10.0 Attainment Demonstration

The 8-Hour Ozone Standard Attainment Plan analyzes the potential of the Washington metropolitan area to achieve attainment of the 8-hour ozone standard. The demonstration of achieving the 8-hour ozone standard is based on both the Community Multiscale Air Quality Model (CMAQ) and Weight of Evidence analysis supporting the attainment modeling results. Photochemical modeling and the Weight of Evidence analyses provide strong evidence that the region will attain the 8-hour ozone standard by 2009. Details of both the CMAQ model and the Weight of Evidence tests are being provided below.

10.1 Modeling Study Overview: Background and Objectives

On June 15, 2004, EPA revoked the 1-hour ozone standard and re-designated the Washington D.C. MSA as a "Moderate" ozone non-attainment area for the new 8-hour ozone standard. Moderate ozone non-attainment areas are required to demonstrate attainment of the new 8-hour ozone standard using photochemical modeling and Weight-of-Evidence analyses.

The objective of the photochemical modeling study is to enable the air agencies to analyze the efficacy of various control strategies, and to demonstrate that the measures adopted as part of the State Implementation Plan will result in attainment of the ozone standard by June 2010. The modeling exercise predicts future 2009 air quality conditions based on the worst episodes in the base year 2002, and applies control measures to demonstrate the effectiveness of new measures in reducing air pollution.

For the reason mentioned above, a photochemical modeling study was undertaken by Virginia Department of Environmental Quality (VADEQ) on behalf of the Washington metropolitan area to demonstrate attainment of the 8-hour ozone NAAQS. The attainment modeling project was directed by the Technical Advisory Committee (TAC) and the Metropolitan Washington Air Quality Committee (MWAQC), a policy committee. EPA's Community Multi-scale Air Quality (CMAQ) was the model used for the attainment demonstration.

Table 10-1 identifies all jurisdictions that EPA has designated as non-attainment within the Washington MSA:

Table 10-1: Washington MSA Designations for 8-hour Ozone Standard

Jurisdiction	Counties	Classification	Maximum Attainment Date (from June 15, 2004)
District of Columbia	District of Columbia	Moderate	June 15, 2010
Maryland	Calvert Charles Frederick Montgomery Prince George's		
Virginia	Alexandria City Arlington Fairfax City Fairfax Falls Church City Loudoun Manassas City Manassas Park City Prince William		

The modeling analyses set forth in this report have been conducted in accordance with the <u>Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, PM2.5, and Regional Haze (Draft 3.2- September 2006)</u>.

10.1.1 Relationship to Regional Modeling Protocols

The state members of the committees for this study are also members of the OTC and ASIP modeling committees. This membership has allowed them to coordinate the analyses performed for Washington, D.C. with the regional modeling analyses conducted by OTC and ASIP.

VADEQ, in consultation with the MDE, DCDOE, and MWCOG, was responsible for conducting CMAQ runs for the Washington, D.C. domain. VADEQ's modeling runs were done in coordination with the Ozone Transport Commission's (OTC) modeling for the 12-state Ozone Transport Region (OTR) and with the ASIP modeling, done for the southeastern states. Modeling centers for OTC included the New York State Department of Environmental Conservation (NYSDEC), the University of Maryland, NESCAUM and VADEQ. Modeling inventories were developed, updated and shared among the regional modeling centers and provided by MARAMA, MANE-VU and VISTAS.

Installation of the models at VADEQ and all participating modeling centers was completed and diagnostic procedures were run successfully. The model has been benchmarked against other modeling platforms across the region to ensure accurate results.

The Policy Committee and the TAC oversaw the modeling work and made appropriate reports to the full MWAQC through regular briefings and offered other information in cases where specific technical decisions had policy implications. The Technical Committee members and members of other committees involved in the project who are also members of OTC and ASIP made sure to the extent practicable that there was consistency between the regional and urban modeling efforts.

10.1.2 Conceptual Model

EPA recommends that a conceptual description of the area's ozone problem be developed prior to the initiation of any air quality modeling study. A "conceptual description" is a qualitative way of characterizing the nature of an area's non-attainment problem. Within the conceptual description of a particular modeling exercise, it is recommended that the specific meteorological parameters that influence air quality be identified and qualitatively ranked in importance.

The conceptual model for this study was prepared by the Northeast States for Coordinated Air Use Management (NESCAUM) for use by the OTC member States. The conceptual model document, The Nature of the Ozone Air Quality Problem in the Ozone Transport Region: A Conceptual Description (NESCAUM, October 2006), is provided in Attachment 1. This document provides the conceptual description of the ozone problem in the OTR states, consistent with the EPA's guidance.

10.2 Domain and Database Issues

10.2.1. Episode Selection

The procedures for selecting 8-hr ozone modeling episodes seek to achieve a balance between good science and regulatory needs and constraints. Modeling episodes, once selected, influence technical and policy decisions for many years. Clearly, both the direct and implicit procedures used in selecting episodes warrant full consideration.

The rationale for the selection of 2002 meteorology as input to the air quality simulations includes a qualitative analysis (Ryan and Piety 2002) and a quantitative analysis (Environ 2005). These documents are provided in Attachment 2.

Recent research has shown that model performance evaluations and the response to emissions controls need to consider modeling results from long time periods, in particular full synoptic cycles or even full ozone seasons. Based on this factor the entire ozone season was simulated for the 2002 and 2009 State Implementation Plan (SIP) modeling runs (May 1 to September 30). As a result, the total number of days examined for the complete ozone season far exceeds EPA recommendations, and provides for better assessment of the simulated pollutant fields.

10.2.2. 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 non-attainment area. Beyond this, the domain includes enough of the surrounding area such that major upwind sources fall within the domain and emissions produced in the non-attainment area remain within the domain throughout the day.

The boundaries of the modeling domain are provided in Attachment 3. This domain covers the

Northeast region including northeastern, central and southeastern US as well as Southeastern Canada. The final SIP modeling analysis utilized the modeling domain boundaries established by OTC.

10.2.3 Horizontal Grid Size

The OTC platform used for the Washington, D.C. modeling analysis utilized a coarse grid continental United States (US) domain with a 36-km horizontal grid resolution. The CMAQ domain is nested in the MM5 domain. A larger MM5 domain was selected for both MM5 simulations to provide a buffer of several grid cells around each boundary of the CMAQ 36 km domain. This was designed to eliminate any errors in the meteorology from boundary effects in the MM5 simulation at the interface of the MM5 model. A 12-km inner domain was selected to better characterize air quality in OTC and surrounding Regional Planning Organization (RPO) regions. Attachment 4 contains the horizontal grid definitions for the MM5 and CMAQ modeling domains.

10.2.4 Vertical Resolution

The CMAQ vertical structure is primarily defined by the vertical grid used in the MM5 modeling. The MM5 model employed a terrain following coordinate system defined by pressure. The layer averaging scheme adopted for CMAQ is designed to reduce the computational cost of the CMAQ simulations. The effects of layer averaging have a relatively minor effect on the model performance metrics when compared to ambient monitoring data.

Attachment 5 contains the vertical layer definitions for the MM5 and CMAQ modeling domains.

10.2.5 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 unknown in every grid cell for the start time. Therefore, typically photochemical grid models are started with clean conditions within the domain and 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.

The winds move pollutants into, out of, and within the domain. The model handles the movement of pollutants within the domain and out of the domain. An estimate of the quantity of pollutants moving into the domain is needed. These are called boundary conditions. To estimate the boundary conditions for the modeling study, three-hourly boundary conditions for the outer 36-km domain were derived from an annual model run performed by researchers at Harvard University using the GEOS-CHEM global chemistry transport model. The influence of boundary conditions was minimized by using a 15-day ramp-up period which is sufficient to establish pollutant levels that are encountered in the beginning of the ozone episode.

10.2.6 Meteorological Model Selection and Configuration

The Pennsylvania State University/National Center for Atmospheric Research (PSU/NCAR) Mesoscale Meteorological Model (MM5) was selected for application in the Washington, D.C. non-attainment modeling analysis. MM5 is a non-hydrostatic, prognostic meteorological model routinely used for urban- and regional-scale photochemical regulatory modeling studies.

Based on model validation and sensitivity testing, the MM5 configurations provided in Attachment 6 were selected. Results of the University of Maryland's detailed performance evaluation of the MM5 modeling used in conjunction with the OTC platform are provided in Attachment 7.

10.2.7 Emissions Model Selection and Configuration

Significant coordination efforts took place between MANE-VU and VISTAS in the development of the emissions inventories used in the modeling study. All analyses conducted in support of the Washington, D.C. modeling analysis were coordinated between the Technical and Policy Committees along with TAC.

These inventories include a base case (2002) which serves as the "parent" inventory off which all future year inventories (i.e., 2009) are based. The future year inventories include emissions growth due to any projected increase in economic activity as well as the implementation of control measures.

The Sparse Matrix Operator Kernel Emissions (SMOKE) Emissions Processing System was selected for application in the Washington, D.C. non-attainment modeling analysis.

SMOKE (Version 2.1) was used for the Washington DC attainment modeling demonstration. 2002 base case and 2009 future base case emissions data files were provided by OTC and ASIP. Wherever possible, the mobile source emission inventories (in VMT format) were replaced with SCC-specific county level emissions to more accurately reflect actual emissions for typical ozone season day.

A detailed description of all SMOKE input files such as area, mobile, fire, point and biogenic emissions files is provided in Attachment 8. The SMOKE model configuration is also provided.

10.2.8 Air Quality Model Selection and Configuration

EPA's Models-3/Community Multi-scale Air Quality (CMAQ) modeling system was selected for the attainment demonstration primarily because it is a "one-atmosphere" photochemical grid model capable of addressing ozone at regional scale and is considered one of the preferred models for regulatory modeling applications. The model is also recommended by the <u>Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, PM2.5, and Regional Haze (Draft 3.2- September 2006)</u>.

The CMAQ configuration is provided in Attachment 9.

10.2.9 Quality Assurance

All air quality, emissions, and meteorological data 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.

Quality Assurance (QA) activities were carried out for the various emissions, meteorological, and photochemical modeling components of the modeling study. Emissions inventories obtained from the Regional Planning Organizations (RPO) were examined to check for errors in the emissions estimates. When such errors were discovered, the problems in the input data files were corrected.

