APPENDIX A

ASSESSMENT METHODOLOGY

Introduction

Costs

Benefits

Other Socioeconomic Impacts

INTRODUCTION

The socioeconomic assessment of the 2007 AQMP is divided into three segments: costs, benefits, and employment and other impacts. The following describes how each segment is assessed.

COSTS

Table A-1 lists the 42 short- and long-term stationary and mobile measures in the 2007 AQMP and shows, for each measure, whether cost data is available. Cost data is not available for those measures where control methods are unknown, or affected sources cannot be identified.

Quantifiable Control Costs

Cost data have been developed for 33 of the control measures listed in Table A-1. Direct costs from complying with the requirements of control measures include capital expenditures on control equipment, annual operating and maintenance costs for the equipment, costs of low-polluting (e.g., reformulated) materials, and potential savings related to new requirements. Investments in transportation projects, their annual operating and maintenance costs, and the resulting savings in automobile operating and maintenance costs from these projects are also accounted for. Capital costs are annualized based on a 4 percent real interest rate and the economic life of the equipment or project.

Cost estimates for SCAG transportation control measures were provided by SCAG. For measures under the CARB and EPA jurisdictions, cost estimates were developed based on the assumptions provided by CARB. Control cost estimates for all other measures were based on information from equipment vendors, raw material manufacturers, and affected industries.

Projected Control Costs

Cost effectiveness, which represents the cost to reduce a ton of pollutant, was estimated for each control measure with data on costs and emission reductions. For measures that reduce emissions from more than one pollutant, emission reductions from one-seventh of CO and all the other pollutants were summed (CARB, 1990). This total emission reduction number was then used to calculate the proportion of emission reductions for the associated control measure within a source category. The weighted cost effectiveness by source category was then computed by summing the products from multiplying cost effectiveness by the proportion across all the measures in that source category.

The annual costs of unquantifiable measures were approximated by multiplying the weighted cost effectiveness by the emission reductions from respective years from the unquantifiable measures as they are implemented.

TABLE A-1
2007 AQMP Control Measures

Control Measure No.	Control Measure Title	Cost Data Available	No Cost Data
SHORT-TERM MEASURES			
	District Jurisdiction		
BCM-03	Emission Reductions from Wood Burning Fireplaces and Wood	X	
BCM-05	PM Emission Reductions from Under-fired Charbroilers	X	
CMB-01	NOx Reduction from Non-RECLAIM Ovens, Dryers, and Furnaces	X	
CMB-02	RECLAIM SOx Reductions	X	
CMB-03	NOx Reductions from Residential Space Heaters	X	
CTS-01	Industrial Lubricants	X	
CTS-03	Consumer Products Labeling	X	
FUG-02	Emission Reductions from Gasoline Transfer and Dispensing	X	
MCS-01	Facility Modernization	X	
MCS-05	Non-Dairy Livestock Waste		
EGM-01	Emission Reductions from New & Re-Development Projects	X	
FLX-02	Petroleum Refinery Pilot Program	X	
	CARB & EPA Jurisdiction		
ARB-ONRD-01	Smog Check Enhancements	X	
ARB-ONRD-02	Expand Vehicle Retirement	X	
ARB-ONRD-03	Modifications to Reformulated Gasoline Program		X
ARB-ONRD-04	Cleaner In-Use Heavy-Duty Trucks	X	
ARB-ONRD-05	Port Truck Modernization	X	
ARB-OFFRD-01	Marine Vessels-Fuel, Auxiliary & Main Engines	X	
ARB-OFFRD-02	Accelerated Introduction of Cleaner Line-Haul Locomotives	X	
ARB-OFFRD-03	Clean Up Existing Harbor Craft	X	
ARB-OFFRD-04	Cleaner In-Use Off-Road Equipment	X	
ARB-OFFRD-05	New Emission Standards for Recreational Boats	X	
ARB-OFFRD-06	Expanded Off-Road Recreational Vehicle Emission Standards	X	
ARB-CONS-1	Consumer Products		X
SCONRD-1	Accelerated Penetration of ATPEVs and ZEVs	X	
MOB-5	ARB 923 Light-Duty Vehicle High-Emitter Identification	X	
MOB-6	ARB 923 Medium-Duty Vehicle High-Emitter Identification	X	
SCONRD-2	Deployment of OBD-III in Light/Medium-Duty Vehicles	X	
SCONRD-3	Further Emission Reductions from On-Road Heavy-Duty Vehicles	X	
SCONRD-4	Further Emission Reductions from Port Trucks	X	
SCOFRD-1	Construction/Industrial Fleet Modernization	X	
SCOFRD-2	Cargo Handling Equipment	X	
SCOFRD-3	Further Emission Reductions from Locomotives	X	
SCOFRD-4	Emission Reductions from Ground Support Equipment	X	
SCOFRD-5	Further Emission Reductions from Truck Refrigeration Units	X	
SCOFRD-6	Accelerated Turnover Pleasure Craft	X	
SCFUEL-1	California Phase III Reformulation Gasoline	X	
SCFUEL-2	Greater Use of Diesel Fuel Alternatives & Reformulation	X	
	SCAG Jurisdiction		
TCM-1A	High Occupancy Vehicle Measures	X	
TCM-1B	Transit and System Management Measures	X	
TCM-1C	Information-based Transportation Strategies	X	
LONG-TERM MEASURES			
SCLTM-03	Further Reduction from Consumer Products		X
LTM-04	Phase II Gasoline Fuels		X
LTM-05	Phase II Diesel Fuel Alternatives		X
SCLTM1-2	NOx Black Box		X

