1998
Clean Air Plan
Appendix D

Ozone Attainment Demonstration

FINAL

December 1998

Santa Barbara County
Air Pollution Control District

Santa Barbara County
ASSOCIATION OF
GOVERNMENTS

FINAL

SANTA BARBARA COUNTY
1998 CLEAN AIR PLAN

APPENDIX D

OZONE ATTAINMENT DEMONSTRATION

DECEMBER 1998

Santa Barbara County
Air Pollution Control District
26 Castilian Drive, Suite B-23
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Peter M. Rooney
Secretary for Environmental Protection

Air Resources Board

John D. Dunlap, M, Chairman
2020 L Street - P.O. Box 2815 - Sacramento, California 95814 - www.arb.ca.gov

August 25, 1998

Mr. Doug Allard
Air Pollution Control Officer
Santa Barbara Air Pollution Control District
26 Castilian B-23
Goleta, California 93117

Dear Mr. Allard:

Enclosed is the Air Resources Board's final report titled A Demonstration of Attainment of the Federal 1-Hour Ozone Standard in Santa Barbara County in the Year 1999. This modeling demonstration was performed at the District's request in order to fulfill the requirements of Federal Clean Air Act amendments as a result of Santa Barbara County being reclassified from a "moderate" to a "serious" ozone nonattainment area.

If you have any questions regarding this analysis, please contact Mr. Dean Saito, Manager of the Liaison Section, at (916) 322-8279.

Sincerely,

Lynn Terry
Executive Officer

Enclosure

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A Demonstration of Attainment of the-Federal 1-Hour Ozone Standard In Santa Barbara County in the Year 1999

Prepared for

Santa Barbara County Air Pollution Control District
26 Castilian Drive, Suite B-23
Goleta, California 93117-3027

By

California Air Resources Board
Technical Support Division/Control Strategy Modeling Section
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FINAL REPORT

August 28, 1998

I. Introduction

Because of violations of the 1-hour federal ozone standard in 1996 and 1997, the USEPA has requested that an ozone attainment demonstration be prepared for Santa Barbara County for the year 1999. Because of the proximity of the 1999 target date, there is little opportunity to develop new tools for this demonstration. Therefore, the ARB staff, in consultation with the staff of the Santa Barbara County Air Pollution Control District (SBAPCD), elected to adapt an existing analysis from the 1994 State Implementation Plan for Ventura County for this demonstration.

Ozone concentrations that exceeded the federal 1-hour ozone standard of 12.0 pphm were recorded at one monitoring site in Santa Barbara County in 1996 and 1997. That site, Las Flores Canyon No. 1, is located approximately 35 Ian (20 miles) west of the city of Santa Barbara (see Figure 1). The design value for this site for the period of 1995, 1996 and 1997 is 13.0 pphm.

The photochemical modeling analysis used in the 1994 SIP to demonstrate attainment of the federal ozone standard in Ventura County is based on data collected during the 1984 South Central Coast Cooperative Aerometric Monitoring Program (SCCCAMP). From that study, photochemical modeling was used to analyze episodes on September 5-7, and September 16-17, 1984. The 'controlling' episode for Santa Barbara County was September 5-7, during which a peak ozone concentration of 15.0 pphm was measured in the city of Santa Barbara.

There were a number of difficulties to be over-come to apply the photochemical modeling analysis of the September 5-7, 1984 episode to demonstrate attainment in the year 1999 at Las Flores Canyon. The difference between a design value ozone concentration of 13.0 pphm and an attainment concentration of 12.0 pphm is 8%. However, the accepted accuracy of photochemical models is 15% (e.g., Radian, 1990). Therefore, it is not reasonable to expect a photochemical model to accurately describe absolute changes in ozone concentrations of between 12 and 13 pphm. Also, the September 5-7, and September 16-17, 1984 episodes are less than ideal for the analysis of peak ozone concentrations at Las Flores Canyon. Although the peak ozone concentration at Gaviota (near Las Flores Canyon) during the September.5-7 episode was 11 pphm, the wind flow patterns during both of these episodes are predominately from west to east. Most of the anthropogenic emissions within the modeling domain are to the east of Las Flores Canyon and significant changes in simulated ozone concentrations at Las Flores Canyon in response to changes in emissions can not be expected during this episode. The peak simulated ozone concentrations in Santa Barbara County during either of these episodes occurs east of the city of Santa Barbara.