The MM5 meteorological and CMAQ air quality model inputs and outputs were plotted and examined to ensure accurate representation of the observed data in the model-ready fields, and temporal and spatial consistency and reasonableness. Both MM5 and CMAQ 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 throughout this document.

10.3 Model Performance Evaluation

There are many aspects of model performance. This section will focus primarily on the methods and techniques recommended by EPA for evaluating the performance of the air quality model. It should be noted that the other parts of the modeling process, the emissions and meteorology, also undergo an evaluation. It is with this knowledge and the desire to keep the report concise, that the air quality model became the primary focus of this section.

The first step in the modeling process is to verify the model's performance in terms of its ability to predict the ozone in the right locations and at the right levels. To do this, the model predictions for the base year simulation are compared to the ambient data observed in the historical episode. This verification is a combination of statistical and graphical evaluations. If the model appears to be producing 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.

The results of a model performance evaluation were evaluated prior to using modeling 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 New York State DEC, Division of Air Resources, conducted a performance evaluation of the 2002 base case CMAQ simulation (May 15-September 30) on behalf of the OTC member States. Attachment 10 provides comprehensive operational and diagnostic evaluation results, including spreadsheets containing the assumptions made to compute statistics. Highlights of this evaluation are provided in the following sections.

10.3.1 Diagnostic and Operational Evaluation

The issue of model performance goals for ozone is an area of ongoing research and debate. To evaluate model performance, EPA recommends that several statistical metrics be developed for air quality modeling. Two of the common metrics that are most often used to assess performance are the mean normalized gross error and the mean normalized bias. The mean normalized gross error parameter provides an overall assessment of model performance and can be interpreted as precision, and the mean normalized bias parameter measures a model's ability to reproduce observed spatial and temporal patterns and can be interpreted as accuracy. EPA suggests the following criteria: a mean normalized bias (MNB) of < ±15%, and a mean normalized gross error (MNGE) of < 35% above a threshold of 40-60 ppb. These results are presented in Table 3-1 below for the local non-attainment area and in Tables 3-2 and 3-3 on a monitor-by-monitor basis averaged over all days for the 40 ppb and 60 ppb thresholds. Figure 3-1 shows the location of the monitors.

Table 10-2: Washington, D.C. MSA Statistics for 8-hour Ozone

Location	Ozone Cutoff Threshold (ppb)	Mean Normalized Gross Error (MNGE) (%)	Mean Normalized Bias (MNB) (%)
Washington, D.C. MSA	40	13.34	-0.43
	60	12.09	-5.78

Table 10-3: Individual Site Statistics for 8-hour Ozone using 40 ppb Cutoff

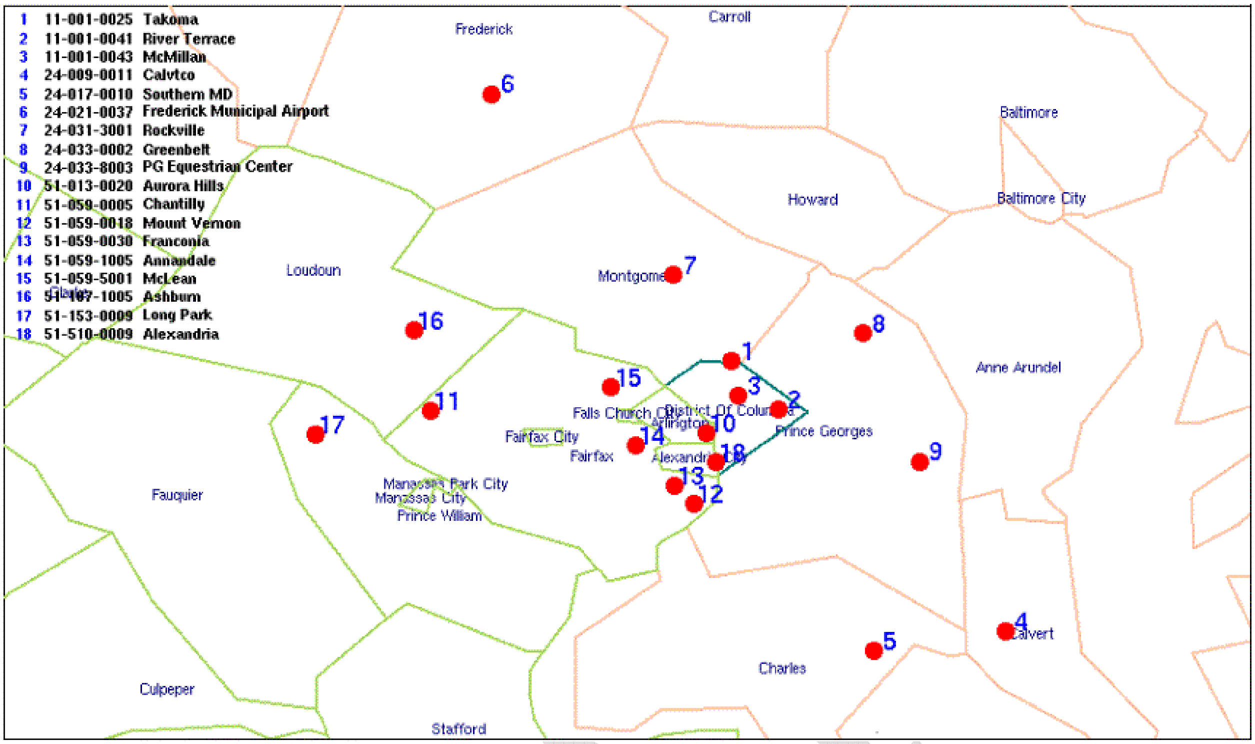
AIRS ID	Site Name	Jurisdiction	State	MNGE (%)	MNB (%)
11-001-0025	Takoma	District of Columbia	---	12.77	6.85
11-001-0041	River Terrace	District of Columbia	---	12.08	-3.13
11-001-0043	McMillan	District of Columbia	---	14.85	-12.04
24-009-0010	Calvert	Calvert	MD	NA	NA
24-017-0010	Southern MD	Charles	MD	12.3	0.55

AIRS ID	Site Name	Jurisdiction	State	MNGE (%)	MNB (%)
24-021-0037	Frederick Municipal Airport	Frederick	MD	12.29	-0.22
24-031-3001	Rockville	Montgomery	MD	13.57	7.6
24-033-0002	Greenbelt	Prince George's	MD	12.82	1.54
24-033-8003	PG Equestrian Center	Prince George's	MD	13.48	3.38
51-013-0020	Aurora Hills	Arlington County	VA	12.73	-6.33
51-059-0005	Chantilly	Fairfax County	VA	13.23	-8.31
51-059-0018	Mount Vernon	Fairfax County	VA	14.63	4.93
51-059-0030	Franconia	Fairfax County	VA	12.57	-3.57
51-059-1005	Annandale	Fairfax County	VA	12.01	-2.94
51-059-5001	McLean	Fairfax County	VA	17.87	11.99
51-107-1005	Ashburn	Loudoun County	VA	13.18	-8.54
51-153-0009	Long Park	Prince William County	VA	12.55	-4.23
51-510-0009	Alexandria	Alexandria City	VA	14.14	9.2

Table 10-4: Individual Site Statistics for 8-hr Ozone using 60 ppb Cutoff

AIRS ID	Site Name	Jurisdiction	State	MNGE (%)	MNB (%)
11-001-0025	Takoma	District of Columbia	---	9.37	2.8
11-001-0041	River Terrace	District of Columbia	---	11.28	-7.57
11-001-0043	McMillan	District of Columbia	---	15.61	-13.66
24-009-0010	Calvert	Calvert	MD	NA	NA
24-017-0010	Southern MD	Charles	MD	11.22	-5.62
24-021-0037	Frederick Municipal Airport	Frederick	MD	10.9	-4.27
24-031-3001	Rockville	Montgomery	MD	11.3	3.24
24-033-0002	Greenbelt	Prince George's	MD	11.42	-2.6
24-033-8003	PG Equestrian Center	Prince George's	MD	11.46	-3.87
51-013-0020	Aurora Hills	Arlington County	VA	13.36	-9.79
51-059-0005	Chantilly	Fairfax County	VA	13.71	-12.57
51-059-0018	Mount Vernon	Fairfax County	VA	11.02	-2.63
51-059-0030	Franconia	Fairfax County	VA	11.99	-7.42
51-059-1005	Annandale	Fairfax County	VA	11.88	-7.5
51-059-5001	McLean	Fairfax County	VA	13.54	5.59
51-107-1005	Ashburn	Loudoun County	VA	14.18	-12.84
51-153-0009	Long Park	Prince William County	VA	12.6	-11.7
51-510-0009	Alexandria	Alexandria City	VA	8.74	1.31

Figure 10-1: Location of Ozone Monitors in the Washington, D.C. Area



The following statistics for the OTC domain have also been provided in Attachment 11.

1. Archive file containing time series of 8-hour average observed and predicted ozone organized by state.
2. Observed and predicted composite diurnal variations of selected species, including but not limited to ozone at SLAMS/NAMS sites, ozone at CASTNet and other sites, VOC species such as ethene, isoprene, formaldehyde and gas phase compounds such as CO, NO and NO_2.
3. Statistical evaluation of daily maximum 8-hour ozone at SLAMS/NAMS sites and CASTNet/other sites; statistics are computed using two different thresholds for observed daily maximum ozone - 40 and 60 ppb; statistics are computed by date (all sites on a given day) and by site (one site over all days).
4. Statistical evaluation of daily maximum 8-hour ozone at SLAMS/NAMS sites that fall within non-attainment counties; statistics are computed by non-attainment area.
5. Statistical evaluation of daily average CO, NO, NO_2, and SO_2 at SLAMS/NAMS and other sites; statistics are computed by date and by site.
6. Statistical evaluation of daily average ethene, isoprene, and formaldehyde at SLAMS/NAMS and other sites; statistics are computed by date and by site.
7. Plots of composite time series for daily max 8-hour ozone, root mean square error and mean bias for illustrative purposes.
8. Daily tile plots of daily 8-hour maximum predicted ozone across the modeling domain compared with actual observations.

10.3.2 Summary of Model Performance

CMAQ was employed to simulate ozone for the 2002 season (May 15 through September 30). 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 the Washington D.C. area.

