A P P E N D I X A

A S S E S S M E N T M E T H O D O L O G Y

Introduction

Costs

Benefits

Other Socioeconomic Impacts

INTRODUCTION

The socioeconomic assessment of the 2003 AQMP is divided into three segments: cost, benefit, and employment and other impacts. The following describes how each segment is assessed.

COSTS

Table A-1 lists, in the draft final 2003 AQMP, the 40 short- and long-term stationary and mobile measures 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

Of the 36 short- and long-term measures (Table A-1), cost data have been developed for 31. Additionally, costs are quantified for control strategies in the area of on-road heavy duty trucks, harbor craft and ocean-going ships, and jet aircraft (part of Tier II of Long-term Measure). In some cases, costs are estimated for combined measures.

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 equipment or a project.

Cost estimates for SCAG transportation measures are provided by SCAG. For measures under the CARB and U.S. EPA jurisdictions, cost estimates were developed based on the assumptions provided by ARB. Control cost estimates for all other measures are 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 developed by respective agency 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 reductrion number was then used to calculate the proportion of emissions 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 measure were approximated by multiplying the weighted cost effectiveness by the 2010 emission reductions from the unquantifiable measures.

TABLE A-1

Draft Final 2003 AQMP Control Measures

Control Measure No.	Control Measure Title	Cost Data Available	No Cost Data
SHORT-TERM MEASURES			
	AQMD Jurisdiction		
CTS-07	Further Emission Reductions of Architectural Coatings (R1113) (VOC)	X	
CTS-10	Misc. Industrial Coating & Solvent Operations (VOC)	X	
FUG-05	Emission Reductions from Fugitive Emission Sources (VOC)	X	
CMB-07	Emission Reductions from Petroleum Refinery Flares (SOx)		1
CMB-09	Emission Reductions from Petroleum FCCU (PM10, PM2.5, NH3)	X	
CMB-10	Additional NOx Reductions for RECLAIM	X	
BCM-07	Further PM10 Reductions from Fugitive Dust Sources (PM10)		2
BCM-08	Aggregate & Cement Plant Manufacturing Operations (PM10)	X	
PRC-03	Emission Reductions from Restaurant Operations (PM10)	X	
PRC-07	Industrial Process Operations (VOC)	X	
WST-01	Emissions Reductions from Livestock Waste (VOC, NH3)	X	
WST-02	Emission Reductions from Composting (VOC, NH3, PM10)	X	
MSC-05	Truckstop Electrification (ALL)	X	
	CARB & US EPA Jurisdiction		
CONS-1	Set New Consumer Product Limits for 2006	X	
CONS-2	Set New Consumer Product Limits for 2006-2010	X	
FVR-1	Recover Fuel Vapors from Above Ground Storage Tanks	X	
FVR-2	Recover Fuel Vapors from Gasoline Dispensing at Marinas	X	
FVR-3	Reduce Fuel Permeation through Gasoline Dispenser Hoses	X	
L/M DUTY-1	Replace/Upgrade Emission Control System on Existing Passenger Vehicles	X	
L/M DUTY-2	Smog Check Improvements	X	
ON-RD HVY DUTY-1	Community-based Truck and Bus Highway Inspections	X	
ON-RD HVY-DUTY-2	Capture and Control Vapors from Gasoline Cargo Tankers	X	
ON-RD HVY DUTY-3	Clean up Existing Truck/Bus Fleet (CARB Portion Only)	X	
OFF-RD CI-1	Clean up Existing Heavy-Duty Off-Road Equipment Fleet	X	
OFF-RD CI-2	Register & Inspect Existing Off-Road Equipment to Detect Excess Emissions		1
OFF-RD LSI-1	Lower Emission Standards for New Off-Road Gas Engines	X	
OFF-RD LSI-2	Clean up Existing Off-Road Gas Equipment Through Retrofit Controls	X	
OFF-RD LSI-3	Require New Forklift Purchases & Rentals to be Electric	X	
SM OFF-RD-1	Lower Emission Standards for Handheld Lawn & Garden Equipment	X	
SM OFF-RD-2	Lower Emission Standards for Non-Handheld Lawn & Garden Equipment	X	
MARINE-1	Clean up Existing Harbor Craft Fleet	X	
	SCAG Jurisdiction		
TCM-1A	HOV Interventions	X	
TCM-1B	Transit and Systems Management Interventions	X	
TCM-1C	Information-based interventions	X	
LONG-TERM MEASURES			
LT1	Tier I		3
LT2	Tier II		3

1—Unknown control methods.
2—No emission reductions from these measures are claimed.
3—Unknown sources.

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 control" scenario for the benchmark years as defined in the air quality models.

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 for the 1989, 1991, 1994, and 1997 AQMPs. Those estimates were generally based on previously published studies. The analysis for the draft final 2003 AQMP quantifies the benefits of traffic congestion relief and reduced damage to building materials and crops using the same methodology as past AQMPs, but with updated air quality and economic data. These methodologies are discussed below.

Health

Based on numerous epidemiology studies published in recent years, concentration-response functions are developed linking ambient PM10 and ozone concentrations with observed health effects (Chestnut and Keefe, 1996). 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.

The modeling results from the Urban Airshed Model (UAM) and PM10 Model are used for attainment demonstration (see Appendix V of the draft 2003 AQMP). The UAM and PM10 model project air quality improvements at each geographic grid cell from implementing the 2003 AQMP as compared to the baseline conditions absent such control. To estimate health benefits, the results from the UAM and PM10 model were fed into the REHEX-II (Regional Human Exposure) model. The REHEX-II model calculates the increased or decreased exposure (in person-days per year) of the basin's population to PM10 and ozone from the draft 2003 AQMP, compared to baseline levels of these pollutants. These comparisons were made for the years 2006, 2010, and 2020 for PM10 and the years 2010 and 2020 for ozone, using projected population by age cohort and gender from REMI and SCAG and ethnic distribution from the 1990 and 2000 census.[1] The projected change in exposure to PM10 and ozone brought about by implementing the 2003 AQMP were then used in the concentration-response functions for specific health effects and for mortality. Finally, the dollar value of improved health and reduced mortality (in terms of willingness to pay to avoid a health effect) was used to quantify these benefits.