In a draft guidance document for transitional areas demonstrating attainment of the 8-hour federal ozone standard (USEPA, 1998), the inherent limitations in photochemical model accuracy were acknowledged. Rather than depending on the accuracy of photochemical models to predict ozone concentrations close to federal ozone standards, the guidance

document recommends using measured ozone concentrations and relying on the sensitivity of photochemical models to predict relative changes in ozone concentrations.

In this exercise to demonstrate attainment of the 1-hour federal ozone standard in Santa Barbara County, photochemical modeling of the September 5-7, SCCCAMP episode was done for the years 1984, 1996 for the ozone design value, and 1999 as the attainment year. The simulation results for 1984 were used to assess over-all model performance. The emission inventory for each of these years was prepared in a consistent manner and model boundary conditions were scaled for each year simulated. The Urban Airshed Model, and all other photochemical input files from the 1994 SIP- for Ventura County were used. The predicted ozone concentration for the year 1999 was determined by scaling the design value ozone concentration of 13.0 pphm by the relative change in the peak ozone concentration within Santa Barbara County between 1996 and 1999.

II. Boundary Conditions

In the 1994 SIP photochemical modeling study (ARB, 1995), boundary concentrations for the SCCCAMP modeling domain were assumed equivalent to the EPA default concentrations for clean air (USEPA, 1991) on the north, west, and south sides of the domain. On the east side of the domain, boundary concentrations below the diffusion break were set based on measured concentrations at Reseda during the September, 1984 field study period. The eastern boundary concentrations above the diffusion break were estimated based on measurements from the 1987 SCAQS (after, ARE, 1990). For simulations done for the year 2005, the concentrations on the eastern boundary were scaled based on anticipated TOG and NOx emissions reductions in the South Coast Air Basin (after ARB, 1995).

For this exercise, the boundary concentrations on the eastern side of the domain were reduced using factors for each year determined by linear interpolation from 1984 to 2005. The pollutant concentrations on the north, south, and west boundaries were not changed.

Table 2. 1. Reduction factors for the eastern boundary of the SCCCAMP modeling domain for each year. The boundary concentrations were reduced from the concentrations used in 1984.

	1996	1999	2005[1]
NOx	0.76	0.70	0.58
03	0.89	0.86	0.80
TOG	0.64	0.55	0.37

[1] From ARB (1995)

III. Emission Inventory Development

For the photochemical modeling analysis, gridded emission inventories were required for the years 1984, 1996, and 1999 (the 1984 emission inventory was necessary to assess model performance against the field data collected during that year). However, the development of gridded emission inventories for each of these years was not feasible for this project. Therefore, the staff decided use an existing gridded emission inventory as a reference, and scale this reference inventory to emission totals of the emission summaries, by county and by source category (CES/SCC), provided by the ARB for each year. The 1984, 1996, and 1999 emission summaries were developed from the 1996 baseline emission inventory and included EMFAC7G emission factors for on-road mobile sources.

There were 3 gridded emission inventories available for use in the South Central Coast modeling domain. There were the year 1984 and the year 2005 emissions files prepared for photochemical modeling for the 1994 Ventura County SIP (ARB, 1995) and a 1990 gridded emission inventory developed for the 1997 Southern California Ozone Study (SCOS -- SAI, 1996). The 1984 and 2005 emission inventories covered only the modeling domain and, therefore, they did not represent emissions for all of Santa Barbara County. The yearly emissions summaries provided by the ARB are totals by county. Thus, to use either of these gridded emission inventories, as a reference would have required additional assumptions on how emissions are distributed throughout Santa Barbara County. For this reason, the 1990 SCOS gridded emission inventory was selected as the reference inventory.

The 1990 SCOS emission inventory was gridded with a resolution of 2x2 Ion for a UTM zone 11 coordinate system. Thus, mapping this inventory into the SCCCAMT modeling domain was a straightforward and relatively simple task. Since Santa Barbara, Ventura, and Los Angeles Counties are completely included within the SCOS modeling domain, the process of developing emission sums for each source category, for each county, for comparison with the emissions summaries for 1984, 1996, and 1999 provided by the ARB was also a straightforward task.