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 the 2002 ozone season show that the modeling system tends to over-predict minimum concentrations and slightly under-predict 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 to daily peak concentrations. It is still important to appropriately model the over-night ozone removal processes and regional transport to accurately estimate peak concentrations.

The model performance for the Washington D.C. area averaged over all stations and all days meet the guidelines suggested by EPA. The criteria for acceptable model performance are met on most individual days as well.

No significant differences in model performance for ozone and its precursors were encountered across the OTC. While there are some differences between the spatial data between 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 OTC domain.

The modeling system is doing a good job of appropriately estimating 8-hour average surface ozone throughout the OTC and in the Washington D.C. area. This confidence in the modeling results allows for the modeling system to be used to support the development of emissions control scenarios and State Implementation Plan to meet the 8-hour ozone NAAQS.

10.4 Attainment Demonstration

The Washington region's demonstration of achieving the 8-hour ozone standard is based on two bodies of evidence: (1) the Community Multi-scale Air Quality Model (CMAQ) and (2) a number of Weight of Evidence tests supporting the attainment modeling results. Details of both the CMAQ model and the Weight of Evidence tests are provided below.

10.4.1 Modeling Attainment Test

The modeled attainment test applied at each monitor was performed using the following equation:

$$(DVF)_I = (RRF)_I \, (DVB)_I$$

Where:

$(DVB)_I$ = the baseline concentration monitored at site I, in ppb
$(RRF)_I$ = the relative response factor, calculated near site I
$(DVF)_I$ = the estimated future design value for the time attainment is required, in ppb.

Table 10-5: Modeling Attainment Test Using EPA Preferred Methodology

AIRS ID	Site Name	Jurisdiction	State	DVB	RRF	DVF
11-001-0025	Takoma	District of Columbia	---	88.7	0.892	79
11-001-0041	River Terrace	District of Columbia	---	89.0	0.883	78
11-001-0043	McMillan	District of Columbia	---	92.7	0.883	81
24-009-0010	Calvert	Calvert	MD	NA	0.836	NA
24-017-0010	Southern MD	Charles	MD	93.0	0.808	75
24-021-0037	Frederick Municipal Airport	Frederick	MD	87.3	0.846	73
24-031-3001	Rockville	Montgomery	MD	86.7	0.881	76
24-033-0002	Greenbelt	Prince George's	MD	94.0	0.869	81
24-033-8003	PG Equestrian Center	Prince George's	MD	94.0	0.865	81
51-013-0020	Aurora Hills	Arlington County	VA	96.7	0.891	86
51-059-0005	Chantilly	Fairfax County	VA	87.0	0.867	75
51-059-0018	Mount Vernon	Fairfax County	VA	96.7	0.883	85
51-059-0030	Franconia	Fairfax County	VA	95.0	0.88	83
51-059-1005	Annandale	Fairfax County	VA	94.0	0.88	82
51-059-5001	McLean	Fairfax County	VA	88.0	0.883	77
51-107-1005	Ashburn	Loudoun County	VA	90.0	0.869	78
51-153-0009	Long Park	Prince William County	VA	85.0	0.871	74
51-510-0009	Alexandria	Alexandria City	VA	90.0	0.883	79

Current design values were calculated using the EPA method of averaging the three design value periods which include the baseline inventory year. Specifically, the average design value was calculated using the 2000-2002, 2001-2003, and 2002-2004 periods.

In the event that there was less than five years of available data at a monitoring site the following procedure was used:

1. 3 years of data - The current design value was based on a single design value.
2. 4 years of data - The current design value was based on an average of two design value periods.
3. Less than 3 years of data – The site was not used in the attainment test.

A 3x3 array of grid cells surrounding each monitor was used in the modeled attainment test as recommended by EPA for 12-km grid resolution modeling to calculate RRFs.

The predicted 8-hour daily maximum concentrations from each modeled day were used in the modeled attainment test with the nearby grid cell with the highest predicted 8-hour daily maximum concentration with baseline emissions for each day considered in the test, and the grid cell with the highest predicted 8-hour daily maximum concentration with the future emissions for each day in the test.

The RRFs used in the modeled attainment test were computed by taking the ratio of the mean of the 8-hour daily maximum predictions in the future to the mean of the 8-hour daily maximum predictions with baseline emissions, over all relevant days.

The following rules shall were applied to determine the number of days and the minimum threshold at each ozone monitor:

1. If there were 10 or more days with daily maximum 8-hour average modeled ozone > 85 ppb an 85 ppb threshold was used.
2. If there was less than 10 days with daily maximum 8-hour average modeled ozone > 85 ppb the threshold was reduced to as low as 70 ppb until there was 10 days in the mean RRF calculation.
3. If there was less than 10 days with daily maximum 8-hour average modeled ozone > 70 ppb then all days > 70 ppb were used.
4. No RRF calculations shall be performed for sites with less than 5 days > 70 ppb.

10.4.2 Unmonitored Area Analysis

An “unmonitored area analysis” using model adjusted spatial fields was performed. The basic steps of this process were as follows:

1. Interpolated ambient ozone design value data to create a set of spatial fields.
2. Adjusted the spatial fields using gridded model output gradients (base year values).
3. Applied gridded model RRFs to the model adjusted spatial fields.
4. Determined if any unmonitored areas are predicted to exceed the NAAQS in the future.

Recommended EPA guidance was utilized in the “unmonitored area analysis”.

10.4.3 Emissions Inventories

For areas with an attainment date of no later than June 15, 2010, the emission reductions need to be implemented no later than the beginning of the 2009 ozone season. A determination of attainment will likely be based on air quality monitoring data collected in 2007, 2008, and 2009. Therefore, the year to project future emissions should be no later than the last year of the three year monitoring period; in this case 2009.

The 2002 base year emissions inventory were projected to 2009 using standard emissions projection techniques. 2009 inventories provided by MANE-VU and VISTAS were used in the attainment demonstration.

Emission inventory guidance documents were followed for developing projection year inventories for point, area, mobile, and biogenic emissions. These procedures addressed projections of spatial, temporal, and chemical composition change between the base year and projection year.

The alternative control strategies for evaluation in the attainment demonstration were selected by MWAQC. These were selected from groups of strategies 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 by other modeling domains. Also, technology-based emission reduction requirements mandated by the Clean Air Act were included in the future year model runs.

10.4.4 Attainment Modeling Results

Applying EPA's preferred methodology to CMAQ model results, the future design values for 2009 shown in Table 10-5 indicate only two monitors will be at or slightly above 84 parts per billion. All other monitors (sixteen) will be below 85 parts per billion. These results place the Washington, DC-MD-VA region well within EPA's range, 82-87 ppb, where weight of evidence will contribute significantly to the region's attainment demonstration.

10.5 Weight Of Evidence Analysis

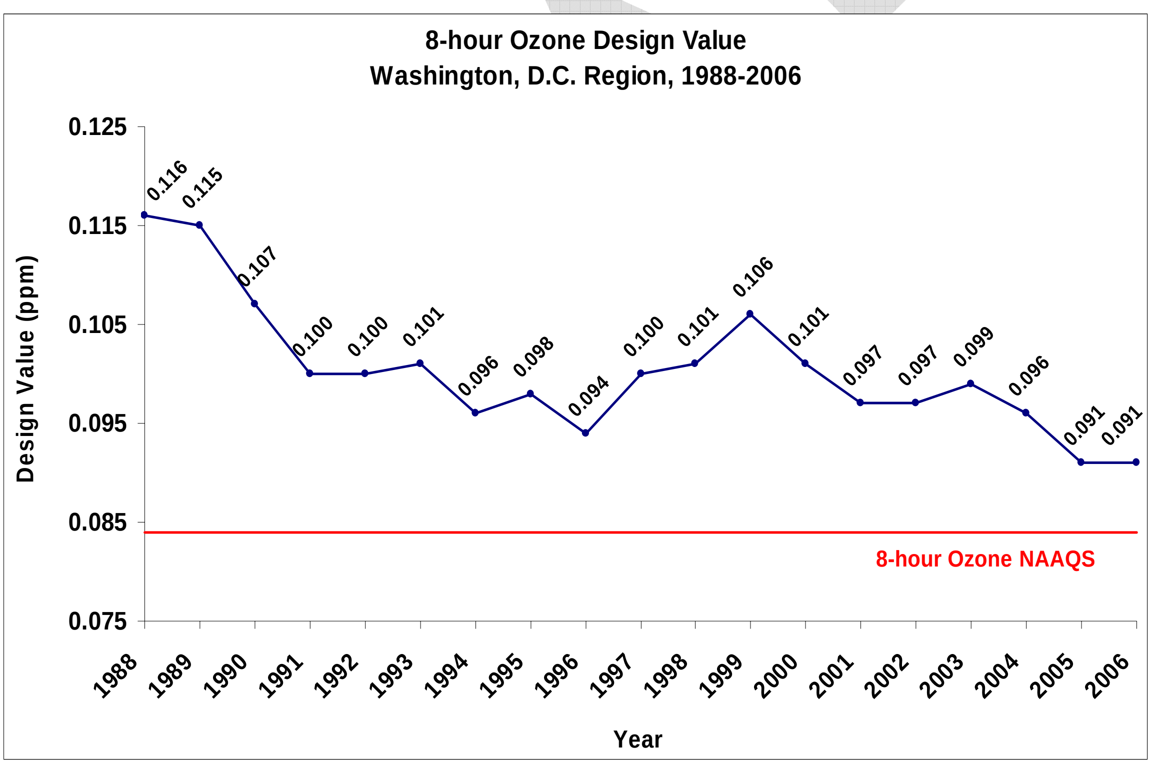
All photochemical models including the CMAQ model has inherent uncertainties. Over or under prediction may result from uncertainties associated with emission inventories, meteorological data, and representation of ozone photochemistry in the model. Therefore, EPA photochemical modeling guidance document provides for other evidence (Weight of Evidence) to address these model uncertainties so that proper assessment of the probability to attain eight-hour ozone standard can be made.

There were number of Weight of Evidence tests employed to test the potential of Washington, D.C. area to attain the eight-hour standard in 2009. Details of each of these tests are being provided below.

10.5.1 Trend in 8-hour Ozone Design Value

Trend in the 8-hour ozone design values between 1988 and 2006 is shown in Figure 10-2. It is clear that the design value has significantly decreased during this period from 0.116 ppm in 1988 to 0.091 ppm in 2006.