[1] The air quality models did not produce air quality data for 2020 as a result of implementing the draft 2003 AQMP. For the purpose of the socioeconomic assessment, the 2010 air quality data was used for 2020. A 2020 baseline based on today's control had to be generated in order to assess the benefit of additional control for that year.

Visibility

The benefits associated with improved visibility are 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 1980 and 1990 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.

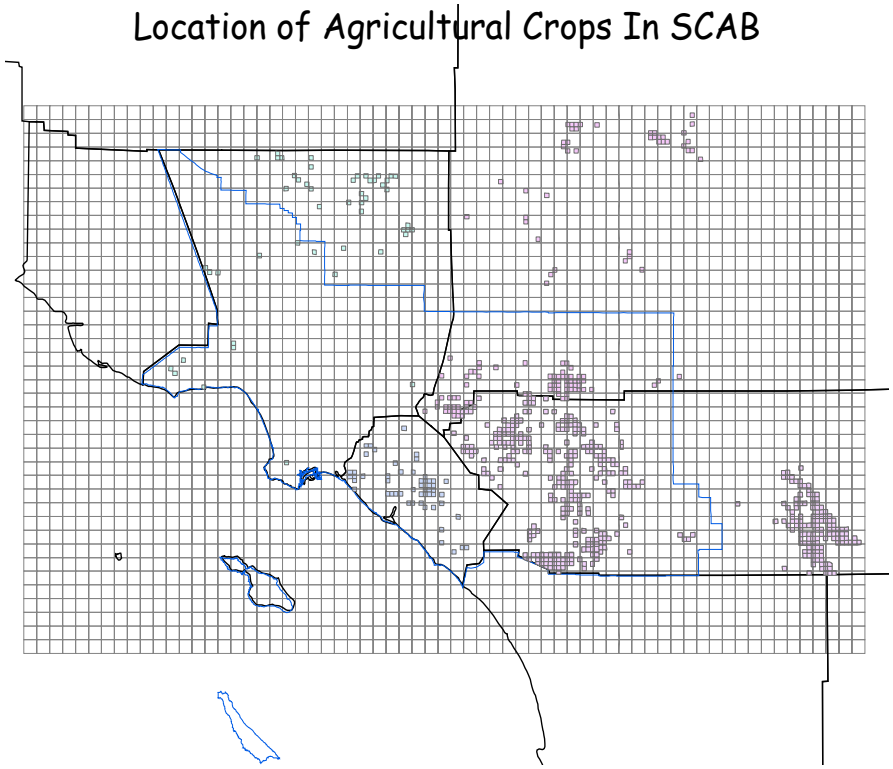
For the draft final 2003 AQMP, the willingness to pay for visibility improvement was calculated at the sub-county region level for the benchmark years 2006, 2010, and 2020. The visibility data at the sub-region level was developed by summing the multiplication of the predicted PM10 concentration at each 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 on household income and education between the 1990 and 2000 census at the sub-region level was used to develop the values for these two variables for 2006, 2010, and 2020. The projection of the number of households is taken from the SCAG forecast and distributed to sub-regions according to the 2000 census 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 is 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 gridded 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 mapping of the agricultural area 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



Materials

The methodology used to assess material benefit of clean air for the previous AQMPs is used here. The assessment was made at the county level and allocated to sub-regions based on population or household counts. The basinwide peak 1-hour ozone data (somewhere in South Riverside County) was used to assess the benefit associated with less frequent replacement of tires (McCarthy et al, 1984). PM10 concentration data at five locations were 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, 2002 and Association of Bay Area Governments, 2002) and potential reductions in vehicle miles traveled (VMT) and vehicle hours traveled (VHT), congestion benefits in the form of reduced vehicle operating and maintenance expenditures and value of lost time due to the draft final 2003 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 2003 AQMP.

OTHER SOCIOECONOMIC IMPACTS

As control measures in the 2003 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 2003 AQMP could lead to differential impacts on industries and at different times.

REMI Model

To estimate potential employment impacts and other socioeconomic impacts (e.g., product prices, profits, and income) of quantified measures and benefits, AQMD 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).