BENEFITS

Better air quality will improve visibility and reduce adverse impacts to human health, building materials, crops, and livestock. Some of these effects can be measured and are quantified in monetary terms relative to the baseline “no additional control” scenario for key benchmark years.

Quantifiable Benefits

The benefits of better air quality in terms of improved human health, reduced damage to building materials and crops, and improved visibility were estimated based on previously published studies. The methodologies used for the Socioeconomic Report are discussed below.

Health

Based on numerous epidemiology studies published in recent years, concentration-response functions linking ambient $PM_{2.5}$ and ozone concentrations with observed health effects were selected (Deck and Chestnut 2006). Epidemiology studies use data on the reported incidence of disease and attempt to discern an association with the concentration of ambient air pollutants measured at the time. The greater breadth of the recent epidemiology literature allows the characterization of more health effects than was possible in the past. New concentration-response relationships for ozone and $PM_{2.5}$ were developed and a new health benefits model, BenMAP, was used for the health benefits analysis.

The modeling results from the CAMx Model (Comprehensive Air Quality Model with Extensions) were used for attainment demonstration (see Appendix V of the 2007 AQMP). The CAMx model projects air quality improvements at each geographic grid cell from implementing the 2007 AQMP as compared to the baseline conditions absent such additional control. To estimate health benefits, the results from the CAMx model were fed into the BenMAP model. The BenMAP model calculates the increased or decreased exposure of the four-county area’s population to $PM_{2.5}$ and ozone from the 2007 AQMP, compared to baseline projections of these pollutants. These comparisons were made for the years 2014 and 2020 for $PM_{2.5}$, and the years 2009, 2012, 2020, and 2023 for ozone, using projected population by age cohort and gender from REMI (adjusted to the SCAG forecast) and ethnic distribution from the 2000 Census. The projected change in exposure to $PM_{2.5}$ and ozone brought about by implementing the 2007 AQMP was then used in the concentration-response functions for changes in specific health effects, including mortality. Finally, the dollar value (in terms of willingness to pay to avoid a health effect or cost of treating an illness) was used to estimate monetary value for health effects.

Visibility

The benefits associated with improved visibility were estimated by using a percentage of the public’s willingness to pay for improved visibility as determined through housing prices (Beron et al., 2001). This study was conducted at the census tract level and based on matching housing sales data with air quality data and neighborhood statistics in the 2000 Census in the four-county area. The average willingness to pay per household for visibility improvements reflects the household income net of housing cost, education, and visibility improvements in each tract.