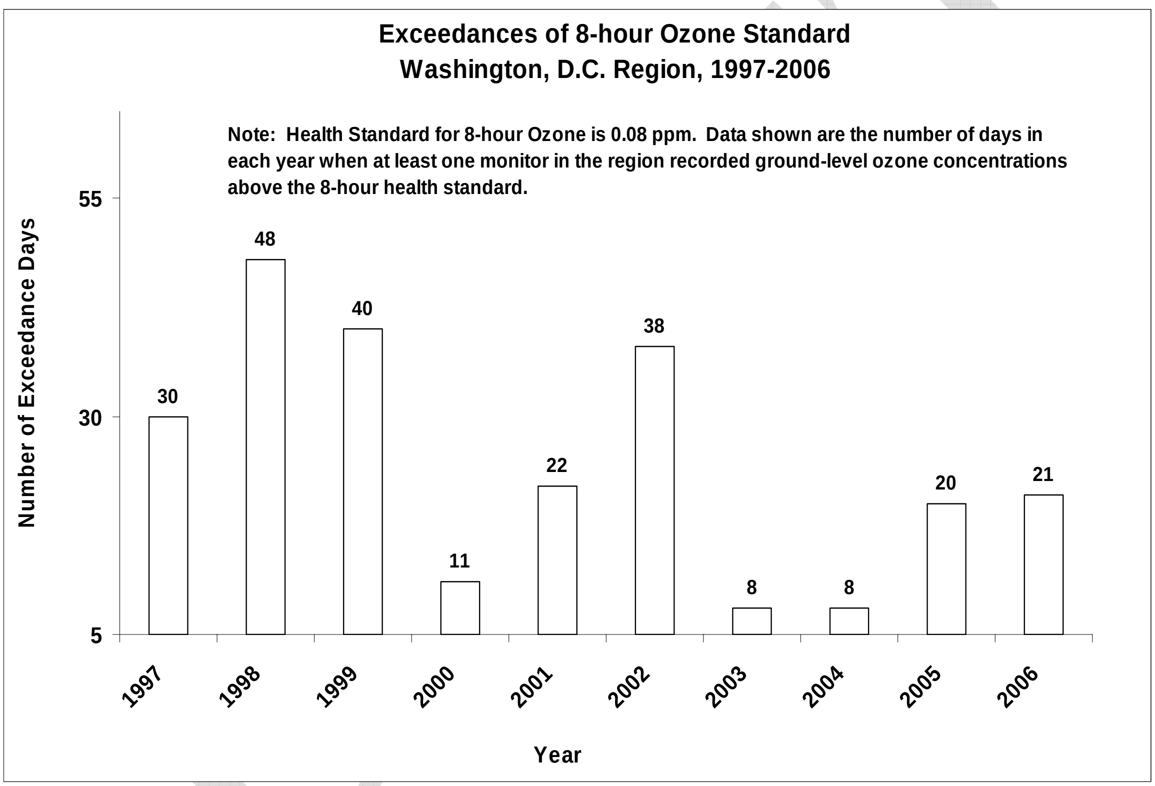
Figure 10-2: Trend in 8-Hour Ozone Design Value in the Washington, DC-MD-VA Nonattainment Area



10.5.2 Trend in Exceedance Count across All Monitors

The trend in the total number of exceedances at the monitor recording the highest number of exceedances between 1997 and 2006 is shown in Figure 10-3. Monitor exceedances occur whenever a monitor's 8-hour ozone concentration is greater than or equal to 0.08 ppm. Though the number of monitors in the Washington, DC-MD-VA 8-hour nonattainment area has actually increased by 20% (15 in 1997 to 18 in 2006), the number of exceedances decreased by 30% (30 in 1997 to 21 in 2006).

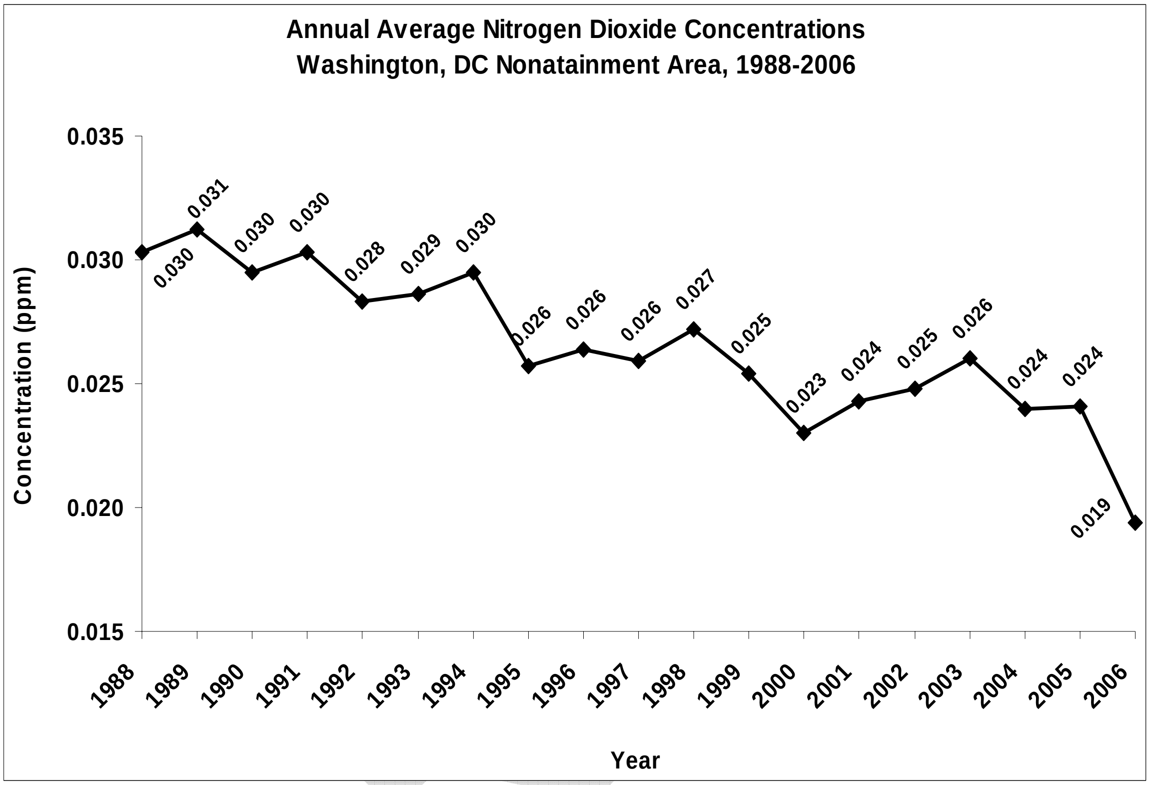
Figure 10-3: Trend in Monitored Exceedances across All Monitors in the Washington, DC-MD-VA Nonattainment Area



10.5.3 Trend in Nitrogen Dioxide Levels

The trend in nitrogen dioxide levels between 1988 and 2006 is shown in Figure 10-4. It is clear from the figure that the levels overall have been declining between 1988 and 2006. A significant (0.011 ppm) decrease is visible between the two years (1988-2006). Implementation of NOx SIP call has brought down significantly the nitrogen dioxide emissions in power plants in upwind areas after 2003. As a result, nitrogen dioxide concentration levels have also been reduced, which is clearly seen after 2003 in the figure below. The NAAQS for NOx (Annual Mean Concentration) is 0.053 ppm and therefore the region is well below the standard. As NOx is a very important factor in ozone formation, its decline over the years has been the one of the main reasons behind the reduction in ozone levels in the region.

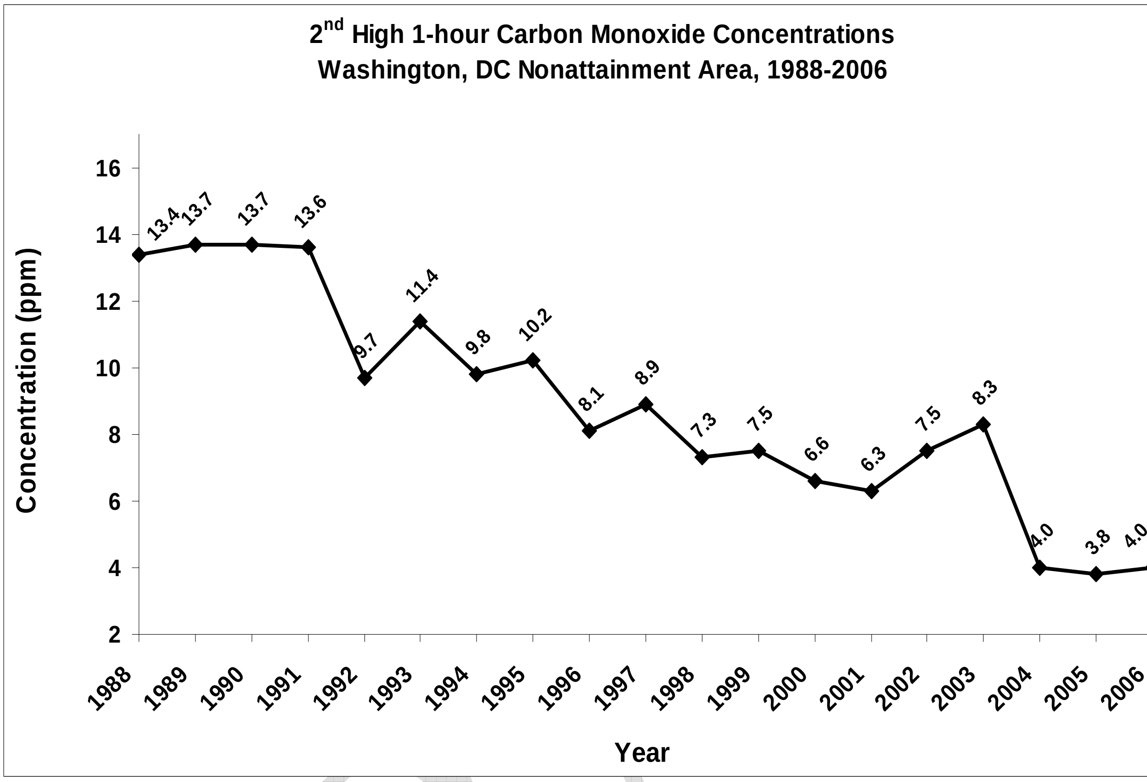
Figure 10-4: Trend in Nitrogen Dioxide Annual Average Concentration in the Washington, DC-MD-VA Nonattainment Area



10.5.4 Trend in Carbon Monoxide Levels

The trend in carbon monoxide levels between 1988 and 2006 is shown in Figure 10-5. It is clear from the figure that the levels have almost consistently been declining between 1988 and 2006. A significant (9.4 ppm) decrease is visible between the two years (1988-2006). Though not very significant, carbon monoxide does play a role in ozone formation and so its decline over the years has certainly helped reduce ozone levels in the region.