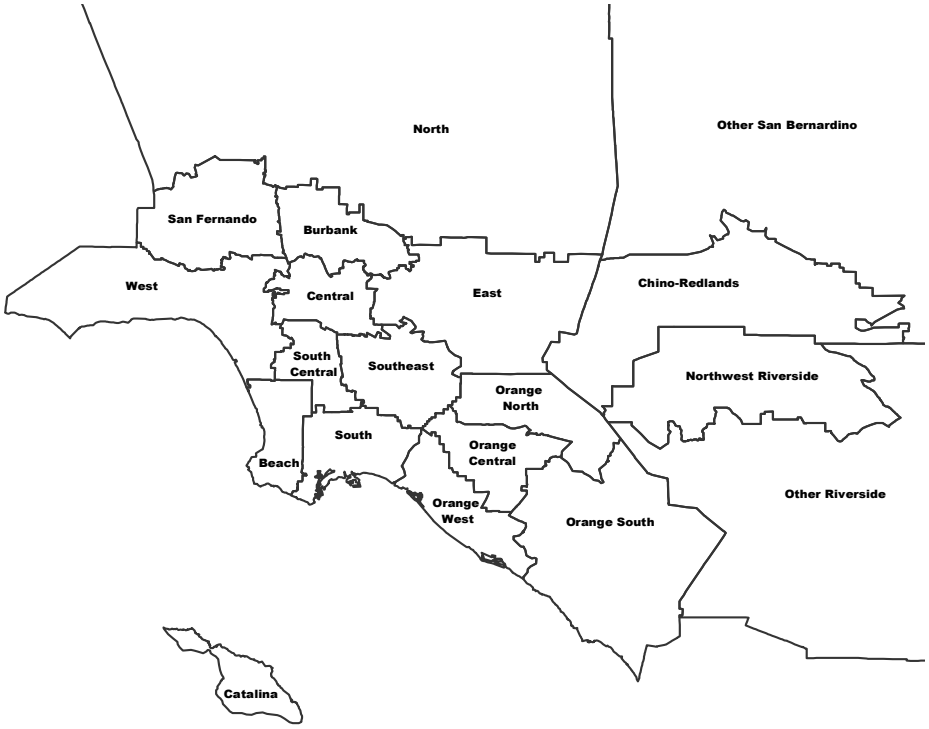
The REMI model is built on published data from 1969 to the present with econometrically estimated parameters and can be used to simulate the impact of public policies on the economy of Los Angeles, Orange, Riverside, and San Bernardino Counties. The REMI model allows an assessment of the economic impacts that a policy (such as an AQMP revision or a proposed rule) may cause to each sub-region economy (Figure A-2) for 53 industries which correspond to two-digit standard industrial classification (SIC) 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 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 30 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 70 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 draft final 2003 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 2020.

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 of traffic congestion. Increased crop yields were divided among cotton, food grains, feed grains, fruits, tree nuts, vegetables, sugar crops, oil-bearing crops, and miscellaneous crops. Visibility improvements and reductions in mortality were translated into additional amenities to the four-county area. Reductions in morbidity would lead to reduced health care expenditures by the general public and employers (the out-of-pocket portion only). The same amount of the expenditures was assumed to flow back to the economy in the form of additional spending on 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 consumption goods. Both the portion of the willingness to pay beyond the out-of-pocket cost in the morbidity benefit for the public and the congestion relief benefit to the owners of light-duty vehicles and commuters were also translates into additional amenities.

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. In addition, the ethnic distribution of the workforce in various industries was adjusted to account for differences in job displacement by ethnic group, based on an extensive literature review and survey data on job displacement and re-employment rates of various ethnic groups (Kletzer and Ong, 1994).

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 profits 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.

A P P E N D I X B

T H E R E M I M O D E L

Introduction
Framework of the REMI Model
Assumptions of the REMI Model
Verification of the Model
Enhancements to the Model

INTRODUCTION

In an effort to expand socioeconomic impact assessments for proposed rules and AQMP revisions, the AQMD has been using a computerized economic model from Regional Economic Models, Inc. (REMI) to assess the socioeconomic impacts on the four-county economy since 1990. The REMI covers the geographic area within the counties of Los Angeles, Orange, Riverside, and San Bernardino. The structure and assumptions of the model are briefly described below.

FRAMEWORK OF THE REMI MODEL

The AQMD's REMI model links the economic activities in the counties of Los Angeles, Orange, Riverside, and San Bernardino. The model used for the 2003 AQMP assessment is unique in that each county is further divided to account for the politically, socially, economically, and geographically diversified structure of Southern California economy. There are 11 sub-county regions in Los Angeles County, four in Orange County, two in Riverside County, and two in San Bernardino County. The divisions of the sub-regions were developed in 1996 and based on the 1990 census.

The REMI model in each sub-region is comprised of a standard module, a demographic/migration module, and an input-output module. The standard module has 53 industries (2-digit SIC), 94 occupations, and 25 final demand sectors. The demographic/migration module captures population changes due to births, deaths, and migration; and has 202 age/sex cohorts. The input-output module contains detailed inter-industry relationships for 466 sectors. The input-output module is used to assess the detailed inter-industry effects of a policy change. The effects are then fed into the standard module to allow for the assessment of total effects.

The standard module can be divided into the following five components: (1) production (output); (2) labor and capital demand; (3) population and labor supply; (4) wages, and prices, and profits; and (5) market share. These five components are interrelated and the linkages are depicted in Figure B-1.

Each component is built upon a two-step process. First, producers and consumers throughout all regions of the country have similar behavioral characteristics. Because of these similarities, statistical techniques can be used to estimate economic responses based on studies done throughout the United States. The second step of the modeling process is region specific, and involves calibration of the model based on region-specific historical data.

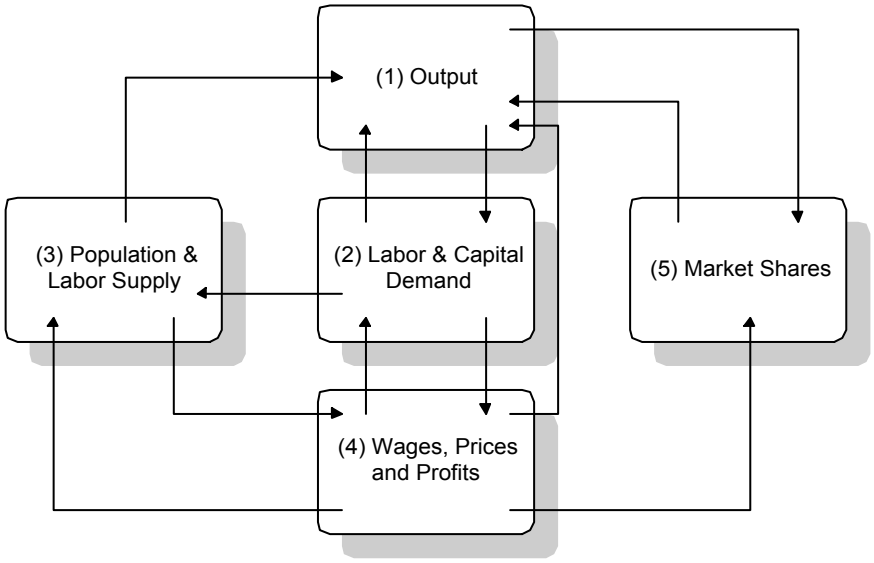
ASSUMPTIONS OF THE REMI MODEL

The REMI model has been built based on well-established economic theory and is updated regularly to incorporate new findings in economic theory and new historical data. Major assumptions behind the REMI model fall into the following three categories: overall,

production, and population and labor. The major assumptions behind the REMI model are as follows.