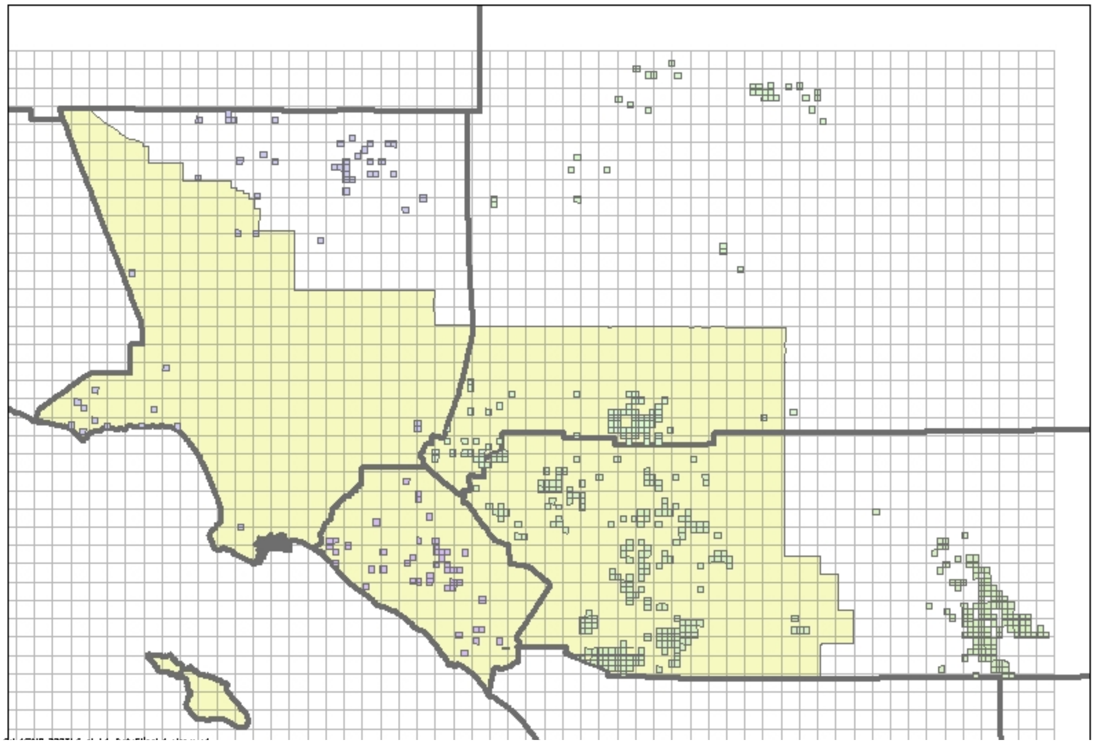
For the 2007 AQMP, the willingness to pay for visibility improvement was calculated at the sub-county region level for the benchmark years 2014 and 2020. The visibility data at the sub-region level was developed by summing the multiplication of the predicted $PM_{2.5}$ concentration at each grid by the total light extinction coefficient (in $10^{-4}m^{-1}$) at the nearest airport for that grid across all the grids within a sub-region. The trend in household income and education between the 2000 Census at the sub-region level was used to develop the values for these two variables for 2014, 2020 and 2025. The projected number of households at the county level from the SCAG forecast was distributed to sub-regions according to the 2000 Census distribution of households for calculating the total willingness to pay for each sub-region.

The public's willingness to pay as determined through housing prices reflects the value of many benefits including improved health and reduced damage to materials and property as well as improved visibility. In an effort to avoid the double counting of those other benefits and account for the visibility aesthetics only, this analysis attributes only 45 percent of the total willingness to pay factor to visibility. The determination to use a 45 percent factor was based upon a 1994 study prepared by Loehman et al.

Agriculture

The development of increased yield for various crops as a result of better air quality was performed at the grid level. This was made possible by spatially joining the acreage data for each of these crops at the 1-mile by 1-mile grid level with the air quality data at the 5-kilometer by 5-kilometer level. The analysis was then brought to the sub-region level by summing the benefits across all the grids within a region. Figure A-1 shows the location of agricultural areas over the air quality modeling grids for the crops of grapes, oranges, lemons, tangerines, beans, field corn, sweet corn, melons, watermelon, potatoes, spinach, tomatoes, cotton, alfalfa, wheat, and avocados.

FIGURE A-1
Location of Agricultural Crops in SCAB



Materials

The material benefit assessment was made at the county level and allocated to sub-regions based on population or household counts. The differences in basinwide peak 1-hour ozone concentrations between base and control cases for the benchmark years 2009, 2012, 2020, and 2023 were used to assess the benefit associated with less frequent replacement of tires (McCarthy et al, 1984). $PM_{2.5}$ concentration data at eight locations was used to estimate the decreased costs of repainting wood and stucco (Murray et al., 1985) and cleaning indoor surfaces (Cummings et al., 1985).

Traffic Congestion Relief

Congestion reduces operating speeds of vehicles, thus resulting in travel delays and increased shipping and storage costs for businesses. Congestion also prevents vehicles from operating under their optimum conditions and thereby increases the operating and maintenance costs of vehicles. Using various studies on congestion costs (SCAG 2004 and Association of Bay Area Governments 2002) and potential reductions in VMT and VHT, congestion benefits in the form of reduced vehicle operating and maintenance expenditures and value of lost time due to the 2007 AQMP were assessed at the sub-region level. Data on reductions in VMT and VHT were provided by SCAG.

Unquantifiable Benefits

Full quantification of health effects is hindered by the lack of known quantitative relationships between pollutant concentrations and the incidence of health effects. In some cases, these quantitative relationships may be known, but the air quality data needed to perform the calculations may be uncertain.

Further establishment of relationships between poor air quality and its damages, as well as the measurement of these damages, is key to quantifying the benefits from improved air quality in the areas of plant life, livestock, building materials, and human health effects. Inadequate data does not allow full assessments to be made at this time. Benefit assessments which incorporate only quantified benefits significantly underestimate the total benefits as a result of implementing the 2007 AQMP.