Figure 10-5: Trend in 2nd High 1-Hour Carbon Monoxide Concentration in the Washington, DC-MD-VA Nonattainment Area



10.5.5 Trend in VOC and NOx Emissions

Comparison of VOC and NOx emissions in the years 2002, 2008, and 2009 are shown in Figures 6 and 7 respectively.

It is clear from Figure 10-6 that VOC emissions are projected to decrease between 2002 and 2009 for nonroad and onroad sources. Point source VOC emission will be increasing a little bit in 2008 and 2009, while area sources will go down in 2008 and then increase again in 2009 by a very small margin. However, total combined VOC emissions will decrease significantly in 2008 and 2009 from 2002 levels.

Figure 10-7 shows that NOx emissions are projected to decrease between 2002 and 2009 for nonroad and onroad sources. Area source NOx emission will be increasing a little bit in 2008 and 2009, while point source NOx emission will increase slightly in 2008 and then decrease by almost 50 percent in 2009. However, total combined NOx emissions will decrease significantly in 2008 and 2009 from 2002 levels.

Figure 10-6 VOC Emissions in the Washington, DC-MD-VA Nonattainment Area

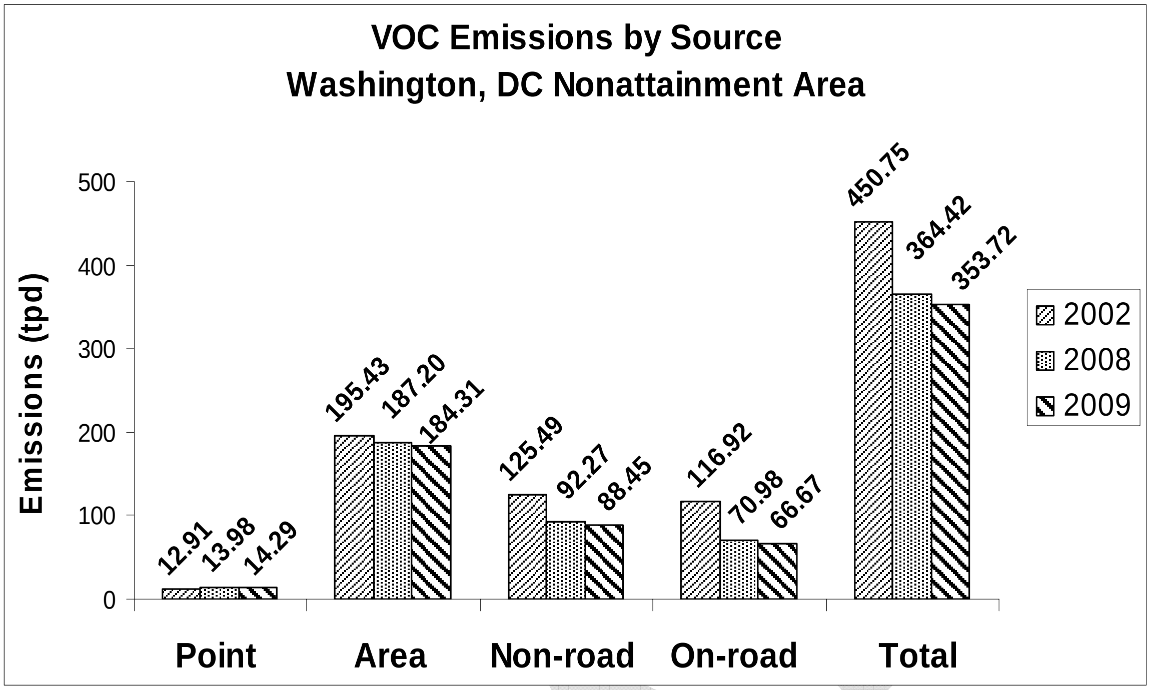
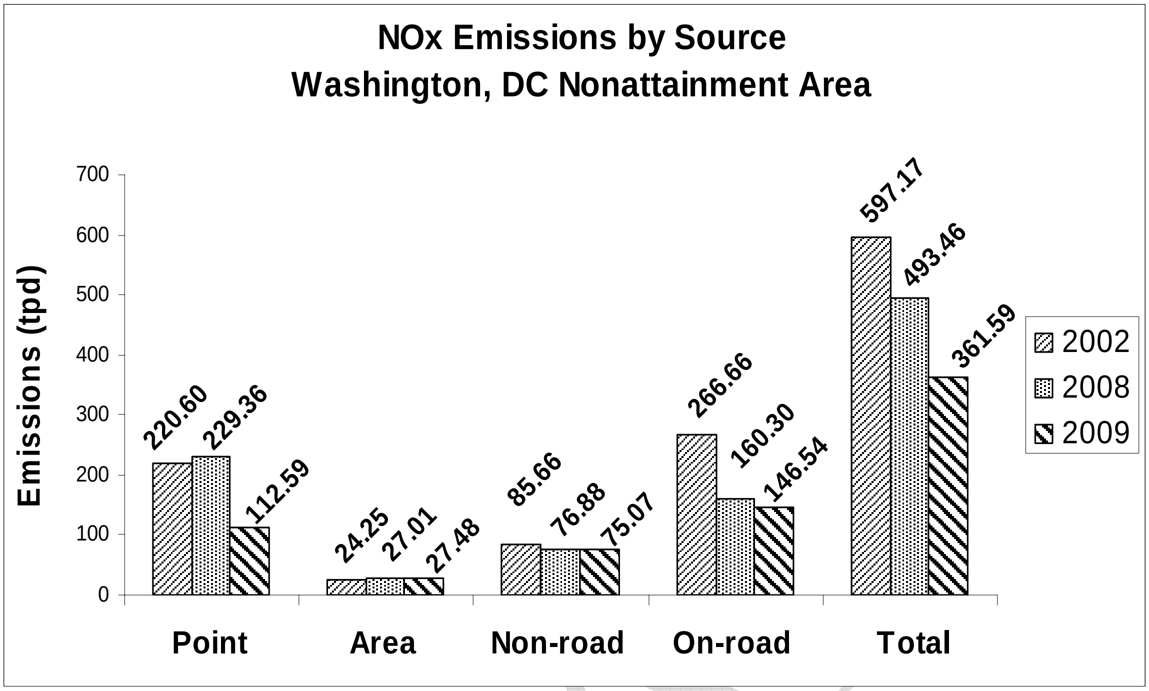


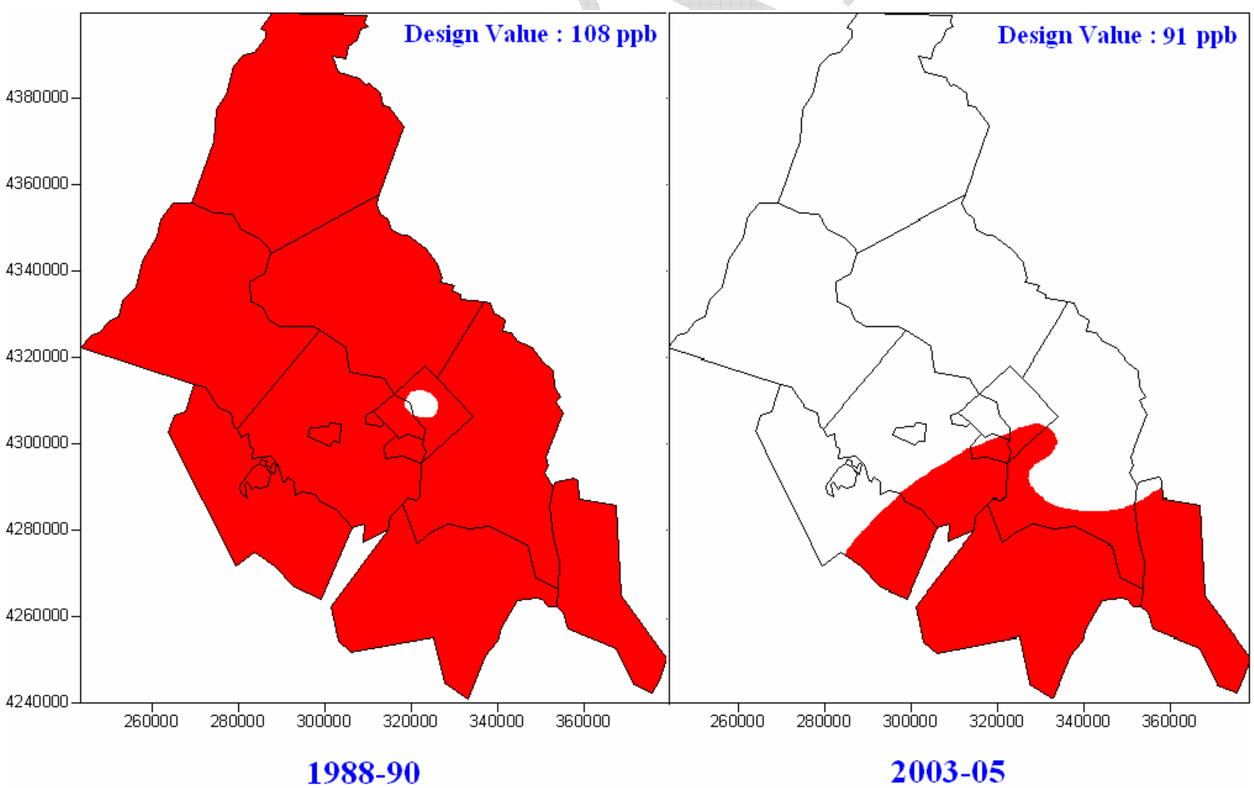
Figure 10-7: NOx Emissions in the Washington, DC-MD-VA Nonattainment Area



10.5.6 Spatial Extent of NAAQS Violations

The Washington, DC-MD-VA nonattainment area's geographical extent of violation has been decreasing in size since 1990. Figure 10-8 shows a decrease in the spatial extent of the nonattainment zone within the Washington, DC-MD-VA nonattainment region between 1990 and 2005. The actual nonattainment geographical area exceeding 8-hour ozone design value of 84 ppbv has been shown in red color in the figure. It is clear that almost entire Washington, DC metropolitan region was in nonattainment during 1988-1990. The 2003-2005 data show that the geographical extent of this area has reduced in size to portions of the District of Columbia, the city of Alexandria, and Arlington, Fairfax, Prince Williams, Charles, Calvert, and Prince George's counties. Ozone levels observed in these areas are not only the product of local emissions but are also impacted a great deal by the transport of ozone and its precursors from upwind areas. Not only the nonattainment zone in 2005 has been reduced to less than half in size compared to 1990, but also the design value has also been reduced by about 16% from 108 ppb to 91 ppb.