FIGURE B-1

Components of REMI Model



Overall

1. Production costs, such as capital equipment, labor and fuel, are allowed to be substituted based on the changes in relative costs of these inputs to those in the United States. Total production costs are the sum of input costs weighted by their usage.

2. Location of a firm is driven by profitability.

3. All industries sell to both local and national markets. The model calculates the proportions of local demand that an industry can satisfy and its export share. Exports are divided into shipments from one county to the remaining counties (e.g., counties of Los Angeles, Orange, Riverside, and San Bernardino) and sales outside of the four-county region.

4. For pricing purposes, industries are classified as national or regional. Goods sold in national markets must be priced at the average national price to be competitive. National industries, on average, supply more than 50 percent of their output to national markets. Regional industries sell more than 50 percent of their output locally. The national industries in the model are hotels and manufacturing sectors with the exception of stone, clay, and glass; printing and publishing; and petroleum and coal products. The regional industries consist of mining, construction, finance, wholesale and retail trade, services (except hotels), and agriculture.

5. The REMI model consists of exogenous and endogenous economic variables. Values of exogenous variables are determined outside of the model. Exogenous variables are a driving force of change in the regional economy. The resulting changes are reflected in the values of endogenous variables calculated by the model. Therefore, policy changes can be simulated by changing exogenous variables whose values are developed by District staff as inputs to the REMI model. For example, increases in demand for control equipment due to a rule can be simulated by increasing the sales of the supplier of control equipment. The impact of such a policy change includes changes in employment, among others.

6. There will be two avenues for market expansion. First, as the cost of production decreases, firms become more competitive in the export market and more competitive with imports. Second, markets are assumed to expand as a region's economy grows.

Production

1. Production costs affect regional competitiveness which impacts the shares of local and export markets. As the relative production costs increase, there will be a reduction in the proportion of local demand which can be satisfied locally as imported goods are substituted for local goods.

2. Production levels drive labor demand which interacts with labor supply to determine wage rates. Combined with other production costs, e.g., capital and fuel costs, wages determine relative production costs in the four-county region compared to the rest of the United States.

3. Production levels are determined by the total demand which consists of consumption, investment, government spending, and net exports. Employment is determined by the level of production and labor intensity, i.e., number of employees per unit of production.

4. An increase in demand will increase production by a factor greater than one because of indirect impacts.

Population and Labor

1. There are four types of migrants: international migrants, retired migrants, former military personnel, and economic migrants. These economic migrants are individuals moving to the region for employment opportunities. They respond to both economic and amenity factors.

2. The demographic section of the model predicts the number of births and deaths that occur in the population. Labor supply is derived from the indigenous labor force and potential job migrants.

3. Labor is segmented by occupation as well as by industry. Employment within an industry is translated to occupation level employment through the use of occupational skill requirements by industry.

VERIFICATION OF THE MODEL

The REMI model for the Southern California geography was independently evaluated by the University of Pittsburgh in 1989 to determine its forecasting and simulation capabilities. The model's performance was judged to meet accepted standards of practice (Cassing and Giarratani, 1992).

ENHANCEMENTS TO THE MODEL

The AQMD's socioeconomic assessment process is an evolving one. The assessment has expanded from impacts on directly affected industries to include employment impacts on all industries. In 1992, enhancements were made to the REMI model to allow the assessment of impacts on different income groups and on low- versus high-wage groups.

Using the nationwide median weekly earnings of full-time workers from the 1998 Bureau of Labor Statistics (BLS) Current Population Survey (CPS), 94 occupations in the REMI model were ranked in ascending order of earnings and divided into five equal (quintile) groups. Table B-1 shows how the 94 civilian occupations were ranked:

TABLE B-1

Ranking of Occupational Earnings

Occupation	Median Weekly Earnings	Quintile Group
Private Household Workers	$223	1
Cashiers	$267	1
Farm Occupations	$285	1
Food Prep. & Service Workers	$288	1
Textile & Related Operators	$293	1
Counter & Rent Clerks	$296	1
Stock Clerks, Sales Workers	$296	1
Fishers, Hunters, & Trappers	$302	1
Other Agricultural-related Workers	$302	1
Non-farm Gardeners	$306	1
Non-farm Animal Care Workers	$308	1
Other Sales Workers, Nec.	$311	1
Personal Service Workers	$311	1
Retail Salespersons	$312	1
Health Service Workers	$318	1
Cleaning Workers	$319	1

Table B-1 (Continued)