The approach used to prepare a gridded emission inventory for each required year, was to calculate for each county the ratio of emissions from the reference year (i.e., 1990) and each required year (e.g., 1984,1996, and 1999) by source category. These ratios were calculated for the unspeciated emission categories of carbon monoxide (CO), nitrogen oxides (NOx), sulfur oxides (SOx), and total organic gasses (TOG). The emissions **in** each cell of the 1990 emission inventory were then scaled using these ratios for each source category within the cell, depending on which county the cell was located in.

In practice, there were a number of problems encountered in the application of Ns approach to the SCCCAMP modeling domain. The emission inventory summaries, by source categories, for Santa Barbara County and Ventura County were acquired from the ARB for 1984, 1996, and 1999. However, the emission summaries for Los Angeles County were not available for these years in a timely manner. Also, the emission inventory source categories identified point and area sources; however, the stack parameters needed to define locations and effective stack heights for large point sources could not be provided without a

much greater level of effort. In the 1990 SCOS emission inventory there were emissions in numerous source categories that did not exist in the 1984, 1996, and 1999 emissions summaries and vice-versa. Therefore, when the 1990 gridded emission inventory was scaled, based on the emission source categories that were found in the summaries for each year, there were significant differences between the scaled emission totals and those from the emission summaries of each of the required years.

The SCCCAMP modeling domain includes a relatively small fraction of Los Angeles County. In the 1984 modeling emission inventory, approximately 15 % of the area-source NOx emissions within the SCCCAMP domain were in Los Angeles County. Because of this relatively small fraction of the domain total, the staff decided to use the Los Angeles County emissions from the model inventories in the place of better estimates. The gridded emissions from that portion of Los Angeles County within the SCCCAMP domain was clipped from the 1984 modeling inventory and inserted in the new 1984 emission inventory. For the new 1996 and 1999 gridded emission inventories, that portion of Los Angeles County in the year 2005 modeling inventory was used. Therefore, for this modeling exercise, the emissions in Los Angeles County did not change between 1996 and 1999.

The Urban Airshed Model (UAM), the photochemical model used to simulate ozone concentrations for the 1994 Ventura County SIP requires separate input files for area sources and elevated point sources (small, or non-elevated point sources are treated as area sources). The point source file contains stack heights, flue-gas exit velocity, and temperatures from which effective plume heights from each point source can be calculated. These stack parameters were defined within the 1984 and 2005 UAM point source input files; however, they were not defined for the 1990 gridded emission inventory or for the 1996 and 1999 emissions summaries. Further, the 1996 and 1999 emission summaries assigned emissions by source category, but not by location or the number of emission sources. The effort to reconcile point sources and stack parameters was beyond the scope of this effort.

To develop the new gridded emission inventories for 1984, 1996, and 1999, the staff decided to estimate the emissions from the area sources (including non-elevated point sources) for each year and rely on the existing 1984 and 2005 emission inventories for elevated point source estimates. To approximate the area source emissions from the 1990 SCOS emission inventory, those point sources (identified by the source category) with NOx emission rates of greater than 10 kgm per hour were removed. For the 1996 and 1999 emission summaries, those point source categories with NOx emissions of greater than 120 kgm per day were removed (the 1990 gridded emissions is formatted as hourly emissions per grid cell, the 1996 and 1999 emissions summaries were formatted as emissions per day for each county; therefore, this unfortunate discrepancy in emissions threshold was necessary). For the 1984 UAM simulations using the new 1984 emission inventory, the elevated point source file from the 1984 SIP modeling was used. For the simulations using the new 1996 and 1999 emission inventories, the elevated point source from the year 2005 were used. Therefore, for this exercise, the elevated point source emissions did not change between 1996 and 1999.