Figure 10-8: Comparison of Nonattainment Zones within Washington, DC-MD-VA Nonattainment Area (1990 – 2005)



10.5.7 Trend in 8-Hour Ozone Exceedance Days and High Temperature Days

Ozone concentrations are quite dependent on meteorological conditions especially temperature. High temperatures help drive ozone production. Correlations can be made between ozone concentrations and meteorological variables such as the number of 90ºF days. Hot dry summers can produce long periods of elevated ozone concentrations while ozone production can be limited during cool and wet summers.

Temperature data from the Dulles International Airport were reviewed during years considered warmer than normal to determine any trends between 8-hour ozone values and high temperature days. The years analyzed were 1998, 2002, 2005, and 2006. During these years, there were more than 30 days when temperatures equaled or exceeded 90ºF. Table 10-2 lists the number of 8-hour ozone exceedance days and the days with temperatures ≥ 90ºF in each of the four years mentioned above in the Washington, DC-MD-VA nonattainment area. In comparing these years to 1998, there has been a decline of 21% (2002), 58% (2005) and 56% (2006) in the number of 8-hour ozone exceedance days.

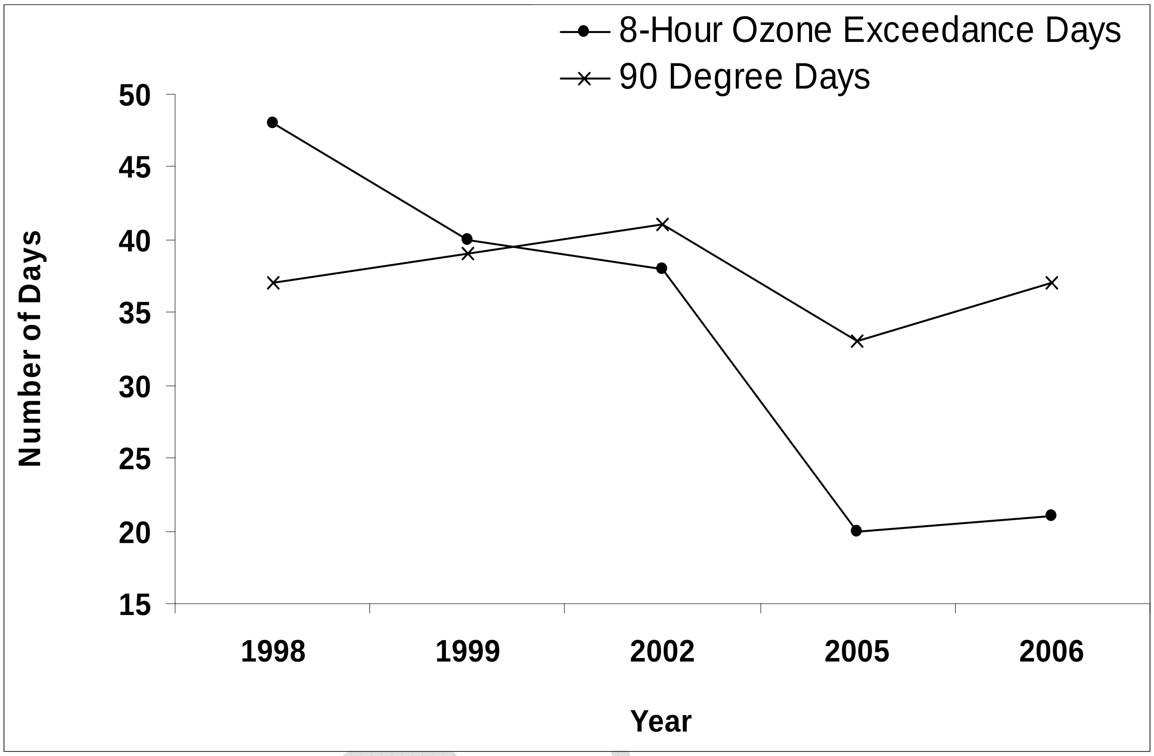
Table 10-6: Temperature and 8-Hour Ozone Exceedances in the Washington, DC-MD-VA Ozone Nonattainment Area

Year	8-Hour Ozone Exceedance Days	Days with Max. Temp ≥ 90ºF
1998	48	37
2002	38	41
2005	20	33
2006	21	37

Trend in the number of 8-hour ozone exceedance days and the number of days with maximum temperature ≥ 90ºF is shown in Figure 10-9. A close look at the Figure 10-9 reveals the number of ozone exceedance days on decline since 1998 even though the number of high temperature days has remained high and at more or less the same level in the four analysis years. The reason behind fewer ozone exceedance days after 1998 can be attributed to lower emission levels. While during 1998 temperatures below 90ºF were able to cause an exceedance, beginning 1999 exceedances occurred only when temperature reached more than 90ºF due to lower emission levels.

It is clear that the emission levels have been decreasing over the years and since 1999 they have been reduced to a level that the temperature must be more than 90ºF in order to exceed. A number of federal control measures such as, Acid Rain Program (Phase 1 – 1996 & Phase 2 – 2000) and NOx SIP Call (2004) were implemented during 1996-2004 to control emissions level. Also a wide range of local and regional control measures were implemented by Maryland, Virginia, and the District of Columbia beginning 1996, full benefits of which began in 1998. Emissions reductions from all the above mentioned measures combined resulted in the decrease in the number of ozone exceedance days since 1998.

Figure 10-9: 8-Hour Ozone Exceedance Days and High Temperature Days (≥ 90ºF) in the Washington, DC-MD-VA Nonattainment Area

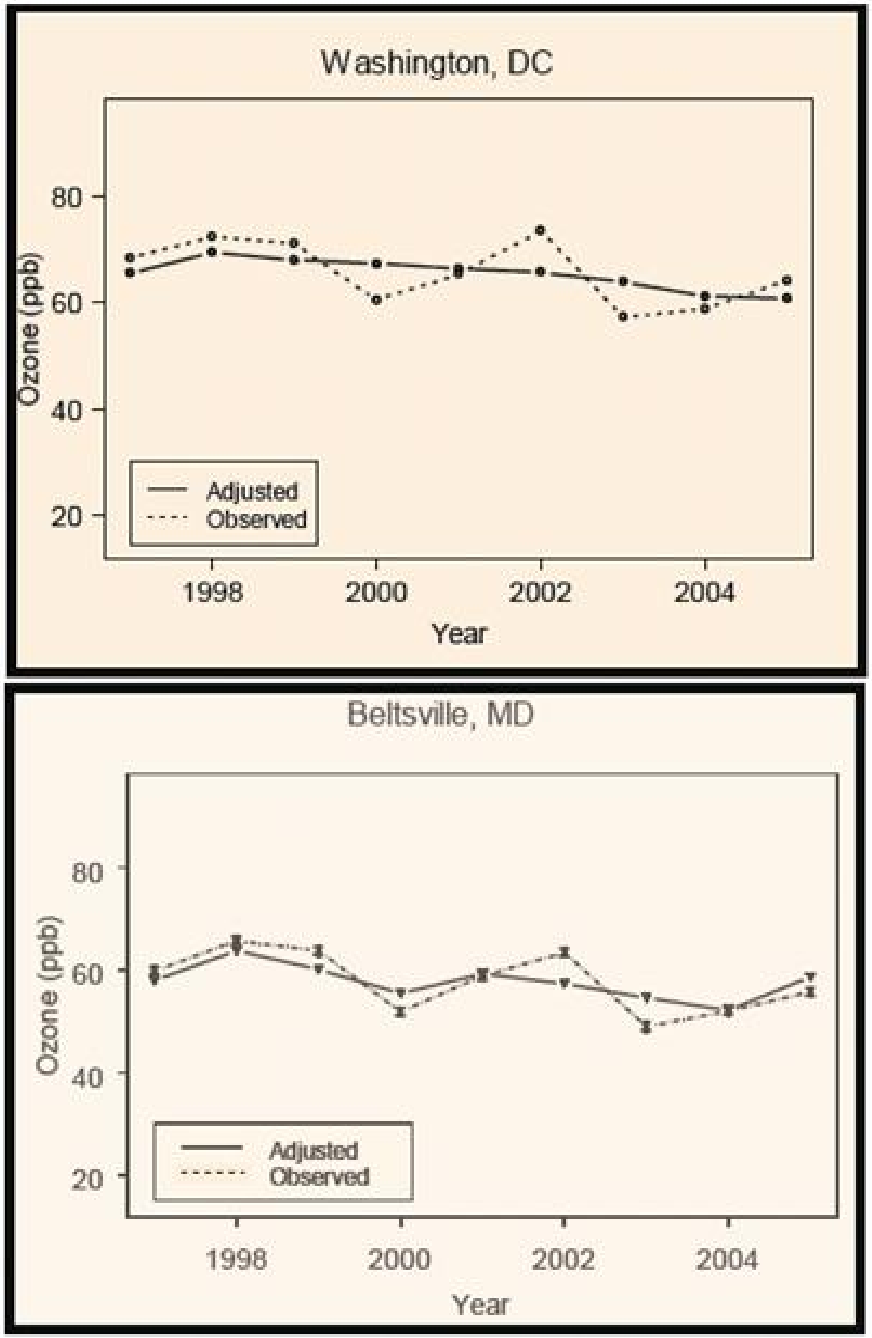


10.5.8 Trend in Meteorology Adjusted Ozone Levels

Cox and Chu (EPA)[1] developed an advanced statistical technique, which allows the effects of meteorology (temperature, humidity, etc.) to be separated from the 8-hour ozone levels. EPA applied this technique at a number of monitors across the country to develop meteorology adjusted 8-hour daily maximum ozone levels and compared them to the observed 8-hour daily maximum ozone levels. This analysis was published in the EPA's ozone trend report titled *"Weather Makes a Difference: 8-hour Ozone Trends for 1997-2005"* in August 2006 and is available at http://www.epa.gov/air/airtrends/weather.html.