Occupation	Median Weekly Earnings	Quintile Group
Other Service Workers, Nec.	$327	1
Mail Clerks & Messengers	$346	1
Hand Helpers, Laborers	$351	2
Information Clerks	$367	2
Woodworking Machine Operators	$379	2
Precision Textile, Apparel Workers	$387	2
Communication Equipment Operators	$397	2
Comb. Machine Tool Operators	$399	2
Machine Tool Cut & Form Operators	$399	2
Metal Fabrication Machine Operators	$399	2
Numerical Control Machine Tool Operators	$399	2
Precision Food Workers	$401	2
Other Clerical Workers, Nec.	$401	2
Other Precision Workers, Nec.	$402	2
Precision Assemblers	$402	2
Precision Print Workers	$402	2
Forestry & Logging Occupations	$414	2
Other Machine Operators, Nec.	$416	2
Non-Financial Record Processing Workers	$417	2
Hand Workers	$421	2
Farm Operators & Managers	$424	2
Secretaries, Stenographers, & Typists	$437	3
Recording, Scheduling, and Dispatching Workers	$446	3
Travel Agents	$463	3
Supervisors, Farm, Forest, & Agriculture	$469	3
Adjustment, Investment, & Collections Occupations	$470	3
Precision Woodworkers	$475	3
Metal & Plastic Machine Operators	$475	3
Printing, Binding & Related Workers	$495	3
Health Technicians & Technology Occupations	$502	3
Motor Vehicle Operators	$503	3
Material Moving Operators	$505	3
Other Transportation Operators, Nec.	$510	3
Computer & Related Equipment Operators	$511	3
Construction Trades Occupations	$543	3
Vehicle, & Mobile Equipment Mechanics	$552	3
Soc., Recreation, & Religious Workers	$557	3
Other Mechanical, Installers, Nec.	$584	3
Water & Liquid Waste Occupations	$586	3
Communication Equipment Mechanics, Installers	$597	4
Protective Services Occupations	$598	4
Blue Collar Workers Supervisors	$599	4

Table B-1 (Continued)

Occupation	Median Weekly Earnings	Quintile Group
Postal Clerks, & Mail Workers	$603	4
Machinery & Related Mechanics, Installers	$608	4
Precision Metal Workers	$610	4
Financial Record Processing Workers	$616	4
Precision Inspectors, Testers	$623	4
Insurance Sales Workers	$629	4
Mining, Quarrying Occupations	$633	4
Oil & Gas Extraction Occupations	$633	4
Other Extraction Occupations, Nec.	$633	4
Engineering & Science Technicians	$638	4
Writers, Artists, Entertainers	$647	4
Management Support Occupations	$660	4
Real Estate Agents	$663	4
Elec. Equip. Mechanics, Installers	$665	4
Teachers, Librarians, & Counselors	$671	4
Chemical Plant & System Operators	$694	5
Electric Power Operators, Distribution Workers	$694	5
Gas & Petroleum Plant Workers	$694	5
Other Plant & System Operators, Nec.	$694	5
Stationary Engineers	$714	5
Other Technicians	$738	5
Health Assessment & Treatment Occupations	$738	5
Life Scientists	$739	5
Managerial and Administrative Occupations	$755	5
Social Scientists	$758	5
Secur. & Fin. Srvcs. Workers	$758	5
Other Professional Workers, Nec.	$763	5
Physical Scientists	$828	5
Water Transportation Workers	$849	5
Rail Transportation Workers	$849	5
Architects & Surveyors	$872	5
Computer, Math., and Operations Research Analysts	$938	5
Engineers	$992	5
Health Diagnosing Occupations	$1,134	5
Lawyers	$1,209	5
Judges, Magistrates	$1,218	5

Nec. means not elsewhere classified.

In doing so, the percentage changes of a policy on each quintile of earnings can thus be reported for occupational wage rate, employment, and wage bill.

The ES-202 data (excluding self-employment) from the BLS for the four-county area provides the average annual wage per worker (full-time and part-time) for the 49 private non-farm industries at the 2-digit SIC level in the REMI model. By ranking the 49 industries in ascending order of the average annual wage per worker, we can divide them into five equal groups, as shown in Table B-2:

TABLE B-2

Ranking of Wages by Sector

Sector	SIC	Average Annual Wage	Quintile Group
Personal Services & Repair	72,76	$8,470	1
Agri., Forest, Fish.,Hunt. Services	7-9	$11,918	1
Eating & Drinking Places	58	$12,202	1
Private Households	88	$12,330	1
Real Estate	65	$15,280	1
Auto Repair/Services/Parking	75	$17,850	1
Rest of Retail	52-57,59	$18,056	1
Amusement & Recreation	79	$18,087	1
Education	82	$18,262	1
Apparel	23	$18,504	1
Local Transit/Interurban Transport.	41	$18,989	2
Hotels	70	$19,127	2
Leather	31	$20,273	2
Non-profit Organizations	83	$21,219	2
Trucking	42	$21,853	2
Furniture	25	$22,146	2
Misc. Manufacturing	39	$22,209	2
Tobacco Manufacturing	21	$22,312	2
Construction	15-17	$22,365	2
Lumber	24	$23,010	2
Textiles	22	$25,284	3
Misc. Business Services	73	$26,553	3
Fabricated Metal	34	$29,288	3
Stone, Clay, etc.	32	$30,423	3
Other Transportation	46,47	$30,887	3
Rubber	30	$31,010	3
Motor Vehicles	371	$32,139	3
Medical	80	$32,391	3
Food	20	$32,791	3
Primary Metals	33	$32,828	3
Printing	27	$34,099	4
Misc. Professional Services	81	$35,704	4
Air Transportation	45	$36,017	4

TABLE B-2 (CONTINUED)

Sector	SIC	Average Annual Wage	Quintile Group
Wholesale	50,51	$39,295	4
Mining, Oil/Gas Extraction	10,12-14	$40,276	4
Credit & Finance	61,62	$40,436	4
Paper	26	$40,661	4
Insurance	63,64	$46,186	4
Chemicals	28	$46,828	4
Communications	48	$48,830	4
Electrical Equipment	36	$49,503	4
Rest of Transportation Equipment	372-379	$49,596	5
Motion Pictures	78	$51,680	5
Public Utilities	49	$52,829	5
Non-electrical Mach., Computers	35	$53,485	5
Instruments	38	$55,876	5
Banking	60	$56,075	5
Railroad Transportation	40	$56,683	5
Petroleum Products	29	$81,859	5

The percentage change in employment, wage bill, and wage rate resulting from a policy can thus be reported for each quintile of wages, by sector.