OTHER SOCIOECONOMIC IMPACTS

As control measures in the 2007 AQMP are implemented, and as industries spend resources to comply with new requirements and transportation infrastructure is built, the four-county economy will be affected. Implementation of the 2007 AQMP could lead to differential impacts on industries at different times.

REMI Model

To estimate potential employment impacts and other socioeconomic impacts (e.g., product prices, cost of production, and income) of quantified measures and benefits, District staff relies on the REMI (Regional Economic Models, Inc.) model. The REMI model is widely used by the U.S. EPA, CARB, other state and local agencies, academicians, and consultants. The REMI model incorporates state-of-the-art modeling techniques and the most recent economic data. The REMI model has been independently evaluated and found to be "technically sound" by the Massachusetts Institute of Technology (Polenske et al., 1992).

The REMI model is built on published data from 1969 to the present with econometrically estimated parameters and can be used to simulate the impact of public policies on the economy of Los Angeles, Orange, Riverside, and San Bernardino Counties. The REMI model allows an assessment of the economic impacts that a policy (such as an AQMP revision or a proposed rule) may cause to each sub-region economy (Figure A-2) for 70 private and public sectors which correspond to three-digit NAICS codes. These impacts include those on jobs, costs of inputs in the production process, personal income, gross regional product, and product prices. A detailed description of the REMI model is provided in Appendix B.

Impact analyses in the REMI model follow a two-step process. First, the national economic projection provided by the Bureau of Labor Statistics (BLS) is used to determine the local baseline economic forecast without any policy change. Second, the direct costs and benefits of a policy are input to the REMI model to generate an alternative forecast for the local economy with the policy. The difference between the baseline and alternative forecasts gives the total effects of the policy. The baseline forecast is recalibrated to ensure consistency with SCAG's population and employment forecasts. Appendix C provides a detailed description of the recalibration process.

FIGURE A-2
Analysis Domain

The assessment of job and other socioeconomic impacts was separately performed for quantified control measures and clean air benefits. This is because only costs associated with 47 percent of required emission reductions for attaining air quality standards were identified. On the other hand, all required emission reductions were used for assessing the clean air benefit. The uncertainty associated with the remaining 53 percent of emission reductions makes the combined assessment of implementing control measures and the resulting clean air benefit less reliable.

Input to REMI

To estimate employment impacts from quantified measures, direct costs associated with each of the control measures were utilized as inputs into the model. Implementation costs of measures were distributed in two ways. First, they were distributed to the regulated industries based on the proportion of emission reductions of these industries by geographic location, as proposed in the 2007 AQMP. These costs are the additional cost of doing business. Second, these costs are additional sales to industries which supply necessary equipment and services. These sales were assumed to occur where the regulated industries are or where emission reductions would take place. The analysis is performed from the implementation year of a control measure to the year 2025.

In addition to the categories already described, a number of benefits from clean air were quantified and input into the REMI model. These benefits are estimated for those benchmark years when air quality data was available. To provide continuous forecast estimates, estimates for years between benchmark years were interpolated linearly. Quantifiable benefits include increased crop yields, improved visibility, reduced damages to materials and health, and relief from traffic congestion. Increased crop yields were converted to increases in farm employment by dividing the value of increased crop yield in each region by the region's value added per farm worker. Visibility improvements and reductions in mortality and morbidity in terms of the willingness to pay and the present value of the future income stream were translated into additional amenities to the four-county area via the migration equation for economic migrants age 65 and below. Reductions in morbidity would lead to reduced health care expenditures by the general public and employers (the cost of illness portion only). The same amount of expenditures was assumed to flow back to the economy in the form of additional spending in other consumption categories. Congestion relief benefits were input as a decrease in the cost of doing business for the trucking and warehousing industry and a decrease in sales for auto repair services. Better traffic flow would result in reduced demand for transportation services. Consumers were assumed to re-spend the savings from vehicle operation and maintenance on other consumer goods. The congestion relief benefit to the owners of light-duty/passenger vehicles and commuters and the material benefit accrued to residents were translated into additional amenity benefits.

Output from REMI

To assess the impacts on socioeconomic groups, the impacts on product prices identified by the REMI model were overlaid on consumption patterns of various income groups to examine the changes in consumer price indexes of these income groups. The data on consumption patterns are from the Bureau of Labor Statistics' Consumer Expenditure Survey.

To assess the impacts of a policy on the competitiveness of the four-county region, the following factors were evaluated: the region's share of national jobs in those industries whose products are also sold in the national market, the impacts on product prices and cost of production by industry, and the changes in imports and exports. These factors were selected based on a review of effects of past public policies on a region's competitiveness.