EPA performed this analysis for Washington, DC and Beltsville (Maryland) in Washington, DC-MD-VA ozone non-attainment area. Figure 10-9 shows the results for these two sites. It is quite clear from the two figures that a consistently declining trend is observed in ozone levels in response to consistently declining VOC and NOx emissions levels once the effect of meteorology has been removed. With emissions further projected to decline in 2009, ozone levels will also decline in the attainment year.

Figure 10-10 Meteorology Adjusted Ozone Season Average 8-Hour Daily Maximum Ozone Trend (1997-2005)



[1] Cox, William M. and Shao-Hang Chu. (1996). "Assessment of Interannual Ozone Variation in Urban Areas from a Climatological Perspective.", *Atmospheric Environment*, 30.14, 2615-2625.

10.5.9 Alternative Design Value Calculation Techniques

10.5.9.1 Methodologies for Calculating Baseline Design Values

The baseline measured concentrations at each monitoring site is the anchor point for future year projected concentrations. The baseline design values are projected to the future using RRFs. In practice, the choice of the baseline design value can be critical to the determination of the estimated future year design values. Therefore, careful consideration should be given to the calculation of baseline values.

EPA guidance also states that there are several possible methodologies to calculate baseline design values. Although EPA recommends using the average of the three design value periods which include the baseline inventory year, there is a high degree of uncertainty that this approach best represents baseline concentrations. Specifically, there is concern that weighting the 2002 concentrations three times in the calculation arbitrarily places too much weight on an individual year of meteorology and does not accurately reflect climate variability which has a significant impact on future design value projections.

Ideally, a statistical model that analyzes the inter-annual variability of pollutant concentrations due solely to meteorology fluctuations (Shao-Hang Chu and W.M. Cox, 1993, 1996) should be used to predict the probability of future violation of the NAAQS at any monitoring site. In the absence of this statistical modeling analysis, a series of baseline design value calculations were performed in order to assess the effect on future design value projections. The following 3 calculation techniques were performed:

1. EPA Recommended Method - Baseline design values were calculated using the weighted average approach, using the three design value periods which include the baseline inventory year. Specifically, the average design values were calculated using the 2000-2002, 2001-2003, and 2002-2004 periods as described in Section IV.B of this report.
2. 2001-2003 Design Value - Baseline design values were calculated using the design value period which straddles the 2002 baseline inventory year. This approach is an alternative approach in the EPA guidance. Sites that did not have adequate data available to calculate a design value for this period were excluded.
3. 2000-2004 Straight Average Design Value - Baseline design values were calculated using a straight average of the 5 year period centered on the 2002 baseline inventory year. Sites with less than 5 years of data were averaged over the number of available years of data. This approach provides a reasonable period of record to assess the inter-annual variability of meteorology without arbitrarily placing emphasis on any one year of meteorology.

Table 10-7: Methodologies for Calculating Baseline Design Values

AIRS ID	Site Name	Jurisdiction	State	EPA Method DVB	2001-2003 DVB	2000-2004 Straight Average DVB
11-001-0025	Takoma	District of Columbia	---	88.7	88	87.6
11-001-0041	River Terrace	District of Columbia	---	89.0	92	85.2
11-001-0043	McMillan	District of Columbia	---	92.7	94	89.6
24-009-0010	Calvert	Calvert	MD	NA	NA	NA
24-017-0010	Southern MD	Charles	MD	93.0	94	91.6
24-021-0037	Frederick Municipal Airport	Frederick	MD	87.3	88	85.8
24-031-3001	Rockville	Montgomery	MD	86.7	88	85.2
24-033-0002	Greenbelt	Prince George's	MD	94.0	93	92.5
24-033-8003	PG Equestrian Center	Prince George's	MD	94.0	NA	94.7
51-013-0020	Aurora Hills	Arlington County	VA	96.7	99	92.8
51-059-0005	Chantilly	Fairfax County	VA	87.0	89	85.2
51-059-0018	Mount Vernon	Fairfax County	VA	96.7	97	95.4
51-059-0030	Franconia	Fairfax County	VA	95.0	97	91.8
51-059-1005	Annandale	Fairfax County	VA	94.0	NA	94.0
51-059-5001	McLean	Fairfax County	VA	88.0	88	86.0
51-107-1005	Ashburn	Loudoun County	VA	90.0	92	87.0
51-153-0009	Long Park	Prince William County	VA	85.0	87	83.6
51-510-0009	Alexandria	Alexandria City	VA	90.0	92	86.8

10.5.9.2 Methodologies for Calculating Relative Response Factors

In addition to the variability associated with base design value calculations, there is also uncertainty in the calculation of relative response factors (RRFs). As a result, 3 techniques were used to calculate the RRFs to assess the impact on future design value projections. RRF calculations for each of the following techniques are provided in Table 4-4.

1. EPA Recommended Method – Utilizes the default recommendations for "nearby" grid cells, with a 3x3 grid cell array for 12-km resolution modeling. The relative response factor (RRF) used in the modeled attainment test is computed by taking the ratio of the mean of the 8-hour daily maximum predictions in the future to the mean of the 8-hour daily maximum predictions with baseline emissions, over all relevant days.

   EPA recommends this approach because of the following three reasons:

   a. Consequence of a control strategy may be "migration" of a predicted peak. If a State were to confine its attention only to the cell containing a monitor, it might underestimate the RRF (i.e., overestimate the effects of a control strategy).

   b. Uncertainty in the formulation of the model and the model inputs is consistent with recognizing some leeway in the precision of the predicted location of daily maximum ozone concentrations.

   c. Standard practice in defining a gridded modeling domain is to start in the southwest corner of the domain, and determine grid cell location from there. Considering several cells "near" a monitor rather than the single cell containing the monitor diminishes the likelihood of inappropriate results which may occur from the geometry of the superimposed grid system.

2. Grid Cell Average Technique – Utilizes the default recommendations for "nearby" grid cells, with a 3x3 grid cell array for 12-km resolution modeling. The relative response factor (RRF) used in the modeled attainment test is computed by taking the ratio of the mean of the 8-hour daily maximum predictions averaged across the 3x3 grid cell array surrounding the monitor in the future to the mean of the 8-hour daily maximum predictions averaged across the 3x3 grid cell array surrounding the monitor with baseline emissions, over all relevant days.

   The following rules shall were applied to determine the number of days and the minimum threshold at each ozone monitor:

   a. If there were 10 or more days with daily maximum 8-hour average modeled ozone > 85 ppb, averaged over the 3x3 grid cell array, an 85 ppb threshold was used.

   b. If there was less than 10 days with daily maximum 8-hour average modeled ozone > 85 ppb, averaged over the 3x3 grid cell array, the threshold was reduced to as low as 70 ppb until there was 10 days in the mean RRF calculation.

   c. If there was less than 10 days with daily maximum 8-hour average modeled ozone > 70 ppb, averaged over the 3x3 grid cell array, then all days > 70 ppb was used.

   d. No RRF calculations shall be performed for sites with less than 5 days > 70 ppb, averaged over the 3x3 grid cell array.

   This technique is effective in that it only looks at days where the average 8-hour ozone maximum surrounding the monitor exceeds 85 ppb and excludes the evaluation of days that have an isolated peak or a tight concentration gradient in the vicinity of the monitor that can be difficult to model.

3. Grid Cell Only Technique – Utilizes the grid cell where the monitor is located and does not employ an array of grid cells surrounding the monitor. The relative response factor (RRF) used in the modeled attainment test is computed by taking the ratio of the mean of the 8-hour daily maximum predictions in the future to the mean of the 8-hour daily maximum predictions with baseline emissions, over all relevant days.

   There are a few reasons why it might be appropriate to use this technique:

   a. There are occasions where the use of unmonitored grid cells nearby a monitor may not adequately characterize what is happening at the monitor.

   b. Model performance evaluations (MPE) are only conducted for the grid cells containing monitors; therefore, it may be beneficial to have the model attainment test remain consistent with the MPE and only use these grid cells.

   c. Calculating RRFs based on nearby cells that change locations between the baseline simulation and future simulation (not paired in space) may lead to erroneous and misleading conclusions.

Table 10-8: Methodologies for Calculating Relative Response Factors

AIRS ID	Site Name	Jurisdiction	State	EPA Method	9-Cell Average Method	Grid Cell Only Method
11-001-0025	Takoma	District of Columbia	---	0.892	0.874	0.886
11-001-0041	River Terrace	District of Columbia	---	0.883	0.872	0.909
11-001-0043	McMillan	District of Columbia	---	0.883	0.872	0.909
24-009-0010	Calvert	Calvert	MD	0.836	0.815	0.81
24-017-0010	Southern MD	Charles	MD	0.808	0.806	0.794
24-021-0037	Frederick Municipal Airport	Frederick	MD	0.846	0.833	0.844
24-031-3001	Rockville	Montgomery	MD	0.881	0.861	0.86
24-033-0002	Greenbelt	Prince George's	MD	0.869	0.857	0.857
24-033-8003	PG Equestrian Center	Prince George's	MD	0.865	0.838	0.837
51-013-0020	Aurora Hills	Arlington County	VA	0.891	0.875	0.893
51-059-0005	Chantilly	Fairfax County	VA	0.867	0.858	0.888
51-059-0018	Mount Vernon	Fairfax County	VA	0.883	0.872	0.868
51-059-0030	Franconia	Fairfax County	VA	0.88	0.873	0.877
51-059-1005	Annandale	Fairfax County	VA	0.88	0.873	0.877
51-059-5001	McLean	Fairfax County	VA	0.883	0.869	0.864
51-107-1005	Ashburn	Loudoun County	VA	0.869	0.872	0.874
51-153-0009	Long Park	Prince William County	VA	0.871	0.865	0.866
51-510-0009	Alexandria	Alexandria City	VA	0.883	0.872	0.868

10.5.9.3 Future Design Value Ranges

In order to assess the sensitivity of the future design value calculations, a matrix using relative response factor and base design values. This results in 9 combinations of future design values for each monitor, except where missing data is noted. A summary of the minimum and maximum DVFs for each monitor is provided in Table 10-9.