The annual Consumer Expenditure Survey (CEX), published by the BLS, provides a continuous flow of information on the buying habits of American households. The CEX reports average annual expenditures and characteristics of households by income group. There are five income groups: from the households earning the top 20 percent of income to those earning the bottom 20 percent of income.

By linking consumption expenditures in the REMI model with spending patterns of the eight income groups in the CEX, we can then develop a composite price change for consumer goods for each income group.

APPENDIX C

ADJUSTMENT OF THE REMI CONTROL FORECAST

The 2003 AQMP uses SCAG's forecasts on population, employment, and other economic variables for future emission projections (Health and Safety Code Section 40460). The REMI model is used in the AQMP to generate a baseline forecast from which the effects of a policy are evaluated. The REMI and SCAG forecasts use different data inputs and assumptions.

An audit of the AQMD's socioeconomic analysis methods by Massachusetts Institute of Technology recommended further evaluation of the inconsistency between the REMI and SCAG forecasts. AQMD and SCAG commissioned the Center for the Continuing Study of the California Economy (CCSCE, 1994) to determine the sources of inconsistency between these forecasts. The CCSCE recommended a three-step process to ensure consistency between REMI and SCAG forecasts.

- REMI and SCAG should use the same U.S. projections for population and employment
- REMI and SCAG should use the same birth rates by age cohort
- REMI and SCAG models should use similar rates of growth for employment projections

The 2001 release of the REMI model was adjusted in 2001 in preparation for work on the 2003 AQMP. This version of the REMI model has the same U.S. population projections as the SCAG model. The U.S. employment growth is at one percent annually until 2020 in both models. Therefore, no further adjustment to the REMI U.S. forecast is needed.

SCAG's birth rates for four race/ethnicity groups (White, Black, Hispanic, Other) and five-year age cohorts for each of the four counties were incorporated into the REMI model from 1999 to 2020. Birth rates for a particular county were used for its sub-regions.

After such replacement the REMI and SCAG models continued to project different levels of employment due to definitional differences in employment data. The REMI model uses employment data published by the Bureau of Economic Analysis (BEA) while SCAG uses data published by the Bureau of Labor Statistics (BLS). The major difference between these two data sources lies in military personnel and the self-employed. The BEA data include federal military jobs and a much higher estimate of the self-employed than the BLS data. The self-employed are embedded in the estimates of sectoral employment in the BEA but are listed separately from the sectoral employment in the BLS.

Export shares of key local industries were modified in the REMI model to narrow the difference in employment growth rates between the two models. The key industries were those that were major contributors to the difference in employment growth rates at the county level between the two models. The key industries vary by sub-region.

Additionally, a special adjustment was made to the number of migrants entering Los Angeles County to account for the population differences between the two models. Adjustments to the employment growth rates and population were carried out iteratively to ensure that the percentage change in employment for the periods of 1997-2010 and 2010-2020 be consistent between the two models at the county level.

Table C-1 shows the region-wide difference in population between 2010 and 2020 between the unadjusted and adjusted REMI and the SCAG forecasts. Table C-2 compares the employment

growth rates between the unadjusted and adjusted REMI and SCAG forecasts for the periods of 1997-2010 and 2010-2020. The difference of the employment growth rates of the two forecasts is less than one percentage point for the four-county region.

TABLE C-1

Adjusted REMI versus SCAG Population Comparison

	2010			2020		
	U Adj. REMI	Adj. REMI	SCAG	U Adj. REMI	Adj. REMI	SCAG
4-county total	17,040,000	18,084,000	18,016,000	18,307,000	20,077,000	20,124,000
	(-5.42%)	(0.38%)		(-9.03%)	(-0.23%)	

The figures in parentheses are the percentage differences between REMI and SCAG population forecasts.

TABLE C-2

Adjusted REMI versus SCAG Employment Comparison (in percentage growth)

Region	1997-2010			2010-2020		
	U Adj. REMI	Adj. REMI	SCAG	U Adj. REMI	Adj. REMI	SCAG
Los Angeles	24.90%	14.42%	13.50%	6.59%	4.95%	5.44%
Orange	25.39%	35.10%	35.80%	6.63%	10.67%	9.93%
Riverside	27.27%	73.69%	74.08%	9.70%	18.66%	19.61%
San Bernardino	23.65%	62.00%	61.07%	7.87%	17.20%	18.19%
Four County Total	25.06%	26.49%	25.87%	6.92%	8.73%	9.04%

APPENDIX D

GLOSSARY

Air Quality Investment Program (AQIP): An emission reduction option in which monies collected by the AQMD from affected facilities are used to fund emission reduction programs that have been approved by the AQMD Governing Board.

Census of Population: The U.S. Constitution provides for a census of the population every 10 years. The 1990 census includes information on population, household, housing, race and ethnicity, economy, and education.

Acute Health Effect: An adverse health effect that occurs over a relatively short period of time (e.g., minutes or hours).

Acute Respiratory Symptoms: Any respiratory disease-related symptoms including chest discomfort, coughing, wheezing, sore throat, head cold, chest cold, sinus trouble, hay fever, headache and doctor-diagnosed flu.

Air Quality Simulation Model: A computer program that simulates the transport, dispersion, and transformation of compounds emitted into the air and can project the relationship between emissions and air quality.

Ambient Air: The air occurring at a particular time and place outside of structures. Often used interchangeably with "outdoor" air.

APCD (Air Pollution Control District): A county agency with authority to regulate stationary, indirect, and area sources of air pollution (e.g., power plants, highway construction, and housing developments) within a given county, and governed by a district air pollution control board composed of the elected county supervisors. (cf. AQMD).

AQMD (Air Quality Management District): A group or portions of counties, or an individual county specified in law with authority to regulate stationary, indirect, and area sources of air pollution within the region and governed by a regional air pollution control board comprised mostly of elected officials from within the region. (cf. APCD).