After scaling the 1990 gridded emission inventories to 1984, 1996, and 1999 for Santa Barbara and Ventura Counties using ratio of emissions by source category and by adjusting the emissions (as described above) for elevated point sources, the total CO, NOx, SOx, and TOG emissions did not match the totals provided in the summaries for 1996 and 1999. These discrepancies were attributed to differences in source categories between the 1990 emission inventory, and those for the other years. To correct these discrepancies, a second adjustment was made by scaling all of the emissions in each county by the ratio of the scaled 1990 emissions and the emission summaries for 1996 and 1999. The most significant adjustments were required for SOx and NOx (Tables 3.1 and 3.2).

The total gridded modeling emission inventory was determined for 1984, 1996, and 1999 by adding the scaled 1990 emissions for that portion of each county within the modeling domain, the portion from Los Angeles County, the elevated point sources, and the biogenic emission inventory from the 1994 SIP modeling study. The emissions from off- shore shipping and oil-extraction operations were included in the 1990 gridded emissions, but were not scaled for different years.

Table 3.1. Daily emission summaries for the year 1996. The adjustment factor was required to adjust the scaled 1990 emissions to the 1996 emission summary total for each county.

County Total (ton)	Point Source (ton)	Area Source (ton)	Adj. Factor
Santa Barbara County			
CO	231.14	20.7	210.7	0.957
NOx	48.3	15.6	32.7	0.835
SOx	21.5	18.7	2.8	0.178
TOG	223.6	12.7	210.9	1.003
Ventura County				
CO	328.7	11.2	317.5	10002
NOx	76.5	18.2	58.3	1.187
SOx	8.3	0.9	7.5	3.894
TOG	104.5	3.0	101.4	10.32

Table 3.2. Emission summaries for the year 1999. The adjustment factor was required to adjust the scaled 1990 emissions to the 1999 emission summary total for each county.

County Total (ton)	Point Source (ton)	Area Source (ton)	Adj. Factor
Santa Barbara County			
CO	207.7	21.1	186.6	0.951
NOx	46.1	16.0	30.1	0.815
SOx	21.5	18.7	2.8	0.181
TOG	226.0	13.2	212.8	1.001
Ventura County			
CO	280.2	11.7	268.5	1.004
NOx	71.3	19.6	51.6	1.221
SOx	8.6	0.9	7.7	3.569
TOG	102.7	3.2	99.5	1.019

IV. Simulation Results

A. 1984 Base Case Simulation Results

To assess the reasonableness of the approach used to scale the 1990 gridded emission inventory for the years 1984, 1996, and 1999, the simulation results for September 5-7, 1984 were compared with ozone concentrations measured during SCCCAAFP. The peak ozone concentrations measured within the modeling domain were 17.0 pphm on September 6 and 18.0 pphm on September 7. The peak concentration measured in Santa Barbara County was 15.0 pphm on September 7. The peak ozone concentration simulated within the modeling domain on September 6, was 18.5 pphm and on September 7, was 17.6 pphm. The peak simulated ozone concentration within Santa Barbara County was 17.6 pphm. The USEPA (USEPA, 1990) provides guidelines for assessing the over-all performance of photochemical models. For September 6 the peak prediction accuracy was +9%, the normalized bias -17% and the gross error 27%. For September 7, the peak prediction accuracy was -2%, the normalized bias was -6% and the gross error was 29%. Except for the bias on September 6 (-17% versus -15%), these statistical measures of model performance meet the USEPA performance guidelines.

B. Year 1996 and 1999 Simulation Results

To project expected maximum ozone concentrations -in Santa Barbara County for the year 1999, simulations were run for the September 5-7, episode using the 1996 and 1999 emission inventories and boundary conditions. For 1996, the peak simulated ozone concentration in Santa Barbara County was 14.8 pphm. For 1999, the peak simulated ozone concentration in Santa Barbara County was 14.2 pphm. For both years, the peak concentration was simulated on September 7. Thus, between 1996 and 1999, the peak simulated ozone concentration was reduced approximately 4%.

V. Attainment Demonstration

The simulated peak ozone concentrations in Santa Barbara County showed a reduction of 4% between 1996 and 1999. The measured design value for ozone in Santa Barbara County was 13.0 pphm for 1996. Based on the simulation results, the projected design value in Santa Barbara County for the year 1999 is 12 pphm (12.47) which can be considered attainment of the 1-hour federal ozone standard.

VI. References

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