The minimum DVFs for all monitors fall below the 85 ppb attainment threshold. It is also important to note that there is a high degree of sensitivity in the DVF calculations for the Arlington County monitor, where the range is from 81 ppb to 88 ppb. Detailed calculations are provided in Attachment 11 for all runs conducted by the OTC, ASIP, and VADEQ.

Table 10-9: Future Design Value Ranges (BOTW +VA CAIR Modeling Run)

AIRS ID	Site Name	Jurisdiction	State	Minimum DVF	Maximum DVF
11-001-0025	Takoma	District of Columbia	---	76	79
11-001-0041	River Terrace	District of Columbia	---	74	83
11-001-0043	McMillan	District of Columbia	---	78	84
24-009-0010	Calvert	Calvert	MD	NA	NA
24-017-0010	Southern MD	Charles	MD	72	75
24-021-0037	Frederick Municipal Airport	Frederick	MD	71	74
24-031-3001	Rockville	Montgomery	MD	73	77
24-033-0002	Greenbelt	Prince George's	MD	79	81

AIRS ID	Site Name	Jurisdiction	State	Minimum DVF	Maximum DVF
24-033-8003	PG Equestrian Center	Prince George's	MD	78	81
51-013-0020	Aurora Hills	Arlington County	VA	81	88
51-059-0005	Chantilly	Fairfax County	VA	73	79
51-059-0018	Mount Vernon	Fairfax County	VA	82	85
51-059-0030	Franconia	Fairfax County	VA	80	85
51-059-1005	Annandale	Fairfax County	VA	82	82
51-059-5001	McLean	Fairfax County	VA	74	77
51-107-1005	Ashburn	Loudoun County	VA	75	80
51-153-0009	Long Park	Prince William County	VA	72	75
51-510-0009	Alexandria	Alexandria City	VA	75	81

10.5.10 Additional Weight of Evidence: Voluntary Action Campaigns

10.5.10.1 Clean Air Partners

Clean Air Partners is a bi-regional public-private partnership in the Baltimore Washington region created to develop and implement voluntary action programs to reduce emissions on the days when ozone levels are expected to be high.

The partnership was created in 1994 by the Metropolitan Washington Air Quality Committee (MWAQC), the Transportation Planning Board of the National Capitol Region (TPB) and the Baltimore Metropolitan Council (BMC). The partnership, originally known as ENDZONE Partners, has conducted an air quality public education campaign in the Washington and Baltimore metropolitan areas since 1995. The purposes of the campaign are to raise public awareness of air quality issues and to promote voluntary actions to improve air quality. The campaign is funded by public funds from Maryland, Virginia, the District of Columbia, and receives staff support from the state air management agencies. In 1997 the partnership formed a new formal public-private partnership, hired a Managing Director, and in 1999 changed its name to Clean Air Partners.

The Ozone Action Days employer program was established in 1995 in the Baltimore/Washington region. This program encourages employers and their employees to take voluntary actions to reduce ozone pollution causing emissions. When the Environmental Protection Agency (EPA) designated both Baltimore and Washington, DC metropolitan regions as nonattainment for fine particles, Clean Air Partners' Board of Directors changed the name of the program from Ozone Action Days to Air Quality Action Days (AQAD).

The AQAD employer program's purpose is to educate employers and employees to take voluntary actions, specifically on Code Red days. It was argued that voluntary actions taken on the worst days of summer would "shave the peaks," or reduce the high ozone levels on the worst days. Clean Air Partners provides resources and information to a network of AQAD participants. Clean Air Partners assists employers in establishing on-site programs designed to reduce employee travel on bad air days; and encourages voluntary actions by business, industry, government, and individuals to restrict activities that contribute to the formation and risks of bad air. Approximately 600 employers and individuals are registered as AQAD participants and have committed to take voluntary actions to reduce emissions on Code Red days.

Clean Air Partners runs an extensive education campaign throughout the ozone season, May to September, to educate the public about the effects of ground-level ozone and what people can do to improve air quality. Air quality forecasts are distributed daily by fax and email to the media and Air Quality Action Days participants. The air quality forecast is color-coded for ease of communication, following EPA's regulation for the Air Quality Index.

During the ozone season, in addition to communicating daily with television and radio meteorologists in the regions, Clean Air Partners places radio and television ads to advise about the health risks and to promote less polluting behaviors on unhealthy air days. The ad messages target individual emission reduction actions for behavior modification and the heath effects of poor air quality.

10.5.10.1 Evaluation of Voluntary Action Campaign

Despite improvements in the region's air quality, new challenges lie ahead for the AQAD employer program. Prior to 2006, Clean Air Partners asked its participants to take voluntary actions on Code Red days, which was associated with the 1-hour ozone standard. When EPA set the 8-hour ozone standard to coincide with the Code Orange Air Quality Index it resulted in approximately 20 or more days per year that exceed the standard.

In light of the potential burden the increase in number of exceedance days may place on the program, Clean Air Partners conducted two focus groups with its AQAD participants. The purpose was to determine their level of participation and how the 8-hour standard may affect their participation in the future. Strong concerns arose over too many Code Orange days. As a result, a "tiered" approach for recommended actions for employers and individuals based on Code Orange and Code Red will be developed and implemented over the next year.

Clean Air Partners conducts surveys to determine the effectiveness and reach of its message. Two types of surveys are conducted, an "end of season" survey and an "episodic survey," taken on the evening of a forecasted Code Red Day. Surveys have been conducted by the partnership since 1995.

The end-of-season survey, conducted eight times since 1995, is used to estimate the potential for behavior change and to help target the right messages. A new baseline end-of-season survey was completed in September 2006 to determine the public's awareness of Clean Air Partners and Code Orange air quality. Episodic surveys began in the summer of 1999. The objective of the episodic survey is to determine if the Clean Air Partners' message is being heard and if the potential for behavior change is being realized. A study looking at trends in results of surveys taken over eight years indicates that the episodic survey, conducted on the evening of a forecasted Code Red Day, provides the most reliable measure of behavior in response to the campaign. Survey results show a steady increase in the public's "willingness to act," with 76% of the respondents indicating a belief that the individual can make a difference.

10.5.10.2 Trends in Survey Results

Data from the two types of surveys indicate that general knowledge levels about air quality and its measurement systems increased substantially in both metropolitan areas during the five years, 1996-2001. Knowledge that Code Red indicates unhealthy air when activity should be limited increased significantly during the period. Over 90% surveyed knew that today was a “Code Red/Bad Air Day,” in 2002, and 67% said the phrase Code Red means “air is unhealthy.”

Over the period, 1996-2001, the end-of-season survey results for the Washington metropolitan region show the percentage of residents willing to act grew from 35% to 44% in 2001. The percentage of people reporting changing their behavior or limiting someone else’s (child) was 66% in 2001, an increase from 40% in 1996. In Washington, seventeen percent of all respondents said they took action to reduce air pollution.

Results:

- Increase in knowledge about ground-level ozone and color-code rating system
- Steady increase in “willingness to act” from 35% in 1996 to 44% in 2001.
- Behavior change in response to bad air days is common

Avoidance of health risk is most common reason for behavior change (66%); second reason is to reduce emissions (17%).[7]

10.5.10.3 Other Voluntary Actions

In addition to participating in Clean Air Partners programs, the local governments and state agencies in the Washington region have taken a coordinated, proactive approach to reducing emissions attributable to their organizations on an episodic basis. These actions reduce VOC and NOx emissions from a variety of source sectors. Shutdowns of county waste-to-energy facilities reduce stationary source emissions. State agencies and county governments ban refueling of non-emergency fleet vehicles and application of traffic paint and pesticides, eliminating area source emissions. Many of these organizations also ban operation of lawn and garden equipment to reduce non-road emissions. Mobile emissions are reduced through liberal leave policies and support for teleworking on Code Red Days. Though the benefits of these episodic programs are not reflected in the region’s 2009 controlled inventory, the programs are an important part of the region’s attainment strategy and provide additional evidence that the region will attain the ozone standard in 2009.

10.5.11 Summary and Conclusions of Attainment Demonstration

The results from the modeling and weight of evidence tests present considerable evidence that the Washington region will attain the 8-hour ozone standard by June 15, 2010. Based on air quality measurements and future predicted air quality modeling results the projected design values for the Washington, D.C. area are below the attainment criteria of 85 ppb.

10.5.12 Procedural Requirements

10.5.12.1 Reporting

Documents, technical memorandums, and data bases developed in this study are available for distribution as appropriate. This report contains the essential methods and results of the conceptual model, episode selection, modeling protocol, base case model development and performance testing, future year and control strategy modeling, quality assurance, weight of evidence analyses, and calculation of 8-hr ozone attainment via EPA's relative response factor (RRF) methodology.

10.5.12.2 Data Archival and Transfer of Modeling Files

All relevant data sets, model codes, scripts, and related software required by any project participant necessary to corroborate the study findings (e.g., performance evaluations, control strategy runs) will be provided in an electronic format approved by the Technical Committee within the framework of MWAQC. The Technical Committee has archived all modeling data relevant to this project. Transfer of data may be facilitated through the combination of a project website and the transfer of large databases via overnight mail. Database transfers will be accomplished using an ftp protocol for smaller datasets, and the use of IDE and Firewire disk drives for larger data sets.

GENERAL REFERENCES

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Stoeckenius, T., Kemball-Cook, S. (2005) Ozone Episode Classification Project for Ozone Transport Commission (Task 2b), ENVIRON International Corporation, Novato, California.

EPA GUIDANCE DOCUMENTS

Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, PM2.5, and Regional Haze (Draft 3.2- September 2006). U.S. Environmental Protection Agency, Research Triangle Park, N.C.

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1. "An Analysis of Air Pollution-Related Knowledge, Attitudes, and Behaviors Across Time: The End of Season and Episodic Surveys," Fox, J. Clifford and Mousumi Sarkar, Virginia Commonwealth University, December 2002, prepared for Clean Air Partners.