AQMP (Air Quality Management Plan): A Plan prepared by an APCD/AQMD, for a county or region designated as a non-attainment area, for the purpose of bringing the area into compliance with the requirements of the national and/or California Ambient Air Quality Standards. AQMPs are incorporated into the State Implementation Plan (SIP).

ARB (California Air Resources Board): The State's lead air quality agency consisting of a nine-member Governor-appointed board. It is responsible for attainment and maintenance of the State and federal air quality standards, and is fully responsible for motor vehicle pollution control. It oversees county and regional air pollution management programs.

Asthma Symptom Days: Days in which asthma symptoms are present in asthmatic individuals.

CAA (Federal Clean Air Act): A federal law passed in 1970 and amended in 1977 and 1990 which forms the basis for the national air pollution control effort. Basic elements of the act include national ambient air quality standards for major air pollutants, air toxics standards, acid rain control measures, and enforcement provisions.

Cardiac Hospital Admissions: Hospital admissions due to heart-related ailments or disease.

CCAA (California Clean Air Act): A California law passed in 1988 which provides the basis for air quality planning and regulation independent of federal regulations. A major element of the Act is the requirement that local APCDs/AQMDs in violation of the CAAQS must prepare attainment plans which identify air quality problems, causes, trends, and the actions to be taken to attain and maintain California's air quality standards by the earliest practicable date.

CEQA (California Environmental Quality Act): A California law which sets forth a process for public agencies to make informed decisions on discretionary project approvals. The process aids decision makers to determine whether any environmental impacts are associated with a proposed project. It requires environmental impacts associated with a proposed project to be identified, disclosed, and mitigated to the maximum extent feasible.

Clean Air Benefits: These are reduced morbidity, avoided mortality, visibility improvements, increased crop yield, traffic congestion relief, reduced spending on refurbishing sensitive building materials, and less damage to plant life and livestock resulting from attaining federal and state air quality standards.

CO (Carbon Monoxide): A colorless, odorless gas resulting from the incomplete combustion of fossil fuels. Over 80% of the CO emitted in urban areas is contributed by motor vehicles. CO interferes with the blood's ability to carry oxygen to the body's tissues and results in numerous adverse health effects. CO is a criteria air pollutant.

Concentration-Response Function: A mathematical relationship derived to calculate the number of cases of a specific health effect expected in a population exposed to a given ambient concentration of an air pollutant.

Chronic Bronchitis: Chronic lung disease characterized by frequent coughing, increased sputum production, and interference with oxygen exchange between air and blood in the lungs of severely affected individuals.

Chronic Health Effect: An adverse health effect which occurs over a relatively long period of time (e.g., months or years).

Consumer Expenditure Survey (CEX): The CEX collects information on the buying habits of American consumers. The survey consists of two components: (1) a Diary survey completed by participating consumers for two consecutive 1-week periods; and (2) an Interview survey in which the expenditures of consumers are obtained in five interviews conducted every 3 months. Each component of the survey queries an independent sample of consumers which is representative of the U.S. population. Over 52 weeks of the year, 5,000 consumers are sampled for the Diary survey. The Interview sample is selected on a rotating panel basis, targeted at 5,000 consumers each quarter.

Current Population Survey (CPS): The CPS provides monthly statistics that serve as measures of both current labor force utilization and the overall performance of the U.S. economy. The information collected from a sample of 60,000 households in the CPS relates to the

employment status of the entire population. For the employed, there are data on hours worked, providing information on the full-time and part-time status of workers, and on their usual weekly earnings. For the unemployed, data routinely are collected on duration of unemployment, the respondent's job status at the time that his or her jobless spell began, and jobseeking methods used. Among those not in the labor force, data are obtained for so-called discouraged workers, who have ceased active job hunting.

Discounted Cash Flow Method: A method to evaluate the present worth of a stream of expenditures in future years. Future expenditures are discounted based on the interest rate and the length of the period in which the expenditures are made.

Disposable Income: It is the sum of the incomes of all the individuals in the economy after all taxes have been deducted.

Dose-Response Function: A mathematical relationship which expresses the likelihood of a connection between exposure to a specific amount of an air pollutant (inhaled dose) and one or more responses elicited by the exposure to the specific pollutant. For human health evaluations, responses are health effects, e.g., eye irritations and restricted activity days. For agriculture, the responses are changes in crop yields.

Emergency Room Visits: Visits to emergency rooms by individuals in need of urgent or immediate treatment.

EPA (Environmental Protection Agency): The United States government agency charged with setting policy and guidelines, and carrying out legal mandates for the protection of national interests in environmental resources.

Episodic Model: A photochemical grid model that typically simulates air quality for a 3-5 day period, e.g., the Urban Airshed Model used for the ozone attainment demonstration .

FIP (Federal Implementation Plan): In the absence of an approved State Implementation Plan (SIP), a plan prepared by the EPA which provides measures that non-attainment areas must take to meet the requirements of the Federal Clean Air Act.

Hedonic Prices: Hedonic prices are a method to compute the price of a good that is not traded in the market based on the price of a traded good that has the attribute of the non-traded good. Based on the amount of the attribute, the imputed price of the non-traded good is a fraction of the price of the traded good. For example, air quality is an attribute of real estate.

Mobile Sources: Sources of air pollution such as automobiles, motorcycles, trucks, off-road vehicles, boats and airplanes. (Contrast with stationary sources.)

NAICS Code: The North American Industry Classification System (NAICS) has replaced the U.S. Standard Industrial Classification (SIC) system. NAICS was developed jointly by the U.S., Canada, and Mexico to provide new comparability in statistics about business activity across North America. Economic units that use like processes to produce goods or services are grouped together. NAICS reflects the structure of today's economy in the United States, Canada, and Mexico, including the emergence and growth of the service

sector and new and advanced technologies. NAICS also provides for increased comparability with the International Standard Industrial Classification System (ISIC, Revision 3), developed and maintained by the United Nations.

