CO, CT	90013007	90	85	**88 - 82**	88 - 80	90	87	**83**	83 - 81
Westport - FAIRFIELD CO, CT	90019003	85	80	**83 - 77**	83 - 75	85	82	**79**	79 - 77
Middletown - MIDDLESEX CO, CT	90070007	84	78	**81 - 75**	81 - 73	84	82	**81**	81 - 79
Hamden - NEW HAVEN CO, CT	90099005	85	80	**83 - 77**	83 - 75	85	84	**81**	81 - 79
Madison - NEW HAVEN CO, CT	90093002	88	82	**85 - 79**	85 - 77	88	85	**82**	82 - 80
SNJ/Phila. Nonattainment Area									
Fairhill - CECIL CO, MD	240150003	81	72	**75 - 69**	75 - 64	81	80	**80**	80 - 76
Brandywine Creek - NEW CASTLE CO, DE	100031010	81	75	**78 - 72**	78 - 67	81	78	**74**	74 - 70
Bellefonte - NEW CASTLE CO, DE	100031013	78	71	**74 - 68**	74 - 63	78	74	**71**	71 - 67
Killens Pond - KENT CO, DE	100010002	78	72	**75 - 69**	75 - 64	78	77	**72**	72 - 68
Lewes - SUSSEX CO, DE	100051003	77	72	**75 - 68**	75 - 63	77	75	**70**	70 - 66
Lums Pond - NEW CASTLE CO, DE	100031007	79	71	**74 - 68**	74 - 63	79	74	**73**	73 - 69
Seaford - SUSSEX CO, DE	100051002	75	67	**70 - 64**	70 - 59	75	75	**73**	73 - 69
Bristol - BUCKS CO, PA	420170012	88	82	**85 - 79**	85 - 74	88	86	**79**	79 - 75
West Chester - CHESTER CO, PA	420290050	82	75	**78 - 72**	78 - 67	82	82	**79**	79 - 75
New Garden - CHESTER CO, PA	420290100	79	71	**74 - 68**	74 - 63	79	78	**78**	78 - 74
Chester - DELAWARE CO, PA	420450002	81	75	**78 - 72**	78 - 67	81	79	**74**	74 - 70
Norristown - MONTGOMERY CO, PA	420910013	81	75	**78 - 72**	78 - 67	81	81	**76**	76 - 72
Elmwood - PHILADELPHIA CO, PA	421010136	75	71	**74 - 67**	74 - 62	75	73	**67**	67 - 63
Lab - PHILADELPHIA CO, PA	421010004	64	60	**63 - 57**	63 - 52	64	62	**57**	57 - 53
Roxborough - PHILADELPHIA CO, PA	421010014	82	77	**80 - 74**	80 - 69	82	80	**73**	73 - 69
Northeast Airport - PHILADELPHIA CO, PA	421010024	87	82	**85 - 79**	85 - 74	87	84	**78**	78 - 74
Colliers Mills - OCEAN CO, NJ	340290006	92	85	**88 - 81**	88 - 76	92	90	**86**	86 - 82
Rider - MERCER CO, NJ	340210005	86	80	**83 - 77**	83 - 72	86	84	**78**	78 - 74
Ancora State Hospital - CAMDEN CO, NJ	340071001	87	80	**83 - 77**	83 - 72	87	86	**82**	82 - 78
Camden - CAMDEN CO, NJ	340070003	88	82	**85 - 79**	85 - 74	88	84	**78**	78 - 74
Clarksboro - GLOUCESTER CO, NJ	340155001	88	82	**85 - 79**	85 - 74	88	87	**80**	80 - 76
Millville - CUMBERLAND CO, NJ	340110007	81	73	**76 - 70**	76 - 65	81	79	**78**	78 - 74
Nacote Creek - ATLANTIC CO, NJ	340010005	77	71	**74 - 67**	74 - 62	77	76	**72**	72 - 68

Note: There are additional non-quantifiable measures that will produce air quality benefits and further reduce these values.
Highlighted sites are the monitor in each nonattainment area with the highest ozone design value, e.g. the controlling monitor.