Nitrogen Oxides (Oxides of Nitrogen, NO_x): A general term pertaining to compounds of nitric acid (NO), nitrogen dioxide (NO_2), and other oxides of nitrogen. Nitrogen oxides are typically created during combustion processes, and are major contributors to smog formation and acid deposition. NO_2 is a criteria air pollutant, and may result in numerous adverse health effects.

Off-Road Mobile Sources: Mobile sources of air pollution (vehicles) which are not authorized to operate on streets and highways. Examples include trains, boats, aircraft, farm equipment, and earthmoving equipment.

On-Road Mobile Sources: Mobile sources of air pollution (vehicles) which are authorized to operate on streets and highways. Examples include passenger cars, trucks, and buses.

Ozone: A strong-smelling, pale blue, reactive toxic chemical gas consisting of three oxygen atoms. It is a product of the photochemical process involving the sun's energy. Ozone exists in the upper atmosphere ozone layer as well as at the earth's surface. Ozone at the earth's surface can cause numerous adverse health effects and is a criteria air pollutant. It is a major component of smog.

Ozone Precursors: Chemicals such as hydrocarbons and oxides of nitrogen, occurring either naturally or as a result of human activities, which contribute to the formation of ozone, a major component of smog.

PIC (Particle-in-Cell) Model: An air quality simulation model that is used to apportion sulfate and nitrate PM10 concentrations to their precursor emissions sources. The PIC model uses spatially and temporally resolved sources of NOx and SOx emissions, with meteorological, physical, and simplified chemical processes, to calculate PM10 contributions .

PM10 (Particulate Matter): Major class of air pollutants consisting of tiny solid or liquid particles of soot, dust, smoke, fumes, and mists. The size of the particles (10 microns or smaller, about 0.0004 inches or less) allows them to enter the air sacs (gas exchange region) deep in the lungs where they may get deposited and result in adverse health effects. PM10 also causes visibility reduction and is a criteria air pollutant.

PM10 Model: Modeling approaches required to assess contributions to primary and secondary PM10. The primary PM10 source apportionment can be accomplished by receptor models and the secondary particles such as sulfate and nitrate can be apportioned to their precursors utilizing the Particle-In-Cell (PIC) dispersion model.

Premature Mortality: Death before the term duration of life expected.

Quantifiable Clean Air Benefits: Clean air is not a commodity exchanged in a market. The contingency valuation method or the hedonic pricing is often used to assess the monetary benefit associated with clean air. There are instances where association

between an effect and clean air (cause) cannot be quantitatively established or is unknown, thus precluding the application of the contingency valuation method or the hedonic pricing. Quantifiable clean air benefits are those benefit categories where monetary values can be placed based on past literature.

REHEX Model (Regional Human Exposure Model): A computer model designed to estimate general population exposures to air pollutants. The model uses air quality data from the Urban Airshed Model as inputs for exposure calculations. The model is structured in a manner that allows for consideration of spatial and temporal variations in concentrations, the variations in human time activity, and the mobility of the population.

REMI (Regional Economic Models, Inc.) Model: The REMI model is an economic and demographic forecasting and simulation model designed to examine the economic and demographic effects resulting from policy initiatives or external events in a local economy. For the socioeconomic analysis of the 2003 AQMP, the REMI EDFS-53 sector model for the 19 sub-regions within the counties of Los Angeles, Orange, Riverside, and San Bernardino is used.

Respiratory Hospital Admissions: Hospital admissions due to respiratory illness.

Restricted Activity Days: Days when activities are either fully or partially restricted due to illness, which include days spent in bed and days missed from work.

ROG (Reactive Organic Gas): A reactive chemical gas, composed of hydrocarbons, that may contribute to the formation of smog. Also sometimes referred to as Non-Methane Organic Compounds (NMOCs) or volatile organic compounds (VOCs).

SIC Code (Standard Industrial Classification Code): The SIC code is used to classify all establishment-based federal economic statistics by industry. The SIC code facilitates the comparability of establishment data in the U.S. economy. The classification covers the entire range of economic activities and defines industries in accordance with the composition and structure of the economy.

SIP (State Implementation Plan): A document prepared by each state describing existing air quality conditions and measures which will be taken to attain and maintain national ambient air quality standards (see AQMP).

Smog: A combination of smoke, ozone, hydrocarbons, nitrogen oxides, and other chemically reactive compounds which, under certain conditions of weather and sunlight, may result in a murky brown haze that causes adverse health effects. The primary source of smog in California is motor vehicles.

SO_2 (Sulfur Dioxide): A strong smelling, colorless gas that is formed by the combustion of fossil fuels. Power plants, which may use coal or oil high in sulfur content, can be major sources of SO_2. SO_2 and other sulfur oxides contribute to the problem of acid deposition. SO_2 is a criteria pollutant.

Stationary Sources: Non-mobile sources such as power plants, refineries, and manufacturing facilities which emit air pollutants. (Contrast with mobile sources.)

UAM (Urban Airshed Model): The three dimensional photochemical grid model used to simulate ozone formation.

VHT: Vehicle Hours Traveled.

VMT: Vehicle Miles Traveled.

Visibility: The distance that atmospheric conditions allow a person to see at a given time and location. Visibility reductions from air pollution are often due to the presence of sulfur and nitrogen oxides, as well as particulate matter.

VOCs (Volatile Organic Compounds): Hydrocarbon compounds which exist in the ambient air. VOCs contribute to the formation of smog and/or may themselves be toxic. VOCs often have an odor. Some examples of VOCs are gasoline, alcohol, and the solvents used in paints.

Willingness to Pay (WTP): WTP is an approach to measuring monetary values of benefits received from non-market goods such as environmental quality. The methods used to arrive at a WTP value include surveys and hedonic